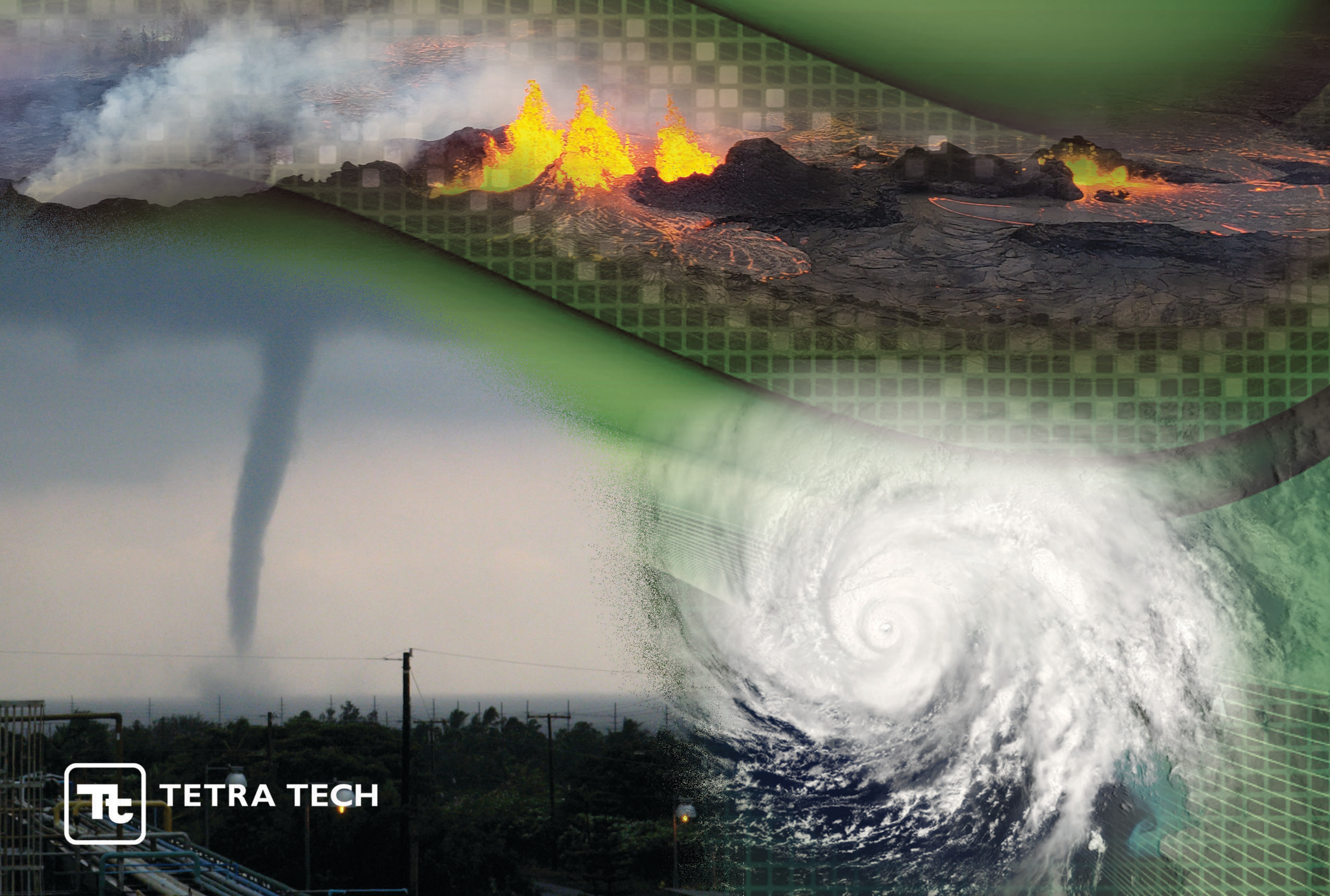
County of Hawai'i Multi-Hazard Mitigation Plan

September 2020



TETRA TECH

County of Hawai‘i Multi-Hazard Mitigation Plan

September 2020

PREPARED FOR

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NOTE:
This document uses spelling for Hawaiian geographic names, including diacritical marks (‘okina or kahakō), as currently included in spreadsheets developed by the Hawai‘i Board of Geographic Names. These are available online at https://planning.hawaii.gov/gis/hbgn/

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ACRONYMS/ABBREVIATIONS

Acronym or Abbreviation	Definition
%g	Percent acceleration force of gravity
44 CFR	Code of Federal Regulations, Title 44
BIISC	Big Island Invasive Species Committee
CARW	Communities at Risk from Wildfires
CDBG	Community Development Block Grant
CDC	U.S. Centers for Disease Control and Prevention
CDP	Community Development Plan
CE	Common Era
CERT	Community Emergency Response Team
CRS	Community Rating System
CWRM	Commission of Water Resource Management
DART	Deep-Ocean Assessment and Reporting of Tsunami
DFIRM	Digital Flood Insurance Rate Maps
DLNR	Department of Land and Natural Resources
DMA	Disaster Mitigation Act of 2000
DOFAW	Division of Forestry and Wildlife Management
DOH	Department of Health
DOT	Department of Transportation
DSCI	Drought Severity and Coverage Index
EMPG	Emergency Management Performance Grant
EMS	Emergency Medical Services
ENSO	El Niño-Southern Oscillation
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
HAR	Hawai‘i Administrative Rules
Hazus	Hazards U.S.
HDOA	Hawai‘i Department of Agriculture
HFO	Honolulu Forecast Office
HIEMA	Hawai‘i Emergency Management Agency
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HSGP	Homeland Security Grant Program
HUD	U.S. Department of Housing and Urban Development
HVO	Hawaiian Volcano Observatory

Acronym or Abbreviation	Definition
IBC	International Building Code
IT	Information Technology
LiMWA	Limit of Moderate Wave Action
MOA	Memorandum of Understanding
MRP	Mean Return Period
NCDC	National Climatic Data Center
NEHRP	National Earthquake Hazards Reduction Program
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PDC	Pacific Disaster Center
PDM	Pre-Disaster Mitigation Grant Program
PGA	Peak Ground Acceleration
PIRCA	Pacific Islands Regional Climate Assessment
ppm	Parts per million
SFHA	Special Flood Hazard Area
SLR-XA	Sea Level Rise Exposure Area
SO2	Sulfur dioxide
SPI	Standardized Precipitation Index
SPS	Sewer Pump Station
UBC	Uniform Building Code
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
USGS	U.S. Geological Survey
vog	Volcanic smog
WUI	Wildland urban interface
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

HAZARD MITIGATION OVERVIEW

Hazard mitigation is the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. The County of Hawai‘i has developed an updated hazard mitigation plan to reduce risks from natural disasters on the island of Hawai‘i. This is a comprehensive update of the hazard mitigation plan that the County of Hawai‘i first developed in 2010 and previously updated in 2015. The plan complies with federal and state hazard mitigation planning requirements to maintain eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

PLAN DEVELOPMENT APPROACH

Organization

A core planning team consisting of a contract consultant and Hawai‘i County staff was assembled to facilitate this plan update. A working group was assembled to oversee the plan update, consisting of both governmental and non-governmental stakeholders. Coordination with other county, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process. Organization efforts included a review of the 2015 *County of Hawai‘i Multi-Hazard Mitigation Plan*, the Hawai‘i statewide hazard mitigation plan, and existing programs that may support hazard mitigation actions.

Public Outreach

The planning team implemented a multi-media public involvement strategy utilizing the outreach capabilities of the County that was approved by the working group. The strategy included public meetings, a hazard mitigation survey, a project website, the use of social media and multiple media releases.

Plan Document Development

The planning team and working group assembled a document to meet federal hazard mitigation planning requirements.

Adoption

Once pre-adoption approval has been granted by Hawai‘i State Civil Defense and FEMA Region IX, the County will formally adopt the updated plan.

RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life resulting from natural hazards, as well as personal injury, economic injury and property damage, in order to determine the vulnerability of people, buildings, and infrastructure to natural hazards. For this update, risk assessment models were enhanced with new data and technologies that have become available since 2015. The working group used the risk assessment to rank risk and to gauge the potential impacts of each hazard of concern on the island of Hawai‘i. The risk assessment included the following:

- Hazard identification and profiling
- Assessment of the impact of hazards on physical, social, and economic assets
- Identification of particular areas of vulnerability
- Estimates of the cost of potential damage.

Based on the risk assessment, hazards were ranked for the risk they pose, as shown in Table ES-1.

Table ES-1. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Ranking Score[a]
High	Wildfire	51
High	Earthquake	51
High	High Windstorms	45
High	Tropical Cyclone	36
High	Flood	33
High	Landslide	33
High	Volcanic Eruption	30
Medium	Climate Change/Sea Level Rise	27
Medium	High Surf/Storm Surge/Coastal Flood	24
Low	Tsunami	10
Low	Dam Failure	6
Low	Drought	6

a. Scores of 30 or greater are rated as “high,” scores of 15 to 29 are “medium,” and scores of less than 15 are “low

MITIGATION GOALS AND OBJECTIVES

The working group established the following goals for the plan update:

1. Utilize state-of-the-art methods and technologies as well as local knowledge to identify hazards, risks, and capabilities.
2. Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly.
3. Protect natural and cultural resources to the extent practicable while mitigating hazards.
4. Promote actions that support land use planning and regulations designed to ensure long-term resiliency.
5. Promote community risk reduction and preparedness through public education, training and awareness.
6. Improve capabilities to implement response protocols and continuity of operations and services.
7. Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of hazards.

The effectiveness of a mitigation strategy is assessed by determining how well these goals are achieved. Objectives were identified that meet multiple goals. The objectives also are used to help establish priorities. The objectives are as follows:

1. Improve warning and emergency communications systems.
2. Conduct studies to determine locations, potential impacts, and links among threats, hazards, and vulnerabilities to support the identification and implementation of mitigation and protection measures in Hawai‘i County.

3. Utilize the best available data, science and technology to identify and communicate the risk exposure to hazards and ways to increase the planning area's capability to prepare for, respond to, recover from, and mitigate the impacts of hazard events.
4. Promote and implement the retrofit, hardening, or replacement of at-risk structures and lifelines to increase community resilience.
5. Support hazard mitigation measures that promote and enhance natural processes and minimize adverse impacts on the ecosystem.
6. Research, develop, promote, adopt and enforce codes and standards that are affordable and feasible for life and property protection.
7. Establish and maintain partnerships among all levels of government, the private sector, community groups, and institutions of higher learning that improve and implement methods to protect life, property and the environment in the planning area.
8. Minimize impacts of hazard events on the economic drivers for the County.
9. Incentivize and implement mitigation measures for hazard risk and repetitive loss areas to address repairs, major alternations, development plans and practices.
10. Integrate local hazard mitigation plans with the general plan other local plans, and provide training and guidance to integrate and strengthen the linkages between the plans.
11. Advance community resilience through preparation, adoption, and implementation of state, county and local multi-hazard mitigation plans and projects.
12. Promote and implement mitigation measures such as fire breaks around communities and along roadways as needed to mitigate the risk of wildland fires.

MITIGATION ACTION PLAN

The County selected mitigation actions to work toward achieving the goals set forth in this plan update. Mitigation actions presented in this update are activities designed to reduce or eliminate losses resulting from natural hazards. The update process resulted in the identification of 31 mitigation actions for implementation, as listed in Table ES-2. The table shows two identified priorities for each action: priority for implementing the action and priority for pursuing grant funding.

IMPLEMENTATION

The working group developed an implementation and maintenance strategy that includes grant monitoring and coordination, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and a recommitment from the County to actively monitoring and evaluating the plan over a five-year performance period.

Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. Hawaiʻi County will assume responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan commits the County to pursue actions when the benefits of a project exceed its costs. The County developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

Table ES-2. Hazard Mitigation Actions

Recommended Action	Implementation Priority	Grant Pursuit Priority
Action HC1—Microwave Network Upgrade. This project involves the hardening of the County’s radio communications system through replacement of the following systems: microwave system, direct current (DC) power system, photovoltaic energy systems, and tower refurbishment.	Medium	High
Action HC2—Public Safety Building Flood Mitigation and Electrical Upgrade. This project will eliminate flooding that endangers the entire electrical system at the Public Safety complex and causes damage in other areas. The electrical system will be upgraded to prevent failure.	Medium	High
Action HC3—IT Data Center. Install a SmartMod 12x45 with a 11x34 utility skit to support the data center that supports critical services for the County currently housed at the Civil Defense building (920 Ululani St., Hilo) and the IT Department building (25 Aupuni St., Hilo).	Medium	High
Action HC4—Wailuku Bridge #1 and Waiānuenue Avenue Bridge Hardening. Wailuku Bridge #1 over Wailuku River on Wainaku Street is an essential part of the traffic network in the area as it serves as a detour or important alternate route for Highway 19. The existing 129-foot, 2 span concrete bridge was built in 1919 and is not in compliance with today’s engineering design standards, specifically in regard to resisting seismic forces.	Medium	High
Action HC5—Generators for Wastewater Treatment Facilities. Install eight stationary generators to service the Hilo Wastewater Treatment Plant (WWTP); Kula‘imano WWTP; Pāpa’ikou WWTP; Wailuku Sewer Pump Station (SPS); Pauka‘a SPS; Wailoa SPS; Onekaakaha SPS; and Kōlea SPS during severe weather events. These facilities experience significant power outages. The installation of generators will mitigate outages during these events.	Medium	High
Action HC6—Emergency Power Transfer Switching Capability for Critical Water Infrastructure. The hardening of the Parker #1, Parker #2, Lālāmilo B, Lālāmilo C, Honoka‘a, Makapala, Wai‘aha, Kahaluu, Queen Lili‘uokalani Trust, Pi‘ihonua #1, Pi‘ihonua #3A and ‘Ōla‘a #3 potable water producing facilities through the purchase and installation of transfer switches and supporting infrastructure (generator tap boxes, junction boxes, conduit, wire, supports, etc.) will allow the County of Hawai‘i Department of Water Supply to better protect the health and welfare of the public.	Medium	High
Action HC7—Waikoloa Reservoir No. 1—Dam Failure Retrofit. The project requires the improvements to address the stability of the embankments as well as the waterproofing of the reservoir itself. The embankments are being improved by widening the base of the embankment and increasing the overall strength supporting the reservoir walls. An underdrain at the toe of the embankment is also being installed to direct groundwater away from the embankment to minimize the chances of liquefaction. Also, waterproofing the reservoir will be accomplished by installing a synthetic liner, which eliminates the possibility of leaks through the numerous cracks in the concrete panels lining the interior of the reservoir.	Medium	High
Action HC8—ArcGIS Data Management, Collection and Tracking. Create an information/data management system to provide actionable information to the planning process during an incident and to capture data for impact statistics and hazard analysis post-incident.	Medium	High
Action HC9—Volcanic Risk Home Buyout Program. Develop and institute a home buyout program that targets eligible properties impacted by lava flows from volcanic eruptions.	Medium	High
Action HC10—Maintain NFIP Compliance. Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance/information on floodplain requirements and impacts.	High	Medium
Action HC11—Maintain CRS Participation. Continue to maintain and enhance (where feasible) the County’s classification under the CRS program.	High	Low
Action HC12—Flood Hazard Needs Assessments. Perform needs assessment and riverine flood studies for Puna, North Kona, and South Kohala to identify flood control projects and for Hāmākua (to figure out what is the real risk associated with landsides).	Medium	High

Recommended Action	Implementation Priority	Grant Pursuit Priority
Action HC13—Wailoa River Bridge Retrofit. Coordinate with the state to upgrade/retrofit Singing Bridge to address chronic coastal flooding and impacts from tsunami. Tsunami project—criticality of the DPW bridge to get retrofitted to prevent isolated populations.	High	Low
Action HC14—Training and Exercise. Augment the County's annual emergency operations training and exercise program with relevant hazard scenario data and models (Hazus) that were developed in support of the risk assessment for this hazard mitigation planning effort.	High	Low
Action HC15—Critical Infrastructure (roads and bridges) needs assessment. Conduct a vulnerability/needs assessment of identified critical roads and bridges that results in the identification of retrofitting projects and identifies critical routes in support of evacuation planning.	Medium	High
Action HC16—Audible Notification Needs Assessment. Conduct a needs assessment that identifies gaps in coverage in the County's audible warning (sirens) system as well as existing systems that need to be replaced and/or updated.	Medium	Low
Action HC17—Rain Gauge Network. Purchase and install rain gauges in the Hāmākua Coast to support landslide and flood risk identification and notification.	Medium	High
Action HC18—Earthquake/Tropical Cyclone Retrofit Incentive Program. Conduct a study to determine the feasibility for the County to deploy an incentive-based program that would encourage private property owners to retrofit their properties against the impacts of earthquakes and tropical cyclones. Key to this study will be a vulnerability analysis that attempts to identify the general building stock within the County that is most vulnerable to these hazards.	High	High
Action HC19—Vulnerable Property Protection. Where appropriate, support retrofitting, purchase or relocation of structures located in hazard areas, prioritizing those that have experienced repetitive losses and/or are located in high- or medium-risk hazard areas.	Medium	Medium
Action HC20——Plan Integration. Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including capital improvement programs, the general plan, recovery plans and strategic plans.	High	Low
Action HC21—Risk Communication. Leveraging existing County public outreach programs, utilize the best available data and science to communicate the risk from all hazards assessed by this plan to the public to promote prevention, preparedness, response, recovery and mitigation actions at the local scale.	High	Low
Action HC22—Damage Assessment Protocol and Capacity Building. Develop protocol for collecting and storing data necessary to develop damage assessments. Research use of drone technology and IT solutions to take footage and convert into assessments.	High	Low
Action HC23—Codes and Policies for Sea Level Rise: Update county codes and policies to require that all coastal development consider and incorporate measures to address sea level rise.	High	Low
Action HC24—Fire Protection: Establish fire breaks around communities and along roadways.	High	High
Action HC25—Shoreline setback for Coastal Erosion: Update county shoreline setback policies to include coastal erosion in order to better regulate development in the high-risk areas	High	Low
Action HC26—Reduce development in high-risk hazard areas: Update and overlay hazard zones and develop conditions for land use and design within high risk zones and within or adjacent to urban growth areas outside of high-risk areas.	High	Low
Action HC27—Evacuation and Sheltering Assessment and Protocol: Perform an assessment of facilities utilized as shelters and identify mitigation needs as well as develop evacuation and sheltering protocol, policies, and procedures.	High	Low
Action HC28—Volcanic Gas Monitoring: Provide training and develop monitoring plan to support gas/particulate monitoring system	High	Low
Action HC29—Emerging Hazards: This plan update was being completed during the COVID-19 pandemic, illustrating the need for the plan to be dynamic and have the flexibility to adapt to emerging hazards that fall outside of the traditional natural hazards targeted in the Disaster Mitigation Act. This action is an open-ended call for the County to adapt this plan as needed through the plan maintenance period to address new and emerging hazards of concern as they affect the Hawai‘i County planning area.	Medium	High

Recommended Action	Implementation Priority	Grant Pursuit Priority
Action HC30—Disaster Distribution System: Develop internal protocol, policies and procedure for logistics, management and resource support during disasters, and develop agreement with state, federal and private partners to implement the plan.	Medium	Low
Action HC31—Mass Gathering Plan: Develop a plan that includes policies, procedures and protocols for conducting mass gathering events with an emphasis on terrorism.	Medium	Low

County of Hawai‘i Multi-Hazard Mitigation Plan

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 THE BIG PICTURE

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects and other steps to reduce the impacts of hazards.

The federal Disaster Mitigation Act (DMA) of 2000 emphasizes planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.2 HAZARD MITIGATION PLANNING FOR THE COUNTY OF HAWAIʻI

The County of Hawaiʻi prepared a hazard mitigation plan in compliance with the DMA in 2010 to help guide and coordinate mitigation activities throughout the county. That initial plan identified resources, information, and strategies for reducing risk from natural hazards. It called for ongoing updates and was last updated in 2015. The 2020 *County of Hawaiʻi Multi-Hazard Mitigation Plan* fulfills the ongoing update requirement. The 2020 hazard mitigation plan update was developed to achieve the following objectives:

- Meet or exceed requirements of the DMA.
- Enable the County to continue using federal grant funding to reduce risk through mitigation.
- Meet the needs of the County as well as state and federal requirements.
- Create a risk assessment of local hazards of concern.
- Meet the planning requirements of the Community Rating System (CRS), so that the County to maintain its participation in the CRS program.
- Coordinate existing plans and programs so that high-priority projects to mitigate possible disaster impacts are funded and implemented.

1.3 WHO WILL BENEFIT FROM THIS PLAN?

All residents and businesses of the County of Hawaiʻi are the ultimate beneficiaries of this update. The plan identifies strategies and actions to reduce risk for those who live in, work in, and visit the County. It provides a viable planning framework for all foreseeable natural hazards. Key stakeholders' participation in development of the plan helped ensure that outcomes will be mutually beneficial. The plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.4 CONTENTS OF THIS PLAN

This hazard mitigation plan is organized into three primary parts:

- Part 1—Planning Process and Community Profile
- Part 2—Risk Assessment
- Part 3—Mitigation Strategy.

Each part includes elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to indicate compliance. The following appendices provided at the end of the plan include information or explanations to support the main content of the plan:

- Appendix A—Public outreach materials
- Appendix B—Detailed hazard maps
- Appendix C—Relevant Federal and State Agencies, Programs and Regulations
- Appendix D—Detailed Assessment of Hawaiʻi County Legal and Regulatory Capabilities
- Appendix E—Hazard Mapping Data Sources and Methods
- Appendix F—Detailed Risk Assessment Results
- Appendix G—Hazard Mitigation Plan Adoption Resolution

2. PLAN UPDATE—WHAT HAS CHANGED

This is the third update to Hawai‘i County's initial 2005 hazard mitigation plan (previously updated in 2010 and 2015). Prior plan updates reconciled changes or enhancements made to the plan as required by the Federal Emergency Management Agency (FEMA) for local hazard mitigation plan updates. This section reconciles changes and enhancements to the 2015 update.

2.1 THE PREVIOUS PLAN

The County of Hawai‘i prepared a hazard mitigation plan that was adopted in 2010. The following factors initiated the initial hazard mitigation planning efforts (County of Hawai‘i, 2015):

- The Island and County of Hawai‘i had experienced 45 natural disaster events since 1977, with six damaging tsunamis since 1940.
- The island is uniquely exposed to major natural hazards due to the following characteristics:
    - ➢ Active volcanoes (lava flow and earthquake hazards)
    - ➢ Young geological age (sheet flow flooding due to undefined drainage-ways)
    - ➢ Land area larger than all the other Hawaiian Islands combined (expansive areas vulnerable to wildfires)
    - ➢ Varied topography dominated by five mountains (complex hurricane wind acceleration patterns)
    - ➢ Southeastern location in the Hawaiian Islands chain (hurricane exposure)
    - ➢ Exposure to distant and local tsunamis.

The initial plan was updated in 2015 and is now undergoing its second comprehensive update in accordance with federal requirements. The 2015 *County of Hawai‘i Multi-Hazard Mitigation Plan* identified the following key hazards of concern (County of Hawai‘i, 2015):

- High windstorms
- Tropical cyclone/hurricane
- Landslide and rock fall
- Earthquake
- Volcanic hazards
- Tsunami
- Flood
- Dam failure
- High surf
- Climate change and coastal erosion
- Drought
- Wildfire
- Hazardous materials

Based on an assessment of risks, the 2015 plan identified 22 mitigation actions to address the identified hazards as follows:

- Tropical cyclones and windstorms—4 actions
- Earthquake—2 actions
- Tsunami—5 actions
- Rainfall flooding and high waves—3 actions
- Volcanic hazards—3 actions
- Droughts and wildfire—3 actions
- Landslides and sea cliff erosion—2 actions

2.2 WHY UPDATE?

2.2.1 Federal Eligibility

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. The Robert T. Stafford Act requires that jurisdictions have current hazard mitigation plans to pursue and receive federal funding.

2.2.2 Changes in Development

Hazard mitigation plan updates must be revised to reflect changes in development within the planning area during the previous performance period of the plan, as stated in 44 CFR Section 201.6(d)(3). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability since the last plan was approved. If no changes in development impacted overall vulnerability, then plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

A forecast of development trends that the County of Hawaiʻi prepared in 2016 estimated about 60 percent growth in housing units and 35 percent growth in non-residential development square footage between 2010 and 2040 (County of Hawaiʻi, 2016). Between the time of the last hazard mitigation plan in 2015 and the most recent available estimates (for 2019), the County planning area experienced a 2.8 percent increase in population. This hazard mitigation plan update assumes that some new development triggered by population since the last plan would have occurred in hazard areas. Because all such new development would have been regulated pursuant to local programs and codes, it is assumed that hazard vulnerability did not increase, although it is possible that an increase in hazard exposure has occurred.

2.2.3 New Analysis Capabilities

The risk assessment for this updated hazard mitigation plan provides more detailed information than the previous plan on exposed population and building counts for each hazard of concern. It focuses on all property and populations in the County, unlike the previous plan's focus on critical facilities and special populations. This update also expands the level of detail in the loss estimate modeling for earthquake, flood, and tropical cyclone. Exposure and vulnerability estimates are presented at the community planning area level in addition to countywide findings. This enhanced risk assessment allows for a more detailed understanding of the County's risk associated with natural hazards.

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

The County used the current update process to make significant changes to the format and content of the hazard mitigation plan. The plan was re-packaged in its entirety to improve readability and to more readily align with DMA and CRS requirements for hazard mitigation plans. A renewed effort was made to establish a plan maintenance and implementation protocol that clearly defines the County's commitment to the plan's ongoing success. Some of the major differences between the current and previous plans are as follows:

- New goals, objectives and mitigation initiatives were developed for the updated plan to more readily align with existing County plans and programs and identified state priorities.
- The list of evaluated hazards was updated based on the most current community experience and concerns.
- A new review was conducted of existing plans and programs that are relevant for hazard mitigation.
- The risk assessment was updated using the best available data, including updated general building stock and critical facility databases.
- Discussion on existing land uses was included for each hazard of concern that has defined extents and locations.
- A new risk ranking protocol was employed to assist in establishing mitigation priorities.
- The protocol for prioritizing actions was updated and included a qualitative benefit-cost review.
- The strategy for plan maintenance and implementation was revised and updated to encourage greater coordination and planning for hazard mitigation funding opportunities.

Table 2-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 2-1. Plan Changes Crosswalk

44 CFR Requirement	2015 Plan Update	2020 Plan Update
§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: **(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;** **(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and** **(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.**	Chapter 2 of the plan provides a description of the planning process. The Plan lays out a development process that includes the following steps: • Establishment of a Working Committee • Data Collection • Analysis • Plan Development • Public Input • Verification, refinement and Public Outreach The 8-member working committee met 4 times over a 7-month time frame to achieve the defined steps.	The plan update was facilitated through a working group made up of stakeholders within the planning area. The Working group was responsible for review of relevant plans and programs, agency coordination, review and identification of goals and objectives, confirmation of a public involvement strategy, development of a plan implementation maintenance strategy, and review and approval of the draft plan. All working group meetings were open to the public. Additional public input was received through several public meetings held early and late in the planning process and through a public survey. A 30-day public comment period was held before the draft plan was submitted for review. Agency coordination occurred through several avenues including the development of the risk assessment and mitigation initiative action plan, the composition of the working group and the dissemination of the draft plan for public comment.

44 CFR Requirement	2015 Plan Update	2020 Plan Update
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The plan profiles 13 identified hazards of concern in Chapters 4 to 16. Chapter 18 of the plan includes a qualitative discussion on vulnerability.	A comprehensive risk assessment for the planning area that looks at 12 hazards of concern: climate change, dam failure, drought, earthquake, flood, high surf/storm surge, high wind, landslide, tropical cyclone, tsunami, volcanic eruption, and wildfire. This assessment used the best available data and science with the Hazus (version 4.2) risk assessment software and GIS analysis.

§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	Chapters 4 through 16, profile 13 identified hazards of concern. Each profile includes discussion of extent and location of the hazard. Each hazard profiles included the following components:
	• Description of Hazard
	• Significant Historical Events
	• Probability of Occurrence
	  • Risk Assessment
	• Mitigation Strategies
	  ○ Previous efforts
	  ○ Future plans
		Comprehensive risk assessments of each hazard of concern are presented in Chapters 7 through 18. Each chapter includes the following:
		• Hazard profile, including maps of extent and location, historical occurrences, frequency, severity and warning time
		• Secondary hazards
		• Exposure of people, property, critical facilities and environment
		• Vulnerability of people, property, critical facilities and natural environment
		• Future trends in development
		• Scenarios
		• Issues
		The hazards are compared to each other via a risk ranking methodology described in Chapter 20.

§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community.	Chapter 18 of the plan includes a qualitative vulnerability assessment of the profiled hazards of concern that addresses the following: • Emergency response capabilities. • Special at-risk populations or areas. • Relationship of land use trends to hazard areas	Vulnerability was assessed for all hazards of concern. The Hazus computer model (version 4.2) was used for the dam failure, earthquake, flood, and tropical cyclone hazards. These were Level-2 (user-defined) analyses using coordinating agency and County data. Critical facilities and assets were defined and inventoried using the Hazus Comprehensive Data Management System and other available datasets. Outputs were generated for other hazards by applying an estimated damage function to affected assets when available. The asset inventory was extracted from the Hazus model. Best available data were used for all analyses.

44 CFR Requirement	2015 Plan Update	2020 Plan Update
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods.	Chapter 10, section 10.3.1 includes a profile on the County's NFIP status as well as discussion on repetitive loss.	The description of the National Flood Insurance Program and repetitive loss discussion was enhanced to meet new DMA and CRS planning requirements. The update includes a comprehensive analysis of repetitive loss properties. For these properties the type of structure was determined and causes of flooding were cited, and the information was reflected on maps. National Flood Insurance Program capability is also assessed.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	The risk assessment in Chapter 18 focuses on critical facilities. The plan includes little or no discussion on the exposure to general building stock in the planning area. Chapter 7 does include average annual loss calculations for the earthquake hazard.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The working group defined "critical facilities" as they pertained to the planning area, and these facilities were inventoried by exposure. Each hazard chapter provides a discussion of future development trends as they pertain to the hazard.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Chapter 18 includes average annual loss calculations for tropical cyclone, earthquake, tsunami, lava flow, flood and rockfall hazards	Dollar loss estimations were generated for all hazards of concern. These were generated by Hazus for the dam failure, earthquake, flood, and tropical cyclone hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in the Hazus model.
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land-use decisions.	Chapters 4-15 include a section on mitigation strategies titled "Future Plans" that attempts to touch on this subject matter. Chapter 18 includes a qualitative discussion on the relationship of land use growth trends to hazard areas.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.	Chapter 19 presents a mitigation strategy that includes the following components: • Mitigation Goals and Objectives • Mitigation Actions by Hazard Type • Priority Criteria • Implementation Plan • Discussion on Past Implementation Actions • Present Implementation Actions	An initiative action plan was developed for Hawaiʻi County (Chapter 23) via a facilitated process that includes: • Risk ranking • Capability assessment • Initiative alternative review • Initiative selection • Initiative prioritization • Initiative category analysis.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	Chapter 19 includes a mitigation strategy that includes mitigation goals and objectives	Chapter 20 identifies 7 goals and 12 objectives. Objectives were selected that meet multiple goals, and initiatives were selected and prioritized based on meeting multiple objectives.

44 CFR Requirement	2015 Plan Update	2020 Plan Update
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	The plan identified a range of future mitigation projects for each hazard. Projects were summarized by hazard type and policy type. The six categories of mitigation (prevention, property protection, public education, natural resource protection, emergency services and capital projects) were discussed, but projects were not sorted using these categories.	A hazard mitigation catalog was developed through a facilitated process that looks at strengths, weaknesses, obstacles, and opportunities in the planning area. A table in the initiative action plan section analyzes each action by mitigation type to illustrate the range of actions selected. This is detailed in Section 23.5.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Section 10.3.1 includes a profile on the County's NFIP status as well as discussion on repetitive loss.	The capability assessment in Section 5.2.6 includes an assessment of capabilities related to NFIP requirements. The action plan in Chapter 23 includes actions supporting continued compliance and good standing under the program..
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Descriptions of future mitigation projects by hazard were included in each hazard profile as well as the mitigation strategy and projects chapter. Identified projects were prioritized using the STAPLEE (social, technical, administrative, political, legal, environmental, and economic) criteria, and projects that passed were subjected to a second set of criteria. Projects were prioritized as high, medium or low. Implementation was discussed in a generalized way. Lead agencies were identified for some projects, but not all. Cost-benefit review was discussed in terms of annualized average losses. However, cost-benefit review was only peripherally tied to identified projects.	Each of the recommended initiatives is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Section 23.4.
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a 5-year cycle.	The plan included a plan maintenance protocol that recommended an ongoing hazard mitigation planning committee intended to meet and produce reports on a quarterly basis to support an annual review.	A detailed plan maintenance strategy, found in Chapter 24, includes the following: • Annual review and progress reporting • Defined role for working group • Plan update triggers • Plan incorporation guidelines • Strategy for continuing public involvement • Grant coordination protocol.
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	The plan did not include this discussion.	This is contained in the detailed plan maintenance and implementation strategy in Chapter 24.

44 CFR Requirement	2015 Plan Update	2020 Plan Update
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The plan maintenance section included discussion of continued public involvement through community-based workshops and symposia. The executive summary stated that the plan would be reviewed annually with input from an organized network of community groups in each district.	This is contained in the detailed plan maintenance and implementation strategy in Chapter 24.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	The plan included a letter of adoption dated August 10, 2015, signed by the County of Hawai‘i Mayor.	Hawai‘i County will seek DMA compliance with this plan update. Chapter 24 contains the adoption resolution.

3. PLAN METHODOLOGY

The process followed to develop this Hawaiʻi County Hazard Mitigation Plan Update had the following primary objectives:

- Form a planning team
- Define the planning area
- Establish a working group
- Coordinate with other agencies
- Review existing programs
- Engage the public.

These objectives are discussed in the following sections.

3.1 FORMATION OF THE PLANNING TEAM

Hawaiʻi County hired Tetra Tech, Inc. to assist with development and implementation of the plan. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to the Hawaiʻi County project manager. A planning team was formed to lead the planning effort, made up of the following members:

- Talmadge Magno, Hawaiʻi County Civil Defense Agency, Civil Defense Administrator
- April Surprenant, Hawaiʻi County Planning Department, Manager of Long-Range Planning
- Barry Periatt, Hawaiʻi County Civil Defense Agency, Administrative Officer
- Bill Hanson, Hawaiʻi County Civil Defense Agency, Administrative Officer
- Rob Flaner, Tetra Tech, Project Manager
- Cindy Rolli, Tetra Tech, Project Planner
- Carol Baumann, Tetra Tech, Risk Assessor.
- Megan Brotherton, Tetra Tech, Planner

3.2 DEFINING THE PLANNING AREA

The planning area was defined as the entire County of Hawaiʻi. For evaluation in this hazard mitigation plan, some analyses were broken down by district, using the boundaries defined for judicial districts in the County.

3.3 THE WORKING GROUP

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A working group was formed to oversee all phases of the plan. The members of this group included key Hawaiʻi County staff, citizens, and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be impacted by its recommendations. The team confirmed a working group of 24 members. Some members chose to designate alternates to attend on their behalf. Table 3-1 lists the working group members.

Table 3-1. Working Group Members

Jurisdiction/Agency	Name	Title
County of Hawai'i Civil Defense Agency		
Primary Member	Talmadge Magno (Chairperson, Spokesperson)	Civil Defense Administrator
Primary Member	Barry Periatt	Administrative Officer
Alternate Member	Bill Hanson	Administrative Officer
County of Hawai'i Planning Department		
Primary Member	April Surprenant (Vice Chairperson, Spokesperson)	Manager of Long-Range Planning
Alternate Member	Bethany Morrison	Planner
Hawai'i County Department of Public Works		
Primary Member	David Yamamoto	Director
Alternate Member	Allan Simeon	Deputy Director
Primary Member	Robyn Matsumoto	Acting Deputy Chief, Building
Primary Member	Bryce Harada	Floodplain Manager
Mayor's Office		
Primary Member	Maurice Messina	Chief of Staff
Hawai'i County Department of Parks and Recreation		
Primary Member	James Komata	Deputy Director
County of Hawai'i Department of Research & Development		
Primary Member	Diane Ley	Director
Alternate Member	Riley Saito	Deputy Director
Hawai'i County CERT		
Primary Member	Patti Pinto	CERT Coordinator
Alternate Member	Pat Steffen	CERT Member
Hawai'i County Department of Finance		
Primary Member	Daniel Chun	Risk Management Officer
Hawai'i County Fire Department		
Primary Member	Robert Perriera	Assistant Fire Chief
Alternate Member	Darren Rosario	Fire Chief
Department of Water Supply		
Primary Member	Keith Okamoto	Manager
Alternate Member	Kurt Inaba	Engineer
Alternated Member	Kawika Uyehara	Deputy
Hawai'i Department of Transportation		
Primary Member	Harry Takiue	Acting DF
Alternate Member	Rob Lee	Engineer
Hawaiian Electric Co.		
Primary Member	David Kurohara	Liaison
Department of Forestry and Wildlife		
Primary Member	Steve Bergfeld	Branch Manager
Spectrum Communications		
Primary Member	Blaine Oyama	System Engineering Manager
Alternate Member	Bob Kamau	Maintenance Technician
Hawai'i Emergency Management Agency (HIEMA)		
Primary Member	Paul Agamata	IT Manager
Department of Health		
Primary Member	Eric Honda	Acting District Health Officer
Alternate Member	Jason Dela Cruz	Public Health Planner

Note: 90 percent of working group members represent government agencies; 10 percent represent non-government interests or groups.

Leadership roles and ground rules were established during the working group’s meeting on December 17, 2019. The working group agreed to meet monthly as needed throughout the course of the plan’s development. The planning team facilitated each working group meeting, which addressed a set of objectives based on the work plan established for the plan update. The working group met five times from October 2019 through April 2020. Meeting agendas, notes, and attendance logs are provided in Appendix A. All working group meetings were open to the public and agendas and meeting notes were posted to the hazard mitigation plan website.

3.4 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). The planning team accomplished this task as follows:

- **Working Group Involvement**—Agency representatives were invited to participate on the working group as indicated above.
- **Public Outreach and Requested Data**—The following agencies assisted with public outreach efforts, provided data that supported the risk assessment portion of the plan, or reviewed the mitigation catalog used for the development of the mitigation initiative action plan:
    - FEMA Region IX
    - Hawai‘i Emergency Management Agency (HIEMA)
    - Hawai‘i State Department of Land and Natural Resources
    - USGS, Hawaiian Volcano Observatory
    - The Pacific Disaster Center (PDC)
    - National Weather Service
    - National Oceanic and Atmospheric Association
    - University of Hawai‘i
- **Pre-Adoption Review**—All agencies listed above were invited to review and comment on this plan during the published public comment period via a direct e-mail. Access to the draft plan was primarily through the hazard mitigation plan website (see Section 3.6). The complete draft plan was sent to the Hawai‘i Emergency Management Agency. After completing its review, HIEMA forwarded the plan to FEMA Region IX for review and approval pending adoption.

3.5 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). The following plans and programs can affect mitigation within the planning area:

- Hawai‘i Hazards Awareness and Resilience Program
- Hawai‘i State Plan
- Hawai‘i State Grants-in-Aid for Capital Improvement Projects
- Hawai‘i State Hazard Mitigation Plan
- Hawai‘i County Capital Improvement Program
- Hawai‘i County General Plan
- Hawai‘i County Municipal Code

An assessment of all Hawaiʻi County regulatory, technical and financial capabilities to implement hazard mitigation initiatives is presented in Chapter 5.

3.6 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). The Community Rating System expands on these requirements by making CRS credits available for optional public involvement activities.

3.6.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Identify and involve planning area stakeholders.
- Include members of the public on the working group.
- Use a survey to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Invite public participation at open-house public meetings
- Attempt to reach as many planning area citizens as possible using multiple media.

Stakeholders and the Working Group

Stakeholders are the individuals, agencies and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan. The effort to include stakeholders in this process included stakeholder participation on the working group. Stakeholders targeted for this process included the following:

- County of Hawaiʻi departments relevant for hazard mitigation planning
- State of Hawaiʻi departments relevant for hazard mitigation planning
- Local disaster-preparedness and relief organizations
- Local utilities.

Survey

The planning team developed a hazard mitigation plan survey with guidance from the working group. The survey was used to gauge household preparedness for natural hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This survey was designed to help identify areas vulnerable to one or more natural hazards. The answers to its 26 questions helped guide the working group in affirming goals and objectives and in the development of mitigation strategies. Multiple methods were used to solicit survey responses:

- A web-based version of the survey was made available on the plan website (see Figure 3-1). A complete copy of the survey is provided in Appendix A.
- Attendees at the public meetings and open houses were asked to complete a survey.
- A press release was distributed to local media urging residents to participate.
- Hawaiʻi County Civil Defense advertised the survey on social media.

Hawai'i County Hazard Mitigation Plan Survey

Hawai'i County Civil Defense and local stakeholders are working together to update the Hawai'i County Hazard Mitigation Plan (HMP). During the course of this update, local leaders and the community are working together to identify risks, assess capabilities, and formulate a strategy to reduce disaster vulnerability.

We want to understand your awareness and knowledge about the natural hazards that affect our communities. We also want to incorporate your recommendations to help residents prepare for hazard events and prevent unnecessary impacts. The following questions will help us look at community demographics, measure how much local citizens already know about disaster-related issues and will help us identify areas where we need to improve. The information you provide will help us organize activities and prioritize projects to reduce the risk of injury or damage to property from future hazard events.

The survey consists of about 26 questions and provides an opportunity to comment. It should take less than 10 minutes to complete the survey and it is anonymous.

Mahalo for taking the time to participate in the 2020 Hawai'i County Hazard Mitigation Plan Survey!

Hawai'i County Hazard Mitigation Plan Survey

1. Where do you live?

- Puna
- South Hilo
- North Hilo
- Hamakua
- North Kohala
- South Kohala
- North Kona
- South Kona
- Ka'u
- I don't live in Hawai'i County

1

Figure 3-1. Sample Page from Survey Distributed to the Public

Public Meetings

Four open-house public meetings were held around the island, all from 6 to 8 pm:

- Aupuni Center Conference Room in Hilo on January 22, 2020
- West Hawai‘i Civic Center in Kailua-Kona on January 23, 2020
- Waimea Community Center in Waimea on January 29, 2020
- Ocean View Community Center in Ocean View on January 30, 2020 in conjunction with the Volcano Awareness Month program by Hawaiian Volcano Observatory (HVO).

The meeting format allowed attendees to examine maps and handouts and have direct conversations with project staff (see Figure 3-2). Reasons for planning were shared with attendees via a brief presentation (see Figure 3-3). Each resident attending the open house was asked to complete a survey, and each was given an opportunity to provide written comments to the working group. Local media outlets were informed of the open house by a press release from the planning team.

Figure 3-2. Hazard Maps at Hilo Open-House Public Meeting (Stephanie Salmons/Tribune-Herald)

Figure 3-3. Hazard Presentation at Ocean View Open-House Public Meeting

Media Outreach

Press Releases

Press releases were distributed over the course of the plan’s development as key milestones were achieved and prior to each public meeting. The planning effort received the following press coverage:

- January 13, 2020 article on HawaiiTribune-Herald.com, “New multi-hazard mitigation plan to help lower risks on Big Island” (https://www.hawaiitribune-herald.com/2020/01/13/Hawai‘i-news/new-multi-hazard-mitigation-plan-to-help-lower-risks-on-big-island/)
- January 14, 2020 article on HawaiiNewsNow.com, “Hawai‘i County to open discussions of hazard mitigation plan” (https://www.hawaiinewsnow.com/2020/01/14/Hawai‘i-county-open-discussions-hazard-mitigation-plan/)
- January 14, 2020 article on USNews.com “Hawai‘i County to Open Discussions of Hazard Mitigation Plan” (https://www.usnews.com/news/best-states/Hawai‘i/articles/2020-01-14/Hawai‘i-county-to-open-discussions-of-hazard-mitigation-plan)
- January 14, 2020 article on HawaiiNewsNow.com, “Latest Hawai‘i news, sports, business and entertainment at 9:20 p.m. HAST” (https://www.hawaiinewsnow.com/2020/01/14/latest-Hawai‘i-news-sports-business-entertainment-am-hast/) (see Figure 3-4).
- January 24, 2020 article on HawaiiTribune-Herald.com “Feedback sought on hazard mitigation plan” (https://www.hawaiitribune-herald.com/2020/01/24/Hawai‘i-news/feedback-sought-on-hazard-mitigation-plan/)

Hawaii County to open discussions of hazard mitigation plan

HILO, Hawaii (AP) — Officials say public meetings have been scheduled to discuss updates to Hawaii County's multi-hazard mitigation plan. The Hawaii Tribune-Herald reported the plan consists of the county's hazard and risk assessment for natural disasters. Officials say the plan includes proposed projects to reduce the potential loss of life and property on the Big Island. Officials say the multi-hazard mitigation plan is required for the county to be eligible for Federal Emergency Management Agency funds and must be updated every five years. Public meetings have been scheduled Jan. 22, 23, 29, and 30 at four Big Island locations.

Figure 3-4. Display of January Press Release on Hawai‘i News Now

Internet

At the beginning of the plan update process, the County created a new hazard mitigation website (https://www.hawaiicounty.gov/departments/civil-defense/multi-hazard-mitigation-plan-2020) to include information about the update process (see Figure 3-5).

Figure 3-5. Sample Page from Hazard Mitigation Plan Website

Throughout the process, the website was used to keep the public informed on milestones and to solicit relevant input. The site's address was publicized in all press releases, mailings, surveys and public meetings. Information on the plan development process, the working group, the survey and phased drafts of the plan was made available to the public on the site throughout the process. Hawai‘i County intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

Public Comment Period

A draft of the hazard mitigation plan was released for public comment during a two-week period from May 18 to June 2, 2020. The planning team provided a press release notifying the public about the review period. The draft was made available on the hazard mitigation plan website. Because the public review period occurred during the stay-at-home period for the Covid-19 pandemic, public opportunity to learn about the plan was provided through an on-line public meeting on May 27. The meeting included a presentation given by a planning team member and information on hazards and general preparedness. Attendees were given the opportunity to provide written or verbal feedback on the draft plan. A recording of the presentation at this meeting was posted on the website.

3.6.2 Public Involvement Results

Survey Outreach

A total of 363 respondents completed the online survey for this plan—358 identified themselves as County residents and 5 identified as non-residents or did not indicate residency. Detailed survey results are provided in Appendix A. Key findings are as follows:

- The primary hazards that residents have experienced in the past 10 years are earthquakes (307 respondents), high windstorm (287 respondents), volcanic eruption (242 respondents), and hurricane (182 respondents).
- Hazards about which the most respondents said they are concerned, very concerned, or extremely concerned are high windstorms (81.4 percent), hurricane (80.3 percent), earthquake (74.7 percent), climate change/sea level rise (67.9 percent), wildfire (67.7 percent), and volcanic eruption (65.5 percent).
- Respondents also indicated concern for hazards not profiled in this plan update or addressed as minor "hazards of interest" (see Section 6.1). These include invasive species, biological threats (dengue, rat lung disease, flu pandemics), missile attacks, cyber terrorism, geothermal gassing, and lack of adequate evacuation routes/detours.
- The majority of respondents consider themselves somewhat prepared for hazard events (48.5 percent). An additional 28.9 percent feel adequately prepared, and 10.6 percent feel well-prepared.
- The most common steps that residents have taken to prepare for a hazard event include the following:

  - Stored flashlights and batteries (81.5 percent)
  - Stored food and water (70.7 percent)
  - Stored medical supplies (first aid kit, medications) (70.7 percent)
  - Stored a fire extinguisher (70.1 percent)
  - Installed smoke detectors on each level of the house (67.9 percent)
  - Subscribed to emergency Civil Defense alerts (67.3 percent)
  - Learned how to turn off utilities, such as power, gas, and water (65.6 percent).

- The greatest number of respondents (80.1 percent) identified the internet as the best way for the County to share preparedness information. The next most popular outreach methods are the Hawaiʻi County Civil Defense website (77.3 percent) and police/fire/EMS (38.5 percent).
- Respondents expect to be notified of an immediate threat primarily by Civil Defense alerts (89.3 percent), radio (58.3 percent), and audible notification systems (49.3 percent).
- Hawaiʻi County residents would prefer more preparedness and awareness information distributed on the following hazards, in order of preference: hurricane, volcanic eruption, high wind storms, earthquake, tsunami, wildfire, and flood.
- Some respondents (25.2 percent) indicated that they do not live in a hazard-prone area. Of the respondents who do, the following hazard-prone areas were the most frequently identified:

  - Earthquake hazard zone (30.5 percent)
  - Wildfire risk area (23.8 percent)
  - Lava zone 3 (20.7 percent)

- Lava zone 2 (14.9 percent).

- The majority of respondents (53.3 percent) indicated that a real estate agent, landlord, or seller did not indicate whether their home was in a hazard zone.
- The most common type of specialty insurance purchased by residents in the County is hurricane insurance (17.1 percent). Earthquake insurance is more common than flood insurance, and some residents have also purchased lava insurance.
- Respondents indicated that insurance premium discounts would be the strongest motivational incentive for taking additional steps to prepare their homes against a hazard. Grant funding for retrofits, a rebate program and mortgage discounts were also popular incentives.
- Respondents cited cost (41.3 percent), followed by lack of knowledge (34.4 percent) as the most reasons for not taking further preparedness steps.
- Respondents' ranked government-sponsored risk reduction projects in the following order of preference:

  - Infrastructure retrofits
  - Retrofits to essential facilities
  - Better public information about risk
  - Projects focused on reducing climate change impacts
  - Projects to restore natural functions in the environment.

- Most respondents (89.8 percent) indicated that they own their home. About 7 percent live in a rental, and a small number live on family property or are in the process of building a home.
- Three respondents own a home that was inundated or isolated by the 2018 lava flow.

Public Meetings

By engaging the public through the public involvement strategy, the concept of mitigation was introduced to the public and the working group received feedback that was used in developing the components of the plan. Details of attendance and comments received are summarized in Table 3-2.

Table 3-2. Summary of Public Meetings

Date	Location	Number of Citizens in Attendance
1/22/2020	Aupuni Center, Hilo	10
1/23/2020	West Civic Center, Kailua-Kona	5
1/28/2020	Waimea Community Center, Waimea	14
1/29/2020	Ocean View Community Center, Ocean View	31
5/27/2020	Online Public Meeting	Unknown
Total		**60**

3.7 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-3 summarizes important milestones in the development of the plan.

Table 3-3. Plan Development Milestones

Date	Event	Description	Attendance
2019			
	Initiate consultant procurement	• Seek a planning expert to facilitate the process	N/A
August	Select Tetra Tech to facilitate plan development	• Facilitation contractor secured	N/A
10/02	Identify Planning Team	• Formation of the Planning Team	N/A
10/15	Planning Team Meeting	• Identification of potential working group members • Confirm agenda for working group meeting • Identify ground rules	
October	Working Group formed	• Potential working group members contacted	N/A
10/29	Working Group Meeting #1	• Introduce potential working group members to planning process • Discuss the role of the working group • Review and discuss proposed ground rules for working group • Review update process and schedule • Introduce and discuss public involvement strategy	20
11/12	Planning Team Meeting	• working group kickoff meeting review • Discuss public engagement strategy	
11/25	Planning Team Meeting	• Public engagement strategy (website, survey, press release, public meeting planning)	
12/10	Planning Team Meeting	• Review survey and feedback • Discuss January public meeting schedule • Set working group agenda • Vision, mission, goals and objectives review • Review scenarios	
12/17	Working Group Meeting #2	• Confirm mission and goals • Adopt hazards of concern • Discuss hazard scenarios • Review public outreach strategy	22
12/24	Planning Team Meeting	• Confirm scenarios • Discuss public engagement strategy	
2020			
1/07	Planning Team Meeting	• Discuss current high wind hazard event relating to hazard mitigation plan process • Decide on public meeting organization	
1/08	Public Outreach	• Press release announcing public meetings	N/A
1/21	Planning Team Meeting	• Public meeting preparation	
1/21	Working Group Meeting #3	• Risk assessment results review • Public outreach strategy	24
1/22	Public Outreach	• Public meeting in Hilo	10
1/23	Public Outreach	• Public meeting in Kailua-Kona	5
1/29	Public Outreach	• Public meeting in Waimea	14
1/30	Public Outreach	• Public meeting in Ocean View	31
2/18	Working Group Meeting #4	• Goals and objectives group exercise	17
4/21	Working Group Meeting #5	• Review final objectives • Review draft action plan • Discuss options for public meeting • Project timeline update	21

Date	Event	Description	Attendance
4/30	Draft Plan	• Internal review draft of Part 1 provided by planning team to working group	N/A
5/8	Draft Plan	• Internal review draft of plan provided by planning team to working group	N/A
5/18	Public Comment Period	• Initial public comment period of draft plan opens. Draft plan posted on plan website with press release notifying public of plan availability.	N/A
5/27	Public Outreach	• Online public meeting on draft plan	N/A
6/1	Public Comment Period	• Initial public comment period of draft plan closes	N/A
6/26	Plan Submittal	• Final draft plan submitted to the Hawaiʻi Emergency Management Agency, FEMA Region IX, and the Insurance Services Office for review and approval.	N/A
9/14	Adoption	• Plan adopted by Hawaiʻi County	N/A
9/15	Final Plan Approval	• Final plan approved by FEMA	N/A

4. HAWAIʻI COUNTY PROFILE

4.1 GEOGRAPHIC OVERVIEW

The State of Hawaiʻi consists of eight major islands (Kauaʻi, Niʻihau, Oʻahu, Maui, Molokaʻi, Lānaʻi, Kahoʻolawe, and Hawaiʻi) and 124 small islands, reef, and shoals (referred to as the Northwest Hawaiian Islands). The islands are divided into five counties—Kauaʻi, City & County of Honolulu (Oʻahu), Maui, Kalawao, and Hawaiʻi. Hawaiʻi County encompasses the entire island of Hawaiʻi, the southeasternmost island in the Hawaiian archipelago. At approximately 4,028 square miles, the island of Hawaiʻi, also known as the Big Island, is larger than all the other islands combined.

The Hawaiʻi County seat is Hilo. Other population centers are Hawaiian Paradise Park, Waimea, Waikoloa Village, Kailua, Kealakekua, Pāhoa, and Honokaʻa. For planning purposes, the County's nine judicial districts are used for analyses throughout this hazard mitigation plan. The planning area and the districts are shown in Figure 4-1.

4.2 HISTORICAL OVERVIEW

Much of the early history of the Hawaiian Islands had its setting on the Big Island. Archaeological data indicates that Polynesian voyagers may have settled on the island as early as 600 CE (common era). The priest Paʻao, likely from Samoa or Tahiti, is said to have arrived on the Big Island some centuries later. Paʻao later brought the chief Pili to the island, and subsequent chiefs on the island all claimed descent from Pili (Wikipedia, 2020).

Significant later rulers include Umi, the first king to unite the entire island of Hawaiʻi, and Kamehameha, the first to conquer and unite all of the Hawaiian Islands into a single kingdom. Kamehameha's rule began in the late 1700s and his unification of the islands was completed in 1810. As king, he maintained Hawaiʻi's independence as a kingdom throughout the period of early European exploration of the islands (Britannica, 2020)

European presence on the islands began with James Cook's landing on Kauaʻi in 1778 (Cook died on the Big Island in 1779). American missionaries arrived in the islands in 1820. Kawaihae was the site of one of the first mission stations in the Hawaiian Islands. Early commerce on the island included sandalwood beginning in the 1790s and whaling and sugar beginning in the early 1800s. The sugar industry flourished with the signing of the Reciprocity Treaty of 1875 with the United States, which removed all duties on Hawaiian sugar imported to the United States.

The Hawaiian Islands were annexed by the United States in 1898, and as a U.S. territory saw population expansion and the establishment of a plantation system for growing sugar cane and pineapples (history.com, 2020). Sugarcane was the dominant industry of the island for more than 120 years. Hawaiʻi became a U.S. state on August 21, 1959. As late as 1969, plantations in Hāmākua, Kohala, and Ka'ū districts contributed more than 37 percent of the state's sugar production.

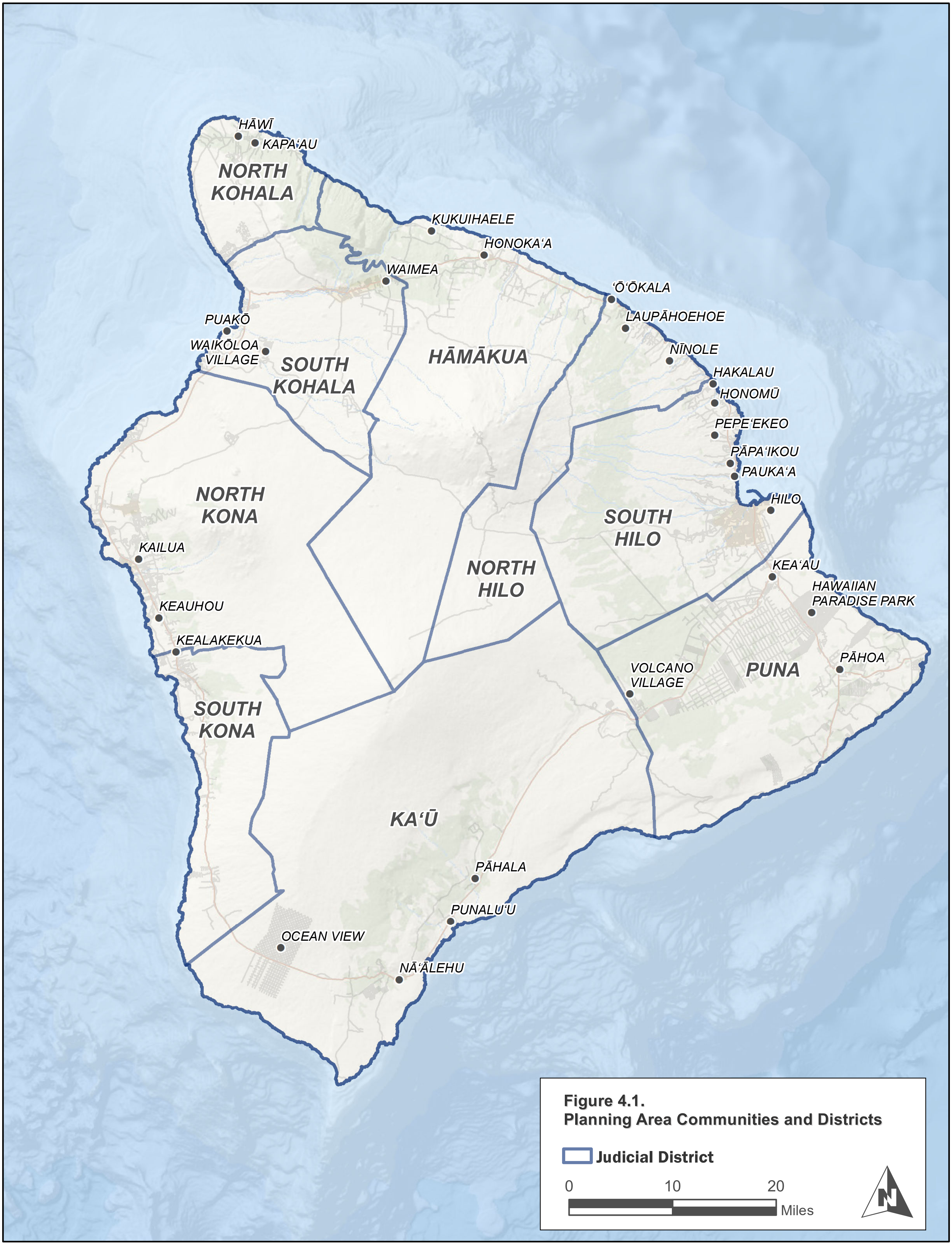


Figure 4.1.
Planning Area Communities and Districts

The process of downsizing and closing plantations began in the 1970s and culminated in the abandonment of sugarcane production on the island in 1996. Throughout the years of sugar’s decline, there has been growth in the island’s tourism sector, based largely in the Kona and South Kohala districts. Diversified agriculture has experienced a generally upward trend as it strives to replace the abandoned sugarcane fields. Since the 1960s, astronomy also has been a growing economic sector on the island.

4.3 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Hawai‘i County has experienced 30 events since 1955 for which presidential disaster declarations were issued. These events are listed in Table 4-1. Review of these events helps identify targets for risk reduction and ways to increase a community’s capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on Hawai‘i County’s communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

4.4 PHYSICAL SETTING

The Hawaiian archipelago consists of 132 volcanic islands, atolls, reef, and shoals in the North Pacific Ocean. Although the Hawaiian Islands were all formed by volcanic eruptions, only the island of Hawai‘i still has active volcanoes.

4.4.1 Geology and Topography

Largest and youngest of the Hawaiian Chain, the island of Hawai‘i covers a land area of 4,028 square miles and is still growing. The island of Hawai‘i was formed by five volcanoes—Kohala, Mauna Kea, Hualālai, Mauna Loa, and Kīlauea. Mauna Kea, Hualālai, Mauna Loa, and Kīlauea are considered “active” by HVO because they have erupted within the past 10,000 years and have the potential to erupt again. At 13,796 feet above sea level, Mauna Kea is the tallest of the island’s mountains. The island extends from craggy ocean cliffs and beaches of black, green and golden sand to mountain peaks that are snow-covered in winter. The island has more than 305 miles of coastline, about 75 percent of which consists of cliffs. Porous lava flows have produced unique ecological niches in ponds along the coast. Lava tube caves are significant geological natural resources (County of Hawai‘i, 2005).

4.4.2 Climate

Located at the northern edge of the tropical zone, the Big Island has a mild climate due in part to its location within the trade-wind zone. The climate is notable for its low day-to-day and month-to-month variability. The annual variation in mean monthly temperatures is only about 9 ºF for areas at sea level. Its mountainous topography makes the island of Hawai‘i’s climate one of the most spatially diverse anywhere. From 20 inches of precipitation in leeward areas to 300 inches in the upper windward areas, this island experiences a range of moisture and temperature regimes exceeding that found across the breadth of a continent.

The tropical conditions of the eastern Pacific—warm ocean water near the equator combined with the cyclonic spin—are ideal for hurricane formation. As the easternmost island in the state, the island of Hawai‘i has a slightly higher probability of tropical cyclone landfall, but historically few events have actually occurred.

Table 4-2 summarizes normal daily climate data at National Climatic Data Center (NCDC) weather stations across the planning area.

Table 4-1. Presidential Disaster Declarations for Hazard Events in Hawaiʻi County

Type of Event	Disaster Declaration #	Date
Volcano	DR-32	4/1/1955
Tidal Wave	DR-71	3/16/1957
Hurricane Dot	DR-94	8/16/1959
Earthquakes and Volcanic Disturbances	DR-96	1/21/1960
Tidal Waves	DR-101	5/25/1960
Heavy Rains and Flooding	DR-152	4/24/1963
Earthquake	DR-383	5/16/1973
Earthquake, Seismic Waves, Volcanic Eruption	DR-490	12/719/75
Severe Storms and Flooding	DR-573	3/7/1979
Kīlauea	FSA-2044	3/4/1983
Lava Flow, Kīlauea Volcano	DR-864	5/18/1990
Hurricane Iniki	DR-961	9/12/1992
Puna District Wildfire	FSA-2196	3/16/1998
Puuaakapu Ranch Lot Fire	FSA-2293	3/20/2000
Severe Storms and Flooding	DR-1348	11/9/2000
Waikoloa Village Fire	FM-2468	5/8/2003
Kawaihae Road Fire	FM-2556	9/14/2004
Lālāmilo Fire	FM-2573	8/02/2005
Akoni Pule Highway Fire	FR-2574	8/04/2005
Earthquake	DR-1664	10/17/2006
Kohala Mountain Road Fire	FM-2722	8/17/2007
Puakō Fire	FM-2740	10/28/2007
Severe Storms, High Surf, Flooding, and Mudslides	DR-1743	02/6/2008
Tsunami Waves	DR-1967	4/08/2011
Tropical Storm Iselle	DR-4194	9/12/2014
Puʻu ʻŌʻō Volcanic Eruption and Lava Flow	DR-4201	11/03/2014
Kīlauea Volcanic Eruption and Earthquakes	DR-4366	5/11/2018
Hurricane Lane	EM-3399	8/22/2018
Tropical Storm Olivia	EM-3404	9/12/2018
Hurricane Lane	DR-4395	9/27/2019

a. Prior to 1964, federal disaster declarations were not issued specific to counties; pre-1964 declarations listed in this table are for the entire state of Hawaiʻi, not Hawaiʻi County specifically

Table 4-2. Normal Daily Hawaiʻi County Precipitation and Temperatures

	Precipitation (inches)	Temperature (°F)		
		Minimum	Average	Maximum
Weather Station: Hilo International Airport 87, 1990-2019	0.34	68.2	74.7	81.7
Weather Station: Kailua Kona Ke Ahole Airport, 1998-2019	0.02	71.9	78.2	84.4
Weather Station: Honokaʻa 2.5 SSW, 2013-2019	0.34	N/A	N/A	N/A
Weather Station: Hawaiian Ocean View 1.7 NNE, 2017-2019	0.08	N/A	N/A	N/A

4.5 SENSITIVE RESOURCES

4.5.1 Culturally Sensitive Resources

The Hawaiʻi County General Plan Cultural Resources subsection provides the following overview of historic resources in the county (County of Hawaiʻi, 2005):

> *An estimated 11,500 archeological and historic sites have been identified on the island of Hawaiʻi. However, only 5 per cent of the island has been surveyed. The other 95 per cent of the island contains and undeterminable number of historic and archeological sites. The abundance of historic sites can be attributed to the fact that much of the early history of the Hawaiian Islands had its setting on the Big Island.*
>
> *There is continuing concern for the historic and archeological sites of the county of Hawaiʻi on the part of the residents, governmental agencies, and private developers. As the early history of Hawaiʻi was kept through oral tradition, the reconstruction of this period is largely based on the physical evidence and data recovered from archaeological and historic sites. It is realized that once destroyed, historic sites and the information they contain cannot be replaced.*

4.5.2 Scenic Resources

Hawaiʻi County features a broad range of scenic resources, including the coastline and Pacific Ocean, coral reefs, volcanic mountains, lava fields, fissures and vents, kiawe deserts, rolling grasslands, native forests, heavily vegetated valleys, waterfalls, agricultural features, and distinctive rural communities. The island is home to flora, fauna and ecological communities that can be found nowhere else in the world. These natural resources face pressure from development, invasive species, natural hazards and climate change.

Coastal Views

Hawaiʻi County's varied and extensive coastline allows for a wide range of scenic vistas from roads and highways, and from beaches, county and state parks, coastal access points and historic trails.

Forests

Forestlands define much of the visual landscape of Hawaiʻi County. Hawaiʻi Volcanoes National Park and 20 State Forest Reserves are all significant protected forests in the county (Hawaiʻi Division of Forestry and Wildlife, 2020). Forestland is abundant well beyond these protected areas. The scenic value of these natural resources, viewed from within or from outside, is of great importance.

Scenic Roadways

Several roads in Hawaiʻi County have unique scenic qualities because of their natural setting. Scenic byways include a defined route for passenger vehicles, as well as sights that can be seen from, or are reasonably close to the road. These include the following (gohawaii.com, 2020):

- Kaʻū Scenic Byway—The Slopes of Mauna Loa
- Māmalahoa Kona Heritage Corridor
- Royal Footsteps Along the Kona Coast (Alii Drive)

Threatened and Endangered Species

The federal list of threatened or endangered species includes 131 species on the island of Hawaiʻi—100 plant species and 31 animal species (U.S. Fish and Wildlife Service, 2020). These resources are an integral part of the economy, sense of place, and traditional culture of the island. They are impacted by natural hazards and can influence the way that hazards impact the built environment.

4.6 DEVELOPMENT PROFILE

4.6.1 Current Land Use

Hawai'i's State Land Use Commission, established in 1961, has defined four land use districts that provide the basic framework for land uses in the state. Most recently updated in 2013, the distribution of these districts in Hawai'i County is as follows (Hawai'i Office of Planning, 2013):

- The Urban District consists of lands in urban use with sufficient reserve to accommodate foreseeable growth. In the County of Hawai'i, this district covers 56,348 acres, 2 percent of the total land area.
- The Rural District consists primarily of small farms mixed with low-density residential lots that have a minimum lot size of one-half acre. In the County of Hawai'i, this district covers 1,618 acres, less than 1 percent of the total land area.
- The Agricultural District includes lands with capacity for intensive cultivation. The minimum lot size is 1 acre. In the County of Hawai'i, this district covers 1,183,339 acres, 46 percent of the total land area.
- The Conservation District includes lands in forest and water reserve zones. In the County of Hawai'i, this district covers 1,343,125 acres, 52 percent of the total land area.

Land uses within the Urban Districts are administered exclusively by the County. In the Agricultural and Rural Districts, the State Land Use Commission establishes use regulations and the County is responsible for their administration. The County, however, may adopt more stringent controls than those imposed by the State within these two districts. Land use in the Conservation District is regulated by the State Board of Land and Natural Resources, except that the County has concurrent permitting power within the Special Management Area near the coast. The County has no land use control over federal property. The Hawaiian Homes Commission has control over uses of the Hawaiian homelands leased to native Hawaiians.

Within the County of Hawai'i, desired future land use patterns were set forth in 2005 by the General Plan Land Use Pattern Allocation Guide Map. Zoning must be consistent with the future land use designations. In the draft General Plan Update for 2020, the 2005 land use boundaries are refined based on input from community development plans and neighborhood analysis areas that were delineated according to subdivision boundaries, census block groups, place types, zoning designations and state land use designations. The future land use designations in the new general plan are as follows (County of Hawai'i, 2019):

- High-density urban
- Medium-density urban
- Low-density urban
- Rural
- Light industrial
- Heavy industrial
- University
- Pastoral
- Resort
- Productive agriculture
- Natural area
- Recreation
- Conservation

Figure 4-2 and Table 4-3 summarize the area and location of current land uses in Hawai'i County. Approximately 27 percent of the total acreage of the County (686,000 acres) is presently being used for agriculture.

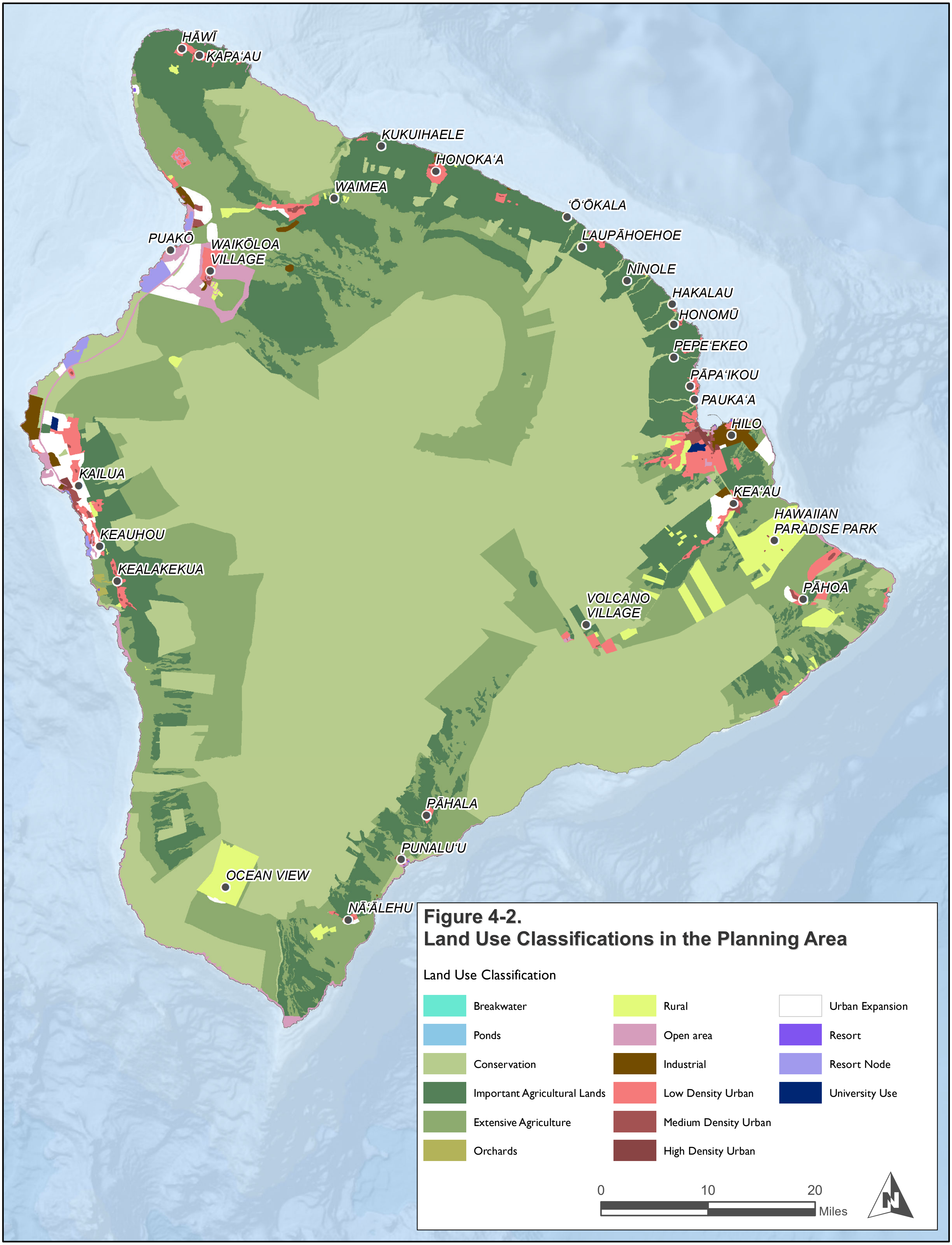


Figure 4-2.
Land Use Classifications in the Planning Area

Table 4-3. Land Use in the County of Hawai'i

Land Use Category	Designated Area (acres)									
	Hāmākua	Ka'ū	North Hilo	North Kohala	North Kona	Puna	South Hilo	South Kohala	South Kona	Total
Breakwater	0	0	0	0	0	0	8	0	0	8
Conservation	235,284	450,255	120,044	11,754	200,124	137,934	167,773	13,989	43,433	1,380,590
Extensive Agriculture	83,138	145,609	31,857	21,881	106,570	89,579	26,149	71,485	66,591	642,859
High Density Urban	0	0	0	0	459	0	852	0	0	1,311
Important Ag. Lands	78,195	47,426	21,701	41,064	25,020	47,796	37,183	51,599	32,178	382,162
Industrial	132	74	30	51	3,895	671	4,207	1,873	0	10,933
Low Density Urban	2,298	1,160	618	2,675	6,433	7,446	11,249	5,116	1,083	38,077
Medium Density Urban	294	422	70	177	1,458	1,279	1,477	1,284	294	6,754
Open Area	1,269	4,748	435	2,101	5,855	2,345	1,804	14,096	2,708	35,360
Orchards	0	0	0	0	409	0	0	0	465	874
Ponds	0	0	0	0	0	0	18	0	0	18
Resort Node	0	0	0	0	2,432	0	6	3,218	0	5,656
Resort	0	29	0	47	0	0	77	0	25	178
Rural	47	13,111	72	423	1,003	29,353	1,710	1,927	116	47,762
Urban Expansion	0	598	62	258	12,092	5,363	122	12,287	0	30,783
University Use	0	0	0	0	462	0	667	0	0	1,129
Total	**400,656**	**663,433**	**174,888**	**80,432**	**366,211**	**321,767**	**253,302**	**176,871**	**146,892**	**2,584,452**

Source: Summarized from Hawai'i County 2015 Land Use Pattern Allocation Guide data.

Building Count, Occupancy Class and Estimated Replacement Value

Table 4-4 presents planning area building counts by building occupancy class. The table also summarizes estimated replacement value for building structures and contents combined.

Table 4-4. Planning Area Building Counts by Occupancy Class

	Number of Buildings								Estimated Total Replacement Value(Structure and Contents)[a]
	Residential	Commercial	Industrial	Agricultural	Religion	Government	Education	Total	
Hāmākua	2,511	92	5	0	7	0	0	2,615	$965,000,890
Ka'ū	3,911	86	1	0	9	0	8	4,015	$1,153,799,589
North Hilo	938	19	1	0	4	0	0	962	$321,051,028
North Kohala	2,456	73	2	0	9	0	4	2,544	$949,266,941
North Kona	18,208	1,062	22	0	49	0	53	19,394	$13,646,633,094
Puna	18,802	328	12	0	37	0	66	19,245	$6,306,660,548
South Hilo	18,368	1,439	21	0	57	0	38	19,923	$26,316,068,455
South Kohala	10,009	378	6	0	19	0	24	10,436	$7,020,085,649
South Kona	3,499	135	8	0	11	0	9	3,662	$1,512,982,374
Total	**78,702**	**3,612**	**78**	**0**	**202**	**0**	**202**	**82,796**	**$58,191,548,568**

a. Values based on 2019 County tax parcel and real property data.

Critical Facilities

Critical facilities are those that are essential to the health and welfare of the population. These become especially important after a hazard event. For this plan, the working group defined critical facilities as structures and infrastructure from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided.

Critical facilities provide indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security. Categories of these facilities include but are not limited to:

- **Safety and Security**—Law Enforcement/Security, Search and Rescue, Fire Services, Government Service, Responder Safety, and Imminent Hazard Mitigation
- **Food, Water and Sheltering**—Evacuations, Schools, Food/Potable Water, Shelter, Durable Goods, Water Infrastructure, and Agriculture
- **Health and Medical**—Medical Care/Hospitals: Patient Movement, Public Health, Fatality Management, Health Care, and Supply Chain
- **Energy**—Power (Grid), Temporary Power and Fuel
- **Communications**—Infrastructure, Alerts, Warnings, Messages, 911 and Dispatch, Responder Communications and Financial Services
- **Transportation**—Highway/Roadway, Mass Transit, Railway, Aviation, Maritime and Pipeline
- **Hazardous Materials**—Facilities, Hazardous Debris, Pollutants and Contaminants

The risk assessment for each hazard in this plan discusses that hazard's potential impact on critical facilities. For some hazards, potential damage to critical facilities was estimated using the Hazards U.S. (Hazus) computer model developed by FEMA. For this reason, the list of critical facilities developed based on the above definitions was distributed into categories that are defined in the Hazus model. Table 4-5 summarizes the number of critical facilities by Hazus-defined category. Due to the sensitivity of this information, a detailed list of facilities is not provided. General locations of critical facilities in the planning area are shown in Figure 4-3 and Figure 4-4; detailed area maps are provided in Appendix B.

Table 4-5. Critical Facilities in the Planning Area

	Number of Facilities							
	Safety and Security	Food, Water and Sheltering	Health and Medical	Energy	Communications	Transportation	Hazardous Materials	Total
Hāmākua	7	11	2	2	5	62	2	**91**
Ka‘ū	13	12	2	4	10	18	2	**61**
North Hilo	4	3	0	0	3	26	0	**36**
North Kohala	4	8	1	2	4	11	0	**30**
North Kona	17	44	6	14	19	22	1	**123**
Puna	20	28	0	6	17	12	0	**83**
South Hilo	32	70	14	20	36	69	5	**246**
South Kohala	10	17	2	13	13	25	0	**80**
South Kona	8	13	0	4	9	0	0	**34**
Total	**115**	**206**	**27**	**65**	**116**	**245**	**10**	**784**

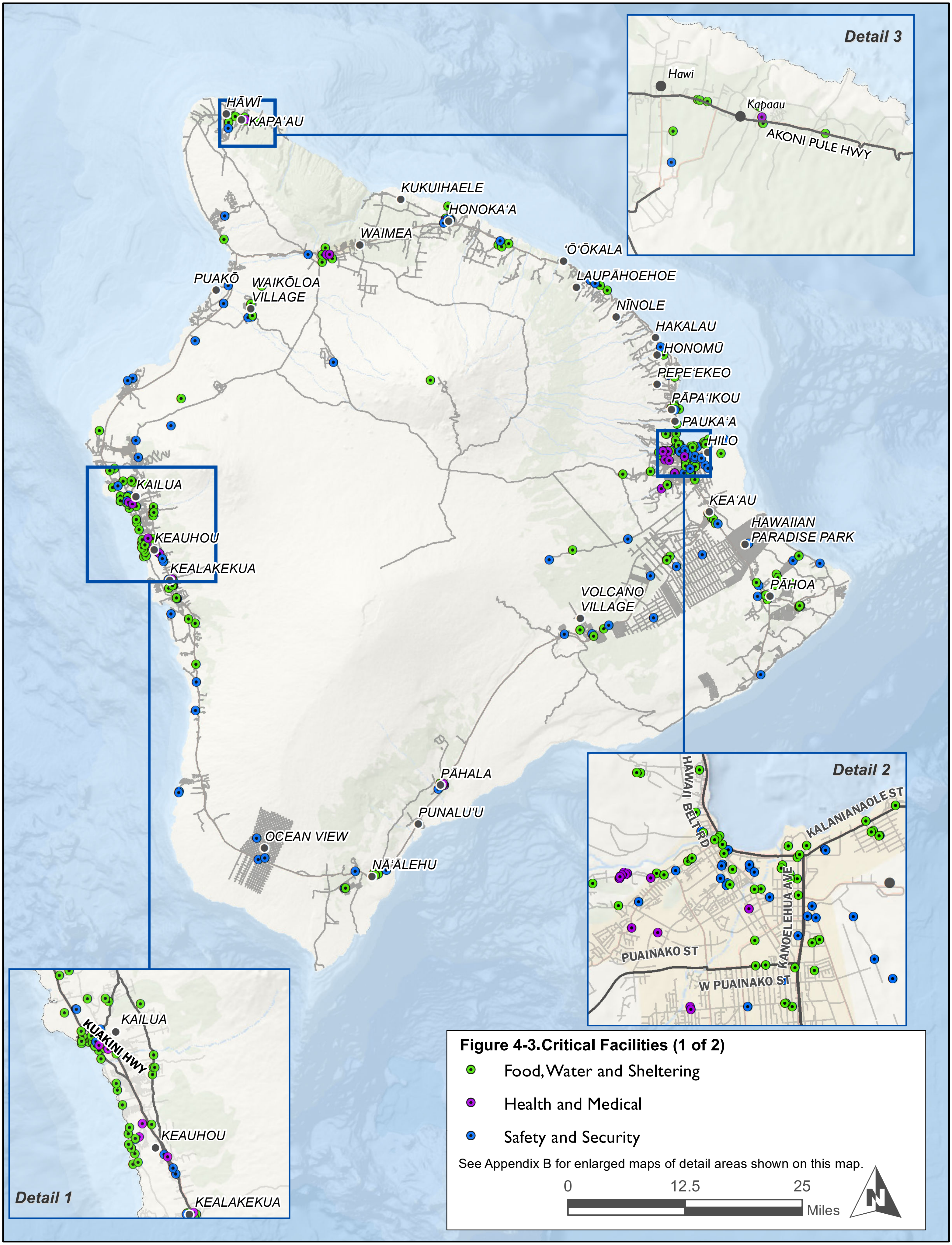


Figure 4-3. Critical Facilities (1 of 2)

- Food, Water and Sheltering
- Health and Medical
- Safety and Security

See Appendix B for enlarged maps of detail areas shown on this map.

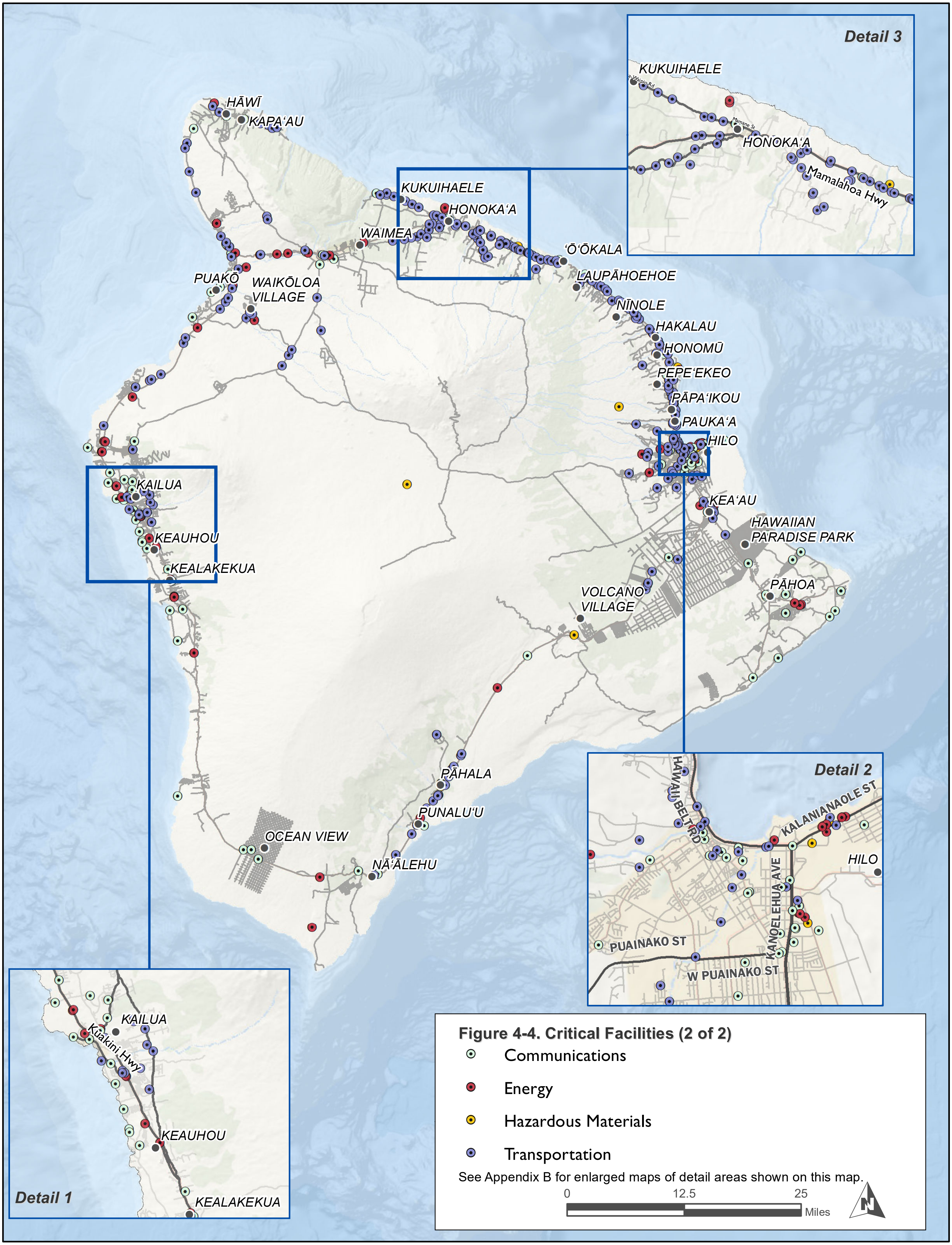


Figure 4-4. Critical Facilities (2 of 2)

- Communications
- Energy
- Hazardous Materials
- Transportation

See Appendix B for enlarged maps of detail areas shown on this map.

0 12.5 25 Miles

4.6.2 Development Trends

The most recent in-depth assessment of development trends in Hawaiʻi County was the Trends and Forecasts Report finalized in 2016. No extensive analysis has been completed of trends since the previous hazard mitigation plan was adopted in 2015. However, the 2016 report projected trends from 2010 to 2040.

Key findings of the 2016 Trends and Forecasts Report are summarized in the draft 2020 update to the County's General Plan, and include the following (County of Hawaiʻi, 2019):

- Hawaiʻi County is rural. Only 60 percent of the population is within the County's eight urban areas, and population density is low in both urban and rural areas.
- The County is expected to grow by 50 percent by 2040. A disproportionate number of residents in 2025 and beyond will be seniors.
- Rates of job growth are expected to match population growth, but due to the economy's reliance on lower-paying service sector jobs, median incomes are likely to remain low. Roughly half the households find housing unaffordable, and many live in overcrowded conditions. Much of the affordable housing is not located in or near job centers, so commutes are getting longer.
- Visitor units are clustered primarily in West Hawaiʻi, and steady growth is expected to continue, though the makeup of that growth (hotel vs. vacation rental) is unknown. The number of housing units in the County in 2015 was estimated to be 87,310. Among those, approximately 80 percent were single-family dwellings, and the remainder were multifamily units. An estimated 64 percent of housing units were owner-occupied.
- Growth rates have varied considerably by region, and that trend is expected to continue. Relative to the Countywide estimate of 59 percent growth in housing units from 2010 to 2040, Hilo (29 percent) and the North Hilo-Hāmākua Villages (36 percent) are expected to grow more slowly. Others are expected to grow more quickly: Waimea (60 percent), Ka'ū (93 percent), and Puna—Keaʻau-Kurtistown (72 percent), Upper Puna (101 percent), and Hawaiian Paradise Park-Orchidland (171 percent).
- Differences in growth rates are forecasted to result in shifts in relative population centers. For example, Hilo and North Kona currently both have about a quarter of the island's housing, while only about 13 percent is in Upper Puna and Hawaiian Paradise Park-Orchidland. But by 2040, only 42 percent of the units are forecasted to be in Hilo and North Kona, while 19 percent is estimated to be in Upper Puna and Hawaiian Paradise Park-Orchidland.
- There is also variation among forecasted growth rates in non-residential square footage (commercial and industrial), but the variation is less extreme.

4.7 DEMOGRAPHICS

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. People living near or below the poverty line, the elderly, individuals with disabilities, women, children, ethnic minorities, and renters all experience, to some degree, more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would help to extend focused public outreach and education to these most vulnerable citizens.

4.7.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. The U.S. Census Bureau estimates the County's total resident population at 201,513 as of July 2019. Table 4-6 presents population estimates for the subdivision units within Hawai‘i County defined by the Census (the most recent data for these estimates is 2018).

Table 4-6. 2018 Population of Hawai‘i County by Census-Defined County Subdivision

Subdivision	Population	Subdivision	Population
Hilo	48,774	**North Kona**	43,631
Honoka‘a-Kukuihaele	4,152	**Pā‘auhau-Pa‘auilo**	2,520
Ka‘ū	9,473	**Pāhoa-Kalapana**	11,215
Kea‘au-Mountain View	35,553	**Pāpa‘ikou-Wailea**	4,162
North Hilo	1,510	**South Kohala**	19,855
North Kohala	6,045	**South Kona**	10,768
County Total			**197,658[a]**

a. Total Hawai‘i County population for 2018 differs between this table and Table 4-7 because data are from different sources.
Source: census.gov

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population signifies economic decline. Table 4-7 shows the population in the County and State of Hawai‘i from 1980 through 2019. The average growth rate over that period, for Hawai‘i County and for the state, is shown on Figure 4-5. The County's average 5-year population growth of over 14 to 15 percent in the 1980s and early 1990s dropped significantly in the late 1990s and rose again in the first five years of the 2000s. Since then, the rate has declined steadily. The state growth followed a similar trend, with a consistently lower growth rate than the County over the period shown.

Table 4-7. Annual Population Data

Year	Hawai‘i County Population	State of Hawai‘i Population	Year	Hawai‘i County Population	State of Hawai‘i Population
1980	92,900	968,500	**2012**	189,161	1,394,804
1985	105,900	1,039,698	**2013**	191,459	1,408,243
1990	121,572	1,113,491	**2014**	193,711	1,414,538
1995	140,492	1,196,854	**2015**	195,975	1,422,052
2000	149,244	1,213,519	**2016**	198,316	1,427,559
2005	168,237	1,292,729	**2017**	199,981	1,424,393
2010	185,363	1,363,963	**2018**	201,509[a]	1,420,593
2011	187,079	1,379,329	**2019**	201,513	1,415,872

a. Total Hawai‘i County population for 2018 differs between this table and Table 4-6 because estimates for the two tables are from different sources.
Source: Hawai‘i Department of Business, Economic Development & Tourism

Source: Hawai'i Department of Business, Economic Development & Tourism

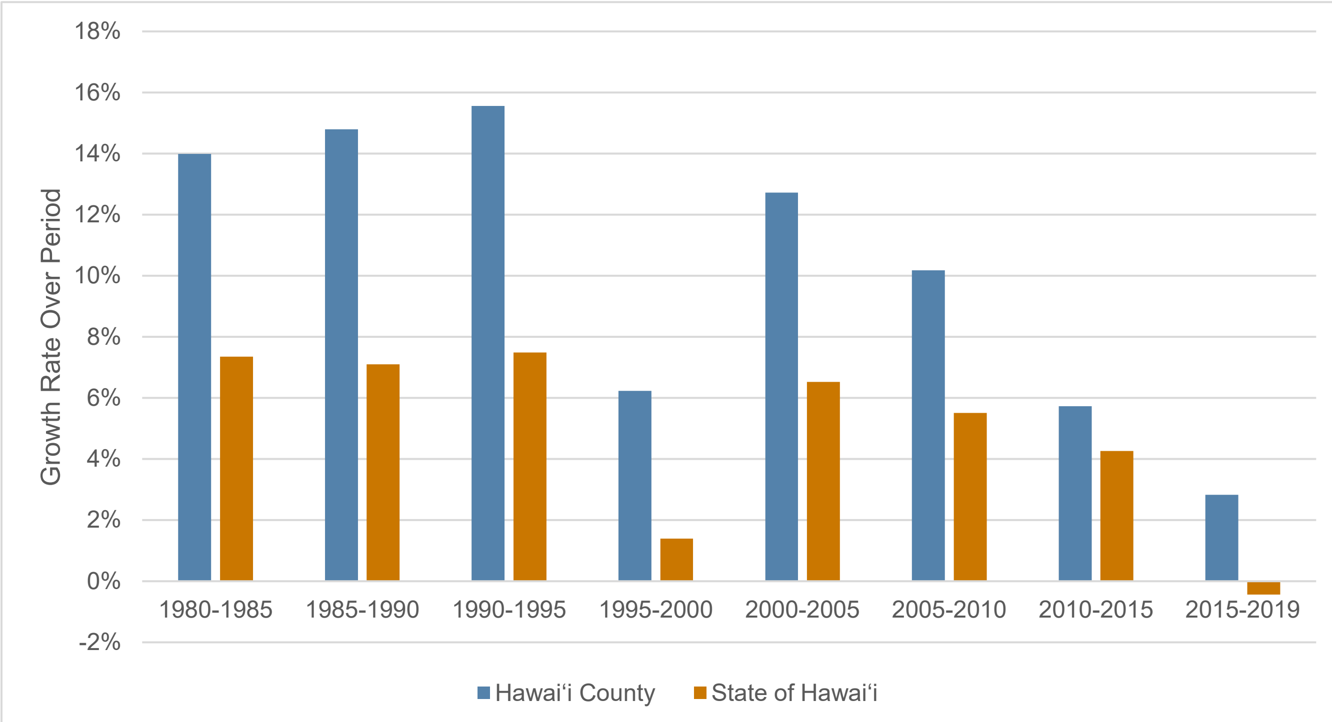


Figure 4-5. State of Hawai'i and Hawai'i County Population Growth

4.7.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. Emergency managers typically identify these facilities as "critical facilities" because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the County is illustrated in Figure 4-6. Based on U.S. Census 2018 data estimates, 21.2 percent of the County's population is 65 or older, higher than the state average of 18.4 percent. According to U.S. Census data, 38.8 percent of the over-65 population has disabilities of some kind and 9.9 percent have incomes below the poverty line. Children under the age of 18 account for 25.6 percent of individuals who are below the poverty line. It is also estimated that 18.3 percent of the population is 14 or younger, about the same as the state average of 18.1 percent.

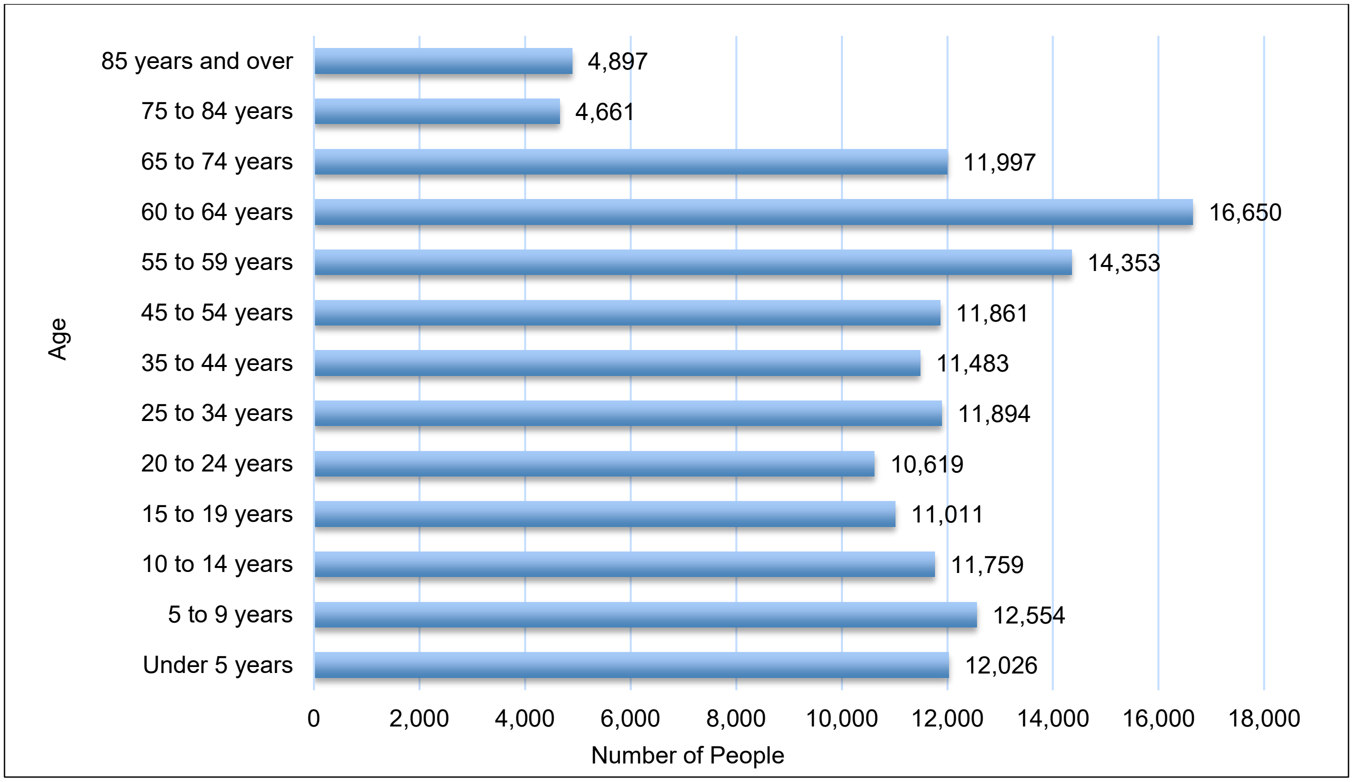


Figure 4-6. Hawai‘i County Age Distribution

4.7.3 Race, Ethnicity and Language

Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during disaster events. Post-disaster recovery is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability. According to the U.S. Census, the racial composition of the County is predominantly white, at about 33 percent. The largest minority populations are Asian at 23 percent and Native Hawaiian or other Pacific Islander at 11 percent. Figure 4-7 shows the racial distribution in the planning area.

The planning area has an 11.7 percent foreign-born population. Other than English, the most commonly spoken languages in the planning area are Asian and Pacific Island languages. The census estimates 5.9 percent of the residents speak English “less than very well.”

4.7.4 Persons with Disabilities or with Access and Functional Needs

The 2018 U.S. Census estimates that nearly 41 million non-institutionalized Americans with disabilities or with access and functional needs live in the U.S. This equates to about one in eight persons. This population is more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability will allow emergency management personnel and first responders to have personnel available who can provide services needed by those with access and functional needs.

According to the U.S. Census 2018 estimates, persons with disabilities or with access and functional needs make up 16.4 percent of the total civilian non-institutionalized population of Hawai‘i County.

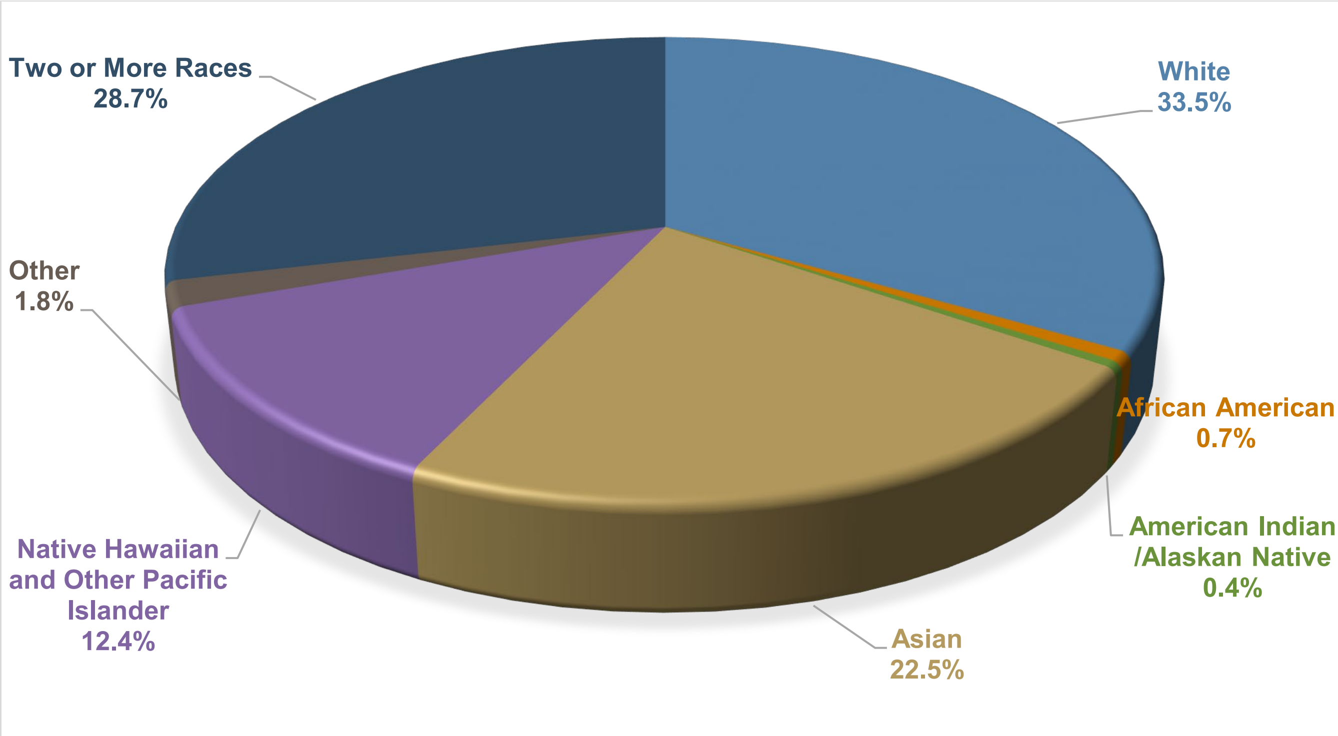


Figure 4-7. Hawai‘i County Race Distribution

4.8 ECONOMY

Hawai‘i County is dependent on off-island sources for energy, food, construction materials, and common daily goods. The local community has expressed a desire for the County’s economy to be more self-reliant. This would mean expanding agriculture, aquaculture, manufacturing, and renewable-energy sectors. By working toward self-sufficiency, Hawai‘i County’s economy could diversify and offer additional opportunities for employment and income (TakePart, 2015). The Hawai‘i Island Economic Development Board was formed in 1984 to assist the County of Hawai‘i to provide and promote private sector support and expertise for balanced growth in the county.

The County has seen continuing growth over the past 10 years, though the County does not have a boom economy like that of Honolulu. Rates of job growth are expected to match population growth, but due to the economy’s reliance on lower-paying service sector jobs, median incomes are likely to remain low. About half of households in the County find housing unaffordable, and much of the affordable housing is not located in or near job centers, so commutes are getting longer. Thus, Hawai‘i County is mostly characterized by the vulnerabilities of rural and residential communities (County of Hawai‘i, 2019).

4.8.1 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters.

This means that residents below the poverty level have a great deal to lose during a natural-hazard event and are the least prepared to deal with potential losses. Past natural disaster events in the United States have shown that personal household economics significantly impact people's decisions on evacuation. If the level of risk is not perceived as high, people often choose to "ride out" the impacts of such events. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, median household income was $57,571 in 2018. It is estimated that about 15.8 percent of households receive an income between $100,000 and $149,999 per year and 12.4 percent of household incomes are above $150,000 annually. Almost 22 percent of households in the planning area make less than $25,000 per year. According to the U.S. Census Bureau, 11.2 percent of families and 16.2 percent of individuals had income that fell below the poverty line. As presented in the State of Hawai'i's *Self-Sufficiency Income Standard* (Hawai'i Department of Business, Economic Development & Tourism, 2018), Hawai'i County had the lowest self-sufficiency income requirements of all counties in the state across all family types. Table 4-8 illustrates the estimated self-sufficiency income requirements for 2018.

Table 4-8. Self-Sufficiency Income Requirement—Hawai'i County (2018)

	One Adult	Two Adult Family	One Adult + One Preschooler	One Adult + One Preschooler + One School Age	Two Adult + One Preschooler + One School Age
Hourly	$13.75	$9.28	$22.75	$28.44	$16.00
Monthly	$2,421	$3,268	$4,004	$5,005	$5,633
Annual	$29,047	$39,211	$48,049	$60,060	$67,601

4.8.2 Industry, Businesses and Institutions

Based on U.S. Census data, the County's economy today is strongly based in the education/health care/social assistance industry—providing about one-fifth of all employment—followed by the entertainment/recreation industry and retail trade industry. Information and wholesale trade make up the smallest source of the local economy. Figure 4-8 shows the breakdown of industry types in Hawai'i County.

The County's General Plan lists the following as primary economic sector:

- **Services producing sector—**Education, health, accommodation, entertainment, food, professional, financial, real estate, public, etc. is by far the largest, representing over 80 percent of employment
- **Goods producing sector—**Construction and manufacturing
- **Agriculture**—Represents about 6 percent of employment.

The structure of commercial agriculture in Hawai'i County is in a state of transition. While commercial agriculture was once dominated by sugar and ranching, trends indicate that a larger number of small independent farmers producing a wide variety of diversified commodities will play an increasingly important role in the future. Diversified agriculture is dominated by macadamia nuts, papaya, flowers, tropical and temperate vegetables, and specialty coffee grown in the unique summer rainfall on the middle slopes of the Kona District. Ranching cattle makes use of the extensive open areas.

4.8.3 Employment Trends and Occupations

Business/science/arts occupations, service occupations, and sales/office occupations make up 32 percent, 24 percent and 23 percent of the jobs in the planning area respectively. Only about 10 percent of employment in the County is in the production/transportation/moving occupations (see Figure 4-9). The U.S. Census estimates that almost 74 percent of workers in the County commute alone (by car, truck or van) to work.

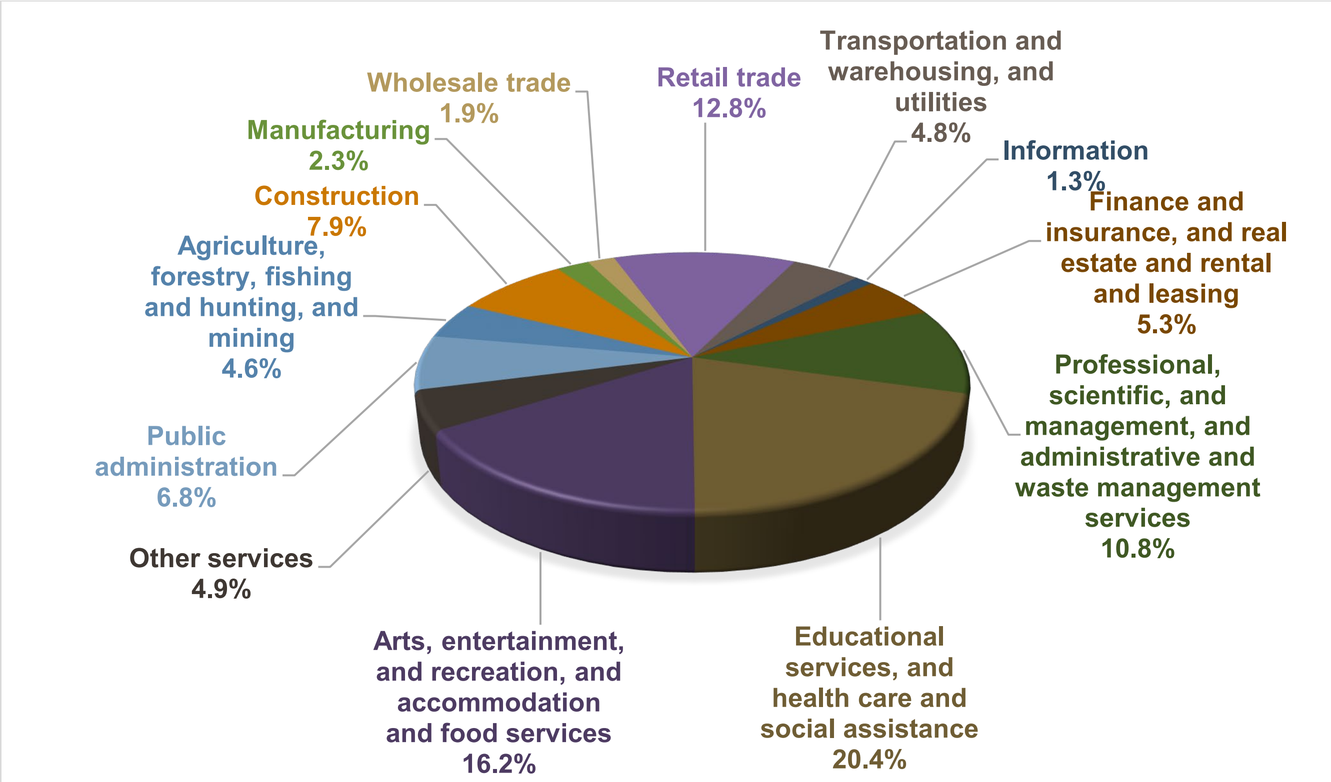


Figure 4-8. Industry in Hawai'i County

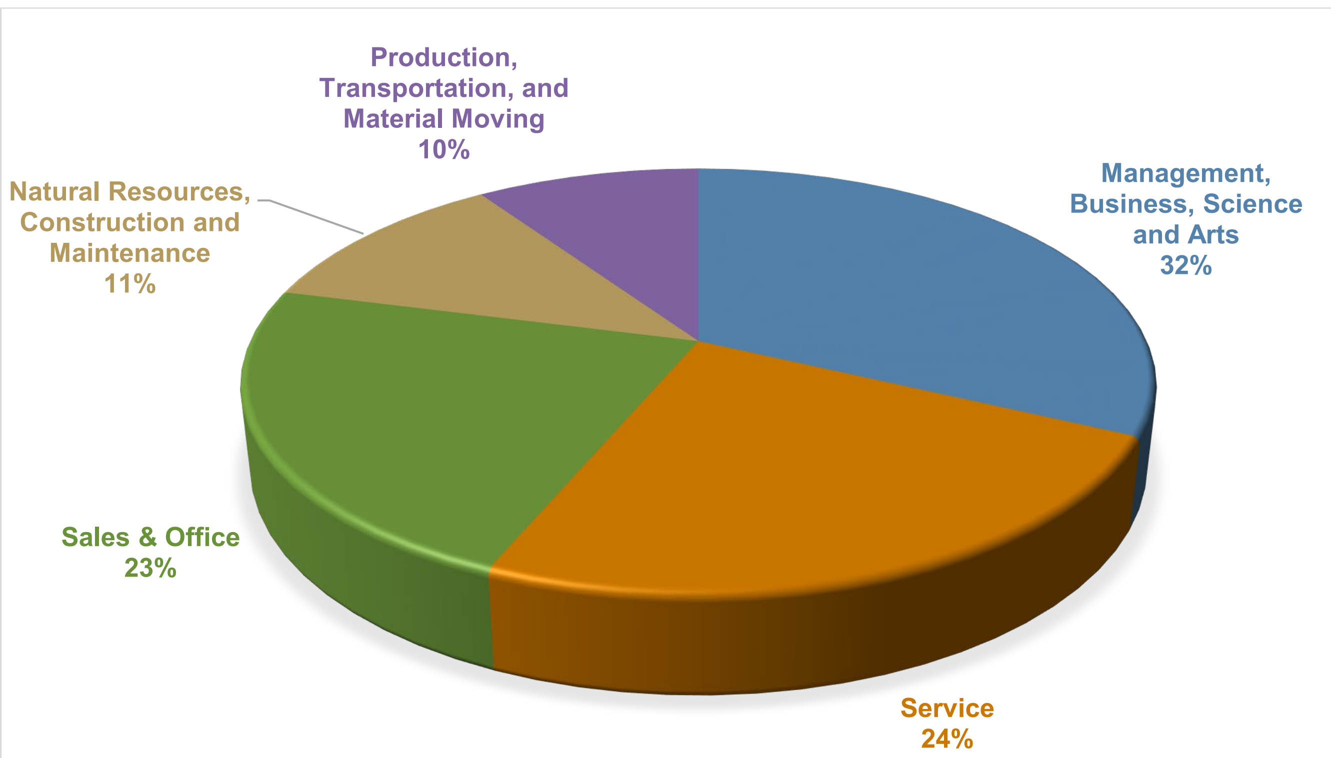


Figure 4-9. Occupations in Hawai'i County (Based on U.S. Census 2018 5-Year Estimates)

Hawaiʻi state data lists 24 employers in Hawaiʻi County with 250 or more employees as of 2017 (State of Hawaiʻi, 2020):

- More than 1,000 employees:
  - County of Hawaiʻi
  - Hilo Medical Center
  - Kohala Spa
- 500 to 999 employees:
  - Hilton-Waikoloa Village
  - Hilton
  - Hāpuna Beach Prince Hotel
  - Hale Ho'ola Hāmākua
  - Mandara Spa at Mauna Kea Beach
- 250 to 499 employees:
  - Kona Community Hospital
  - Four Seasons-Hualālai
  - Walmart-Hilo
  - Mauna Kea Beach Hotel
  - Walmart-Kona
  - Marriott-Waikoloa Beach
  - Roberts Hawaiʻi Tours
  - Mauna Lani Bay Hotel
  - KTA Super Stores
  - North Hawaiʻi Community Hospital
  - Life Care Center of Hilo
  - Courtyard King Kamehameha's
  - Mauna Loa Macadamia Nut Corporation

According to the American Community Survey, about 58 percent of the County's population 16 and older is in the labor force. Figure 4-10 compares unemployment trends from the State of Hawaiʻi and Hawaiʻi County from 2010 through 2019. For that time period, Hawaiʻi County's unemployment rate was highest in 2010, at 9.9 percent, dropped to a low of 2.9 percent in 2017, and then rose to 3.6 percent, in 2019. The state unemployment rate has been consistently lower than that of the County.

Source: Department of Business, Economic Development & Tourism

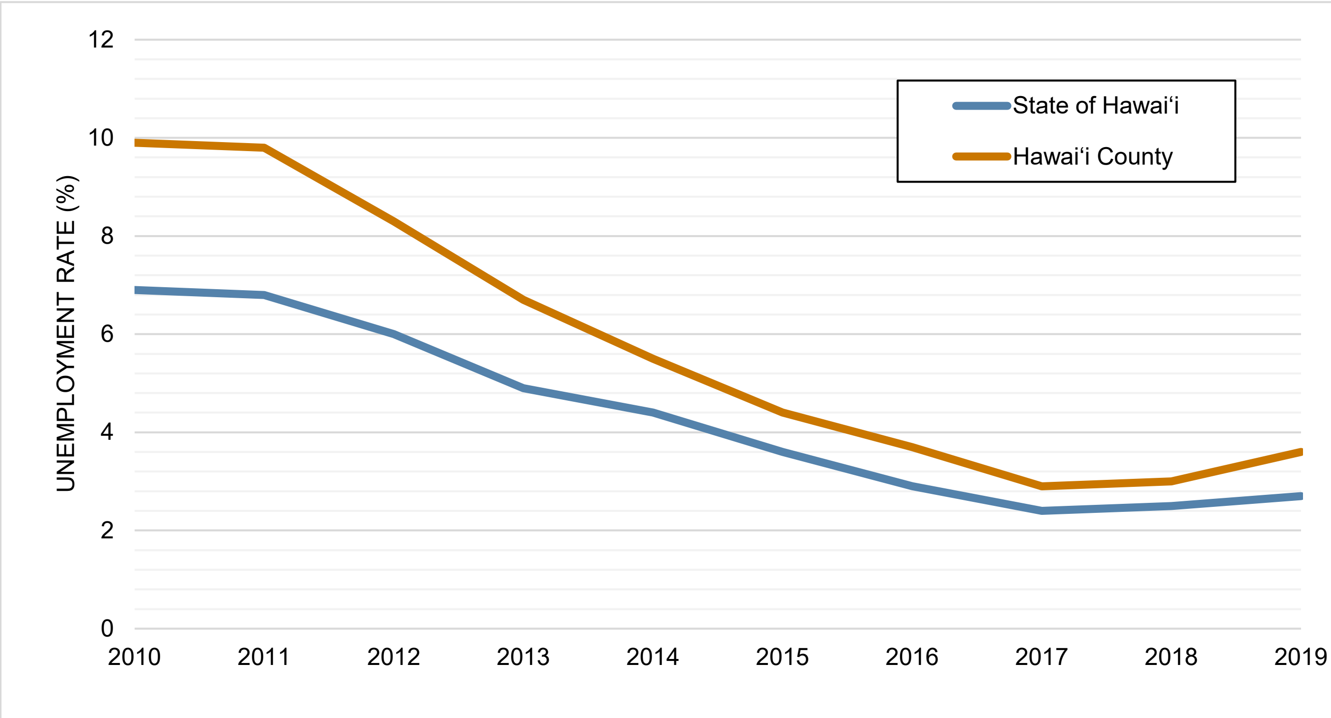


Figure 4-10. State of Hawaiʻi and Hawaiʻi County Unemployment Rate

5. REGULATIONS AND PROGRAM

Existing laws, ordinances and plans at the federal, state and local level can support or impact hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process, as stated in 44 CFR, Section 201.6(b)(3). Pertinent federal, state, and local laws are described below.

5.1 RELEVANT FEDERAL AND STATE AGENCIES, PROGRAMS AND REGULATIONS

State and federal regulations and programs that need to be considered in hazard mitigation are constantly evolving. For this plan, a review was performed to determined which regulations and programs are currently most relevant to hazard mitigation planning. The findings are summarized in Table 5-1 and Table 5-2. Short descriptions of each program are provided in Appendix C.

Table 5-1. Summary of Relevant Federal Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Americans with Disabilities Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Bureau of Land Management	Wildfire Hazard	The Bureau funds and coordinates wildfire management programs and structural fire management and prevention on Bureau lands.
Civil Rights Act of 1964	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Clean Water Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Community Development Block Grant Disaster Resilience Program	Action Plan Funding	This is a potential alternative source of funding for actions identified in this plan.
Community Rating System	Flood Hazard	This voluntary program encourages floodplain management activities that exceed the minimum National Flood Insurance Program requirements.
Disaster Mitigation Act	Hazard Mitigation Planning	This is the current federal legislation addressing hazard mitigation planning.
Emergency Relief for Federally Owned Roads Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
Emergency Watershed Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
Endangered Species Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Federal Energy Regulatory Commission Dam Safety Program	Dam Failure Hazard	This program cooperates with a large number of federal and state agencies to ensure and promote dam safety.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Federal Wildfire Management Policy and Healthy Forests Restoration Act	Wildfire Hazard	These documents mandate community-based collaboration to reduce risks from wildfire.
Hazard Mitigation Assistance Grant Programs	Action Plan Implementation	These programs are potential sources of funding for the implementation of mitigation actions recommended in this plan
National Dam Safety Act	Dam Failure Hazard	This act requires a periodic engineering analysis of most dams in the country
National Environmental Policy Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
National Fire Plan (2001)	Wildfire Hazard	This plan calls for joint risk reduction planning and implementation by federal, state and local agencies.
National Flood Insurance Program	Flood Hazard	This program makes federally backed flood insurance available to property owners in exchange for communities enacting floodplain regulations
National Incident Management System	Action Plan Development	Adoption of this system for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards is a prerequisite for federal preparedness grants and awards
Presidential Executive Order 11988, Floodplain Management	Flood Hazard	This order requires federal agencies to avoid long and short-term adverse impacts associated with modification of floodplains
Presidential Executive Order 11990 (Protection of Wetlands)	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable presidential executive orders.
U.S. Army Corps of Engineers Dam Safety Program	Dam Failure Hazard	This program is responsible for safety inspections of dams that meet size and storage limitations specified in the National Dam Safety Act.
U.S. Army Corps of Engineers Flood Hazard Management	Flood Hazard, Action Plan Implementation, Action Plan Funding	The Corps of Engineers offers multiple funding and technical assistance programs available for flood hazard mitigation actions
U.S. Fire Administration	Wildfire Hazard	This agency provides leadership, advocacy, coordination, and support for fire agencies and organizations.
U.S. Fish and Wildlife Service	Wildfire Hazard	This service’s fire management strategy employs prescribed fire throughout the National Wildlife Refuge System to maintain ecological communities.

Table 5-2. Summary of Relevant State Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Hawai‘i Coastal Zone Management Program	Action Plan Implementation, Surf/Storm Surge/Coastal Flood Hazard	Mitigation actions need to conform to the goals and policies of this plan
Hawai‘i Hazards Awareness and Resilience Program	Action Plan Implementation	Provides a resource for hazard education measures
Hawai‘i State Plan	Action Plan Implementation	Mitigation actions need to conform to the goals and policies of this plan
Hawai‘i State Grants-in-Aid Capital Improvement Projects Program	Action Plan Implementation	This program provides a potential source of funding for implementing mitigation actions
Ocean Resources Management Plan	Action Plan Implementation, Surf/Storm Surge/Coastal Flood Hazard	Mitigation actions need to conform to the goals and policies of this plan
State Building Code and Design Standards	Action Plan Implementation	Mitigation actions need to comply with all state building code requirements
State General Flood Control Plan	Action Plan Implementation, Flood Hazard	Mitigation actions need to conform to the goals and policies of this plan
State of Hawai‘i Hazard Mitigation Plan	Mitigation Plan development	The state hazard mitigation plan provides information that is useful in developing local hazard mitigation plans
State of Hawai‘i Land Use Law	Action Plan Implementation	Mitigation actions need to comply with all state land use requirements

5.2 LOCAL

5.2.1 General Plan 2040

The Hawai‘i County General Plan is a long-term comprehensive blueprint for the physical, economic, and environmental development and cultural identity of Hawai‘i County. The general plan was last adopted in 2005, and a process to update it began in 2015. The update, which will outline the County’s vision for growth through 2040, is in draft form as of spring 2020, and is expected to be adopted sometime in 2020.

The General Plan 2040 contains goals and measurable sustainability objectives along with policies and actions to achieve these objectives. Decisions on land use will be governed by this and other County planning documents. The hazard mitigation plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the planning area. The results of the risk assessment will be integrated into the Natural Hazards Element of the community plans. This will ensure that all future trends in development can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan.

5.2.2 Community Development Plans

Hawai‘i County’s Community Development Plans (CDP) translate broad General Plan goals, policies, and standards into implementation actions as they apply to specific geographical regions around the island. CDPs also serve as a forum for community input into land-use, delivery of government services, and any other matters relating to the planning area. CDP planning areas are as follows:

- Hāmākua
- Ka’ū
- North and South Kona
- North Kohala
- Puna
- South Kohala

5.2.3 Hawai‘i County Code

The Hawai‘i County Code is a compilation of all ordinances of a general and permanent nature, with some exceptions. Ordinances relating to the County budget, appropriations, the issuance of bonds, state land use boundary amendments, improvement districts, salary ordinances, and emergency ordinances are not included in the code. Likewise, the County of Hawai‘i general plan and community development plans are adopted by reference but published as separate documents. The 2016 edition of the Hawai‘i County Code contains all ordinances enacted through June 30, 2016. Its three volumes include 36 chapters of code as well as a subject matter index, a legislative history table that lists ordinances and the chapters they affected by year, and an ordinance table that lists ordinances effective from 2015 to the present.

5.2.4 Zoning Code

Hawai‘i County applies zoning (under Chapter 25 of the County Code) to promote the health, safety, and general welfare of the County. County zoning regulates and restricts the height and size of buildings and other structures, the percentage of a building site that may be occupied, off-street parking, setbacks, size of yards, courts, and other open spaces, the density of population, and the location and use of buildings, structures, and land for trade, industry, residence, or other purposes. The zoning regulations are applied and administered within the framework of the General Plan which is a long-range, comprehensive, general plan prepared to guide the overall future development of the County.

The County building official enforces zoning provisions relative to building construction and occupancy. The County Planning Department director enforces all other provisions pertaining to land use. All County departments, officials, and public employees authorized to issue permits or licenses must conform to the provisions of zoning code, and no permit or license for any use, building, or other purpose may be issued where the license or permit would be in conflict with zoning provisions.

The zoning code divides the lands in the County into the following Zoning Districts:

- RS—single-family residential districts
- RD—double-family residential districts
- RM—multiple-family residential districts
- RCX—residential-commercial mixed use districts
- RA—residential and agricultural districts
- FA—family agricultural district
- A—agricultural districts
- IA—intensive agricultural districts
- V—resort-hotel districts
- CN—neighborhood commercial districts
- CG—general commercial districts
- CV—village commercial districts
- MCX—industrial-commercial mixed use districts
- ML—limited industrial districts
- MG—general industrial districts
- O—open districts
- Special districts

5.2.5 Hawai'i County Capital Improvement Program

All County capital improvements are sanctioned and primarily funded by the County's Capital Improvement Program and budget. The Capital Improvement Program and budget must clearly set forth the qualification of each budgeted item and its priority in the General Plan, community development plan, or special purpose plans such as this hazard mitigation plan. The County Planning Department director prioritizes lists of capital improvement projects based on the following:

- Funding source—The capacity of a funding source available to a proposed improvement may be a factor in determining priority. The capital budget may not exceed prudent debt service limits that affect the borrowing capacity of the County.
- Action Committee recommendations—County Action Committees may provide their priorities for the fiscal year to the director.
- Project delivery phases—All phases of a project, including planning, land acquisition, design, construction, equipment and furnishing, must be addressed in the Capital Improvement Program.
- Deferred maintenance—Deferred maintenance of existing facilities should be considered a high priority for facilities intended to remain in active, long-term service.
- Level of service—The General Plan's level of service standards should be considered.
- Land use policies—Higher priority may be given to improvements that influence growth patterns consistent with the General Plan or community development plans.

The General Plan 2040 calls for hazard mitigation projects to be prioritized in the County's capital improvements program (Natural Resource Planning Section Policy 82).

5.2.6 Capability Assessment

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of a jurisdiction's mission, programs and policies, and evaluates its capacity to carry them out. This assessment identifies potential gaps in the jurisdiction's capabilities. The sections below describe the specific capabilities evaluated under the assessment.

Legal and Regulatory Capabilities

Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body.

Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision and land development ordinances, building codes, building permit ordinances, floodplain, and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation. A summary assessment of existing state and local legal and regulatory capabilities relevant to hazard mitigation is presented in Table 5-3. A more detailed assessment is provided in Appendix D.

Table 5-3. Legal and Regulatory Capability

	Applies Statewide, Countywide or to Specific District?	County Authority	Other Jurisdiction Authority
County of Hawaiʻi Building Code	Countywide	Public Works, Building Division	None
Hawaiʻi Administrative Rules (HAR) State Building Code	Statewide	N/A	State Building Code Council
Hawaiʻi County Zoning Code	Countywide	Planning Department	None
MOA Between County of Hawaiʻi and Department of Hawaiian Homelands	Countywide	N/A	Department of Hawaiian Homelands
Hawaiʻi Coastal Zone Management	Statewide	Planning Director	State
Special Management Areas	Statewide	Planning Director	None
Hawaiʻi County Subdivision Control Code	Countywide	Planning Department	None
Hawaiʻi County Floodplain Management Code	Countywide	Public Works	None
Hawaiʻi County Eligible FEMA Community Rating System, Class 7	Countywide	Public Works	None
Transfer of Development Rights	Statewide		None
County of Hawaiʻi Emergency Operations Plan	Countywide	Civil Defense Agency	None
Storm Drainage Standards	Countywide	Department Public Works	None
Mandatory Seller Disclosures in Real Estate Transactions	Statewide	N/A	None
Hawaiʻi County Affordable Housing Code	Countywide	Housing Administrator	None
County of Hawaiʻi Building Code, Site Plan Review	Countywide	Public Works, Building Division	None
Hawaiʻi Environmental Policy Act	Statewide	N/A	State Agencies
State Water Code	Statewide	N/A	State Commission of Water Resource Management (CWRM)
Hawaiʻi Water Plan	Statewide	N/A	CWRM
Groundwater criteria for designation	Statewide	N/A	CWRM

	Applies Statewide, Countywide or to Specific District?	County Authority	Other Jurisdiction Authority
Cultural and Historical Resource Protection	Statewide	N/A	State Historic Preservation Division
Hawai‘i State Burial Law	Statewide	N/A	State Historic Preservation Division
Land Fire Protection Law	Statewide	N/A	State Division of Forestry and Wildlife
Hawai‘i Wastewater Systems Administration Rules	Statewide	Department of Environmental Management	State Department of Health
Urban Renewal Law	Statewide	Planning Department	None
Hawai‘i Emergency Management Agency (HIEMA)	Statewide	Mayor; Civil Defense	State HIEMA
Hawai‘i Climate Change Mitigation and Adaptation Initiative	Statewide	N/A	State Office of Planning and Department of Land and Natural Resources (DLNR)
Short Term Vacation Rental Law	Countywide	Planning Department	None
Drainage, flood, and erosion mitigation measures	Countywide	Public Works	None
Hawai‘i County General Plan	Countywide	Planning Department	None
Community Development Plans	Individual Districts	Planning Department (with local community partners)	None
Capital Improvement Plan	Countywide	County Council	None
Hawai‘i State Marine Debris Action Plan	N/A	N/A	NOAA
Three Mountain Alliance Watershed Plan	‘Ōla‘a-Kīlauea, La‘u-Kapāpala, South Kona, and North Kona management areas	N/A	Three Mountain Alliance Members
Kohala Watershed Alliance Watershed Plan	Kohala watershed area	N/A	Kohala Partnership
Mauna Kea Alliance Watershed Plan	Mauna Kea Watershed	N/A	Mauna Kea Alliance
Hawai‘i Drought Plan	Statewide	N/A	CWRM
Hawai‘i County Water Use and Development Plan	Countywide	Department of Water Supply	None
State of Hawai‘i Water Quality Management Plan	Statewide	N/A	State Department of Health
County Comprehensive Economic Development Strategy,	Countywide	Hawai‘i Island Economic Development Board	None
Rural Economic Development Planning Report	Statewide	N/A	Office of Planning, Department of Business, Economic Development & Tourism, State of Hawai‘i
Natural Disaster Economic Recovery Strategy	Statewide	N/A	None
Hawai‘i Island Tourism Strategic Plan	Countywide	Department of Research and Development	None
Hawai‘i Island Tourism Road Map	Countywide	Department of Research and Development	None
Consolidated Plan 2015-2019	Countywide	Office of Housing & Community Development	None
Housing Planning Study for County of Hawai‘i	Countywide	County of Hawai‘i	None

	Applies Statewide, Countywide or to Specific District?	County Authority	Other Jurisdiction Authority
Affordable Rental Housing 10-year Report	Statewide	N/A	Special Action Team on Affordable Rental Housing*
Community Wildfire Protection Plans	Kaʻu, South Kona, North Kona, Northwest Hawaiʻi, Ocean View, Hawaiʻi Volcanoes National Park	Hawaiʻi Fire Department	None
Firewise	Countywide	• Honokoa • Kanehoa • Kohala by the Sea • Kohala Waterfront • Puʻukapu • Waialea • Waikiʻi Ranch • Waikoloa Village	State Division of Forestry and Wildlife
Integrated Wildland Fire Management Plan	Statewide	N/A	None
County of Hawaiʻi Transit and Multi-Modal Master Plan	Countywide	Mass Transit Agency	None
Hawaiʻi County Food Self-Sufficiency Baseline Study	Countywide	Department of Research and Development	None
A Blueprint for Action: Water Security for an Uncertain Future, 2016-2018	Statewide	N/A	None
Hawaiʻi Sea-level Rise Vulnerability and Adaptation Report	Statewide	N/A	DLNR/Office of Planning
Puna Regional Circulation Plan	Puna District	Planning Department	None
County of Hawaiʻi Energy Sustainability Program Five Year Roadmap Report	Countywide	Department of Research and Development	None
Hawaiʻi County Food Self-Sufficiency Baseline 2012	Countywide	Department of Research and Development	None
Threat & Hazard Identification & Risk Assessment	Statewide	Civil Defense	Yes
Continuity of Operations Plan	Countywide	Civil Defense	None
Public Health Plan	Statewide	N/A	Department of Health

Fiscal Capabilities

Assessing a jurisdiction's fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees. An assessment of fiscal capabilities is presented in Table 5-4.

Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers. An assessment of administrative and technical capabilities is presented in Table 5-5.

Table 5-4. Fiscal Capability

Financial Resources	Accessible or Eligible to Use?
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes: Sewer, Water
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	No
Incur Debt through Private Activity Bonds	No
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes
Land Bank or Other Support for Transfer of Development Rights	No

Table 5-5. Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency
Planners or engineers with knowledge of land development and land management practices	Yes	Planning Department; Department of Public Works; Department of Water Supply
Engineers or professionals trained in building or infrastructure construction practices	Yes	Department of Environmental Management; Department of Public Works; Department of Water Supply;
Planners or engineers with an understanding of natural hazards and climate change	Yes	Department of Public Works; Department of Water Supply; Finance Department; Planning Department; Research and Development
Staff with training in benefit/cost analysis	Yes	Department of Public Works; Finance Department; Department of Housing
Surveyors	Yes	Department of Public Works
Personnel skilled or trained in GIS applications	Yes	Department of Environmental Management; Department of Water Supply; Planning Department
Scientist familiar with natural hazards in local area	Yes	Department of Water Supply
Emergency manager	Yes	Department of Environmental Management; Fire Department; Civil Defense
Grant writers	TBD	Finance Department; Hawaiʻi Island Disaster Assistance Response and Recovery Team; Housing Department

NFIP Compliance

Community participation in the NFIP creates opportunity for additional grant funding associated specifically with flooding issues. Assessment of current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities. Information on National Flood Insurance Program (NFIP) compliance is presented in Table 5-6.

Public Outreach Capability

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement. An assessment of education and outreach capabilities is presented in Table 5-7.

Table 5-6. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Public Works
Who is your floodplain administrator? (department/position)	Director of Public Works
Are any certified floodplain managers on staff in your jurisdiction?	No
What is the date that your flood damage prevention ordinance was last amended?	January 2018
Does your floodplain management program meet or exceed minimum requirements? • **If exceeds, in what ways?**	Exceeds Includes a 1-foot freeboard provision. References and defines repetitive loss structures, 3-year cumulative qualifier for substantial improvements
When was the most recent Community Assistance Visit or Community Assistance Contact?	6-30-2014 Community Assistance Visit currently in process 2019
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? • **If so, state what they are.**	Yes Minor
Are any RiskMAP projects currently underway in your jurisdiction? • **If so, state what they are.**	No
Do your flood hazard maps adequately address the flood risk within your jurisdiction? • **If no, state why.**	No The flood conditions for Puna are not currently reflected of the effective FIRM for Hawai'i County.
Does your floodplain management staff need any assistance or training to support its floodplain management program? • **If so, what type of assistance/training is needed?**	Yes Floodplain management and duties of local administrator; substantial improvement and substantial damage; flood elevation certificate
Does your jurisdiction participate in the Community Rating System (CRS)? • **If yes, is your jurisdiction interested in improving its CRS Classification?** • **If no, is your jurisdiction interested in joining the CRS program?**	Yes Possibly N/A
How many flood insurance policies are in force in your jurisdiction?[a] • **What is the insurance coverage in force?** • **What is the premium in force?** • **What is the average cost of a flood insurance policy?**	4,582 $1,208,209,000 $3,465,523 $756
How many total loss claims have been filed in your jurisdiction?[a] • **What were the total payments for losses?** • **What is the average claim paid?**	695 since 1978 $18,534,602 $26,668

a. According to FEMA statistics as of 7/31/2019 (https://www.fema.gov/policy-claim-statistics-flood-insurance)

Table 5-7. Education and Outreach Capability

Criterion	Response	Department/Agency
Do you have a public information officer or communications office?	Yes	Department of Public Works; Department of Water Supply; Mayor's Office; Recovery Team; Civil Defense
Do you have personnel skilled or trained in website development?	Minimal	Planning Department; Recovery Team
Do you have hazard mitigation information available on your website? **If yes, briefly describe.**	Yes	Police Department; Recovery Team; Civil Defense
Do you use social media for hazard mitigation education and outreach? **If yes, briefly describe.**	Yes	Department of Public Works; Department of Water Supply; Planning Department; Recovery Team; Facebook
Do you have any citizen boards or commissions that address issues related to hazard mitigation? **If yes, briefly describe.**	Yes	Police Department; Recovery Team Recovery Support Function groups
Do you have any other programs already in place that could be used to communicate hazard-related information? **If yes, briefly describe.**	Yes Tabling/ direct outreach at community events & safety fairs	Planning Department; Civil Defense; Recovery Team CDP Action Committees; Preparedness Fairs; Project 360; Recovery Support Function groups
Do you have any established warning systems for hazard events?	Yes	Civil Defense
If yes, briefly describe.		Emergency warning sirens. Hosted mass notification system and commercial radio for everything else

Participation in Other Programs

Other programs, such as the Community Rating System, Storm/Tsunami Ready, and Firewise USA, can enhance a jurisdiction's ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum requirements set forth by local, state and federal regulations in order to create a more resilient community. These programs complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards on a community. Classifications under various community mitigation programs are presented in Table 5-8.

Table 5-8. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	Yes	8	10/1/2000
Building Code Effectiveness Grading Schedule	No	99/99	N/A
ISO Public Protection Classification	Yes	3 – 10[a]	varies
StormReady	Yes	StormReady	
TsunamiReady	Yes	TsunamiReady	
Firewise	No	N/A	N/A

a. Protection Classes in Hawai'i County vary across the island, based on location of property in relation to fire stations, water supply, natural disaster issues like lava zone and other fire-related factors.

Development and Permitting Capability

Identifying previous and future development trends is achieved through a comprehensive review of permitting since completion of the previous plan and in anticipation of future development. Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to a hazard within a community. An assessment of legal and regulatory capabilities is presented in Table 5-9.

Table 5-9. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? • **If no, who does? If yes, which department?**	Yes, Department of Public Works, Building Division N/A
Does your jurisdiction have the ability to track permits by hazard area?	No
Does your jurisdiction have a buildable lands inventory?	Yes

Adaptive Capacity

The County views all core jurisdictional capabilities as fully adaptable to meet its needs. Every code can be amended, and every plan can be updated. Such adaptability is itself considered to be an overarching capability. If the capability assessment identified an opportunity to add a missing core capability or expand an existing one, then doing so has been selected as an action in the action plan.

An adaptive capacity assessment evaluates the ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against issues such as sea level rise. The adaptive capacity assessment provides an opportunity to identify areas for improvement by ranking such capacity as high, medium or low. The County's adaptive capacity for the impacts of climate change is presented in Table 5-10.

Table 5-10. Adaptive Capacity for Climate Change

Criterion	Department/ Division with Capacity	Rating[a]
TECHNICAL CAPACITY		
Jurisdiction-level understanding of potential climate change impacts on critical infrastructure, housing, natural and cultural resources critical ecosystems, etc.	Research & Development, Planning Department	Low
Comment: Some understanding of sea-level rise impacts in coastal areas. County needs a very specific climate adaptation plan. Current approach is to use the General Plan update and Multi-Hazard Mitigation Plan to understand climate change impacts and develop adaptation strategies.		
Jurisdiction-level monitoring of climate change impacts on critical infrastructure, housing, natural and cultural resources critical ecosystems, etc.	Planning Director	Low
Comment:		
Technical resources to assess proposed strategies for feasibility and externalities	Research & Development	Low
Comment:		
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	Research & Development	High
Comment: Greenhouse gas inventory completed. Will be used to establish County greenhouse gas targets, develop mitigation strategies, and monitor County greenhouse gas emissions over time.		
Capital planning and land use decisions informed by potential climate impacts	Planning Department	Low
Comment: General Plan update contains goals, objectives, and actions that incorporate climate change impacts into land use decisions.		
Participation in regional groups addressing climate risks	Planning Director	Medium
Comment: Participation in State Climate Commission		

Criterion	Department/ Division with Capacity	Rating[a]
IMPLEMENTATION CAPACITY		
Clear authority/mandate to consider climate change impacts during public decision-making processes	Planning Department	Low
Comment:		
Identified strategies for greenhouse gas mitigation efforts	Research & Development	High
Comment: County Research and Development represents the County on the state Greenhouse Gas Sequestration Task Force, which is exploring economic opportunities in carbon markets. County also received a FEMA grant to develop a Climate Action Plan.		
Identified strategies for adaptation to impacts	Planning Department	Low
Comment: No dedicated climate adaptation plan. Adaptation strategies will be identified through the General Plan and Community Development Plans.		
Champions for climate action in local government departments	Planning Department, Research and Development	High
Comment:		
Political support for implementing climate change adaptation strategies	Planning Department	Low
Comment:		
Financial resources devoted to climate change adaptation	Research & Development	Low
Comment: Resources are dedicated to greenhouse gas mitigation policies		
County authority over sectors likely to be negatively impacted	Planning Department	Low
Comment:		
PUBLIC CAPACITY		
Local residents’ knowledge of and understanding of climate risk		Low
Comment: Some understanding of sea-level rise impacts.		
Local residents’ support of adaptation efforts		Low
Comment:		
Local residents’ capacity to adapt to climate impacts		Low
Comment:		
Local economy current capacity to adapt to climate impacts		Low
Comment:		
Local ecosystems capacity to adapt to climate impacts		Low
Comment:		

a. High = Capacity exists and is in use; Medium = Capacity may exist, but is not used or could use some improvement; Low = Capacity does not exist or could use substantial improvement; Unsure= Not enough information is known to assign a rating.

County of Hawai‘i Multi-Hazard Mitigation Plan

PART 2—RISK ASSESSMENT

6. IDENTIFIED HAZARDS OF CONCERN AND RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from natural hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of disasters may affect a jurisdiction, how often they can occur, and their potential severity.
- **Vulnerability identification**—Determine the impact of natural hazard events on the people, property, environment, economy and lands of the region.
- **Cost evaluation**—Estimate the cost of potential damage or cost that can be avoided by mitigation.

6.1 IDENTIFIED HAZARDS OF CONCERN

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the DMA (44 CFR, Section 201.6(c)(2)). This statute requires a full risk assessment of "all natural hazards that can affect the jurisdiction." Other hazards may be assessed at the discretion of the planning jurisdiction. For this update, the County of Hawaiʻi followed FEMA guidance for defining natural hazards. Future updates to this plan can choose to expand on this approach using guidance and best management practices that are in place at that time. The definition of a natural hazard may be open to interpretation as, for example, wildfires are considered natural hazards, even though they often are started by human actions.

The working group considered the full range of natural hazards that could impact the planning area and then listed hazards that present the greatest concern. The process incorporated review of state and local hazard planning documents, as well as information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Ultimately, the working group directed that the update fully assess the following natural hazards of concern and provide qualitative profiles of additional hazards of interest (invasive species, mass events, cyber, pandemic outbreaks, food supply):

- Climate change/sea level rise
- Dam failure
- Drought
- Earthquake
- Flood
- High surf/storm surge/coastal flood
- High windstorms
- Landslide
- Tropical cyclone
- Tsunami
- Volcanic eruption
- Wildfire

Hazard profiles in this plan are presented in alphabetical order; the order has no relevance to hazards' relative severity or level of concern.

6.2 RISK ASSESSMENT TOOLS

6.2.1 Mapping

A review of national, state, and county databases was performed to locate available spatially based data relevant to this planning effort. Where available, data sets that define areas at greatest risk of experiencing harmful effects from a specific hazard, based on historical experience and vulnerability analyses, were used in the risk assessments for this plan. These areas, which include mapped flood zones, wildfire hazard areas and other locations susceptible to hazards, are generically referred to in this plan as "high-risk zones" or "high-risk areas."

Maps were produced using GIS software to show the spatial extent and location of identified hazards when such data were available. Maps are included in the hazard profile chapters of this document. Information regarding the data sources and methodologies employed in these mapping efforts is located in Appendix E.

6.2.2 Modeling

Overview

In 1997, FEMA developed the standardized Hazards U.S.-Multi-Hazard (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology, Hazus, with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that it can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates the review of mitigation plans because it ensures that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability and hazards; this default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. This data is derived from national databases and describes in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.

- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

6.3 RISK ASSESSMENT APPROACH

The risk assessments in this plan describe the risks associated with each identified hazard of concern. Each chapter describes the hazard, the planning area's vulnerabilities, and probable event scenarios. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - A summary of past events that have impacted the planning area
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity descriptions
  - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was determined by overlaying hazard maps with an inventory of structures, facilities, and systems to determine which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities—**Vulnerability of exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as geographic information systems (GIS) and FEMA's hazard-modeling program called Hazus (Hazus) were used to perform this assessment for the dam failure, flood, earthquake and tropical cyclone hazards. Outputs similar to those from Hazus were generated for other hazards, using maps generated through GIS.

6.3.1 Hazard Profile Development

Hazard profiles were developed through web-based research and review of previously developed reports and plans, including community general plans and state and local hazard mitigation plans. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others.

6.3.2 Exposure and Vulnerability

Dam Failure, Earthquake, Flood and Tropical Cyclone

The following hazards were evaluated using Hazus:

- **Dam Failure**— A Level 2 user-defined analysis was performed for general building stock and critical facilities and assets in mapped dam failure inundation areas. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Earthquake**—A Level 2 user-defined analysis was performed to assess earthquake exposure and vulnerability for three scenario events and one probabilistic event:
  - 100-year probabilistic earthquake

- **Scenario Earthquake #1**—Hawaiʻi (South Kohala) Magnitude-6.7 scenario with a depth of 24 miles located 17 miles north-northeast of Kailua-Kona (19.88°N, 155.94°W). This scenario represents the Hawaiʻi (South Kohala) earthquake on October 15, 2006.
- **Scenario Earthquake #2**—Kalapana 1975 Magnitude-7.7 scenario with a depth of 6 miles located 26 miles south-southeast of Hilo (19.34°N, 155.00°W). This scenario represents the Kalapana earthquake on November 29, 1975.
- **Scenario Earthquake # 3**— Kaʻū Magnitude-8.0 scenario with a depth of 6 miles located 4 miles northwest of Pāhala (19.25°N, 155.50°W). This scenario represents the Kaʻū District earthquake on April 3, 1868.

- **Flood (Riverine and Coastal)**—A Level 2 user-defined analysis was run using the flood methodology described above for dam failure. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance flood event.
- **Tropical Cyclone**—A Level 2 general building stock analysis was performed to assess tropical cyclone wind exposure and vulnerability for a Category 4 event with a storm track west by northeast.

Sea Level Rise, High Winds, Landslide, Tsunami, Volcanic Eruption, and Wildfire

For most of the hazards of concern, historical data were not adequate to model future losses. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means and exposure was evaluated. For other hazards, a qualitative analysis was conducted using the best available data and professional judgment.

Drought

The risk assessment methodologies used for this plan focus on damage to structures. Because drought does not impact structures, the risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern.

6.4 SOURCES OF DATA USED IN HAZUS MODELING

6.4.1 Building and Cost Data

Replacement cost values and detailed structure information derived from tax assessor parcel and real property data provided by the County were loaded into Hazus. When available, an updated inventory was used in place of the Hazus defaults for critical facilities and assets.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RSMeans Square Foot Costs* (RSMeans, 2019). It is calculated using the RSMeans square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

6.4.2 Hazard Risk Areas

Hazard risk area data input to Hazus for the risk assessment were derived from the mapping effort, using the sources described in Appendix E.

6.4.3 Data Source Summary

Table 6-1 summarizes the data sources used for the risk assessment for this project.

Table 6-1. Hazus Model Data Documentation

Data	Source	Date	Format
Property parcels	Hawai‘i County	2019	Digital (GIS) format
Real property data (including use description, area, date of construction, number of stories, and foundation type)	Hawai‘i County	2019	Digital (text) format
Building replacement cost	RSMeans	2019	Paper format. Updated RSMeans values
American Community Survey 5-year Population Estimates at the Census block group level	Hawai‘i Statewide GIS Program Geospatial Data Portal	2015	Digital (GIS) format
Land Use Pattern Allocation Guide	Hawai‘i County	2015	Digital (GIS) format
Sea Level Rise Exposure Area (SLR-XA) 3.2ft	Hawai‘i Sea Level Rise Vulnerability and Adaptation Report	2017	Digital (GIS) format
1%-Annual-Chance Coastal Flood Zone (1%CFZ) + 3.2ft SLR	Hawai‘i Sea Level Rise Vulnerability and Adaptation Report	2017	Digital (GIS) format
Dam failure inundation areas	Provided by Pacific Disaster Center (original data prepared for DLNR)	2009	Digital (GIS) format
Earthquake ShakeMaps	USGS Earthquake Hazards Program website	2017	Digital (GIS) format
NEHRP Soils	AECOM	2008	Digital (GIS) format
Effective DFIRM	FEMA	2017	Digital (GIS) format
Straight Line Wind Awareness Area	Hawai‘i County	2019	Digital (GIS) format
Landslide susceptibility	Provided by Pacific Disaster Center (original data prepared by URS)	2009	Digital (GIS) format
Hazus wind field import files for the Hawai‘i Catastrophic Hurricane Plan	Provided by Pacific Disaster Center	2015	Hazus import format
Sea, Lake and Overland Surges from Hurricanes (SLOSH) Model Data for the State of Hawai‘i	NOAA National Hurricane Center, Storm Surge Unit	2018	Digital (GIS) format
2009 Hawai‘i Tsunami Mapping Project tsunami inundation areas	Provided by Hawai‘i County	2009	Digital (GIS) format
Lava flow hazard zones	Hawai‘i Statewide GIS Program Geoportal (original data prepared by USGS Hawaiian Volcano Observatory)	1991	Digital (GIS) format
Historic lava flows (1790 to 2018)	USGS Hawaiian Volcano Observatory	2018	Digital (GIS) format
Communities at Risk from Wildfire	Provided by Hawai‘i Wildfire Management Organization (prepared in conjunction with DLNR Division of Forestry and Wildlife	2013	Digital (GIS) format
Coastal 3-meter Digital Elevation Model	NOAA Office for Coastal Management website	2013	Digital (GIS) format
10-meter Digital Elevation Model	USGS	2016	Digital (GIS) format
Makani Pahili 2017 Emergency Power Prioritization Workshop Series Final Report (Critical facilities including EOCs, buses, electrical power, fuel, gas, communication, water wells, pump stations, nursing homes, assisted living centers, residential care, extended care, ice distributors, grocery stores, jails, community centers, and gyms)	Hawai‘i Emergency Management Agency (HI EMA)	2017	Digital (GIS) format
Fire stations	State of Hawai‘i Office of Planning	2017	Digital (GIS) format

Data	Source	Date	Format
Hospitals/Medical facilities	State of Hawai‘i Department of Health	2019	Digital (GIS) format
Police stations	State of Hawai‘i Office of Planning	2017	Digital (GIS) format
Sirens	County of Hawai‘i	2019	Digital (GIS) format
Harbors	State of Hawai‘i Department of Transportation Harbors Port Handbook		Digital (GIS) format
Airports	State of Hawai‘i Department of Transportation	2019	Digital (GIS) format
Bridges	State of Hawai‘i Office of Planning	2018	Digital (GIS) format
Electrical Power	U.S. Environmental Protection Agency	2013	Digital (GIS) format
Puna Geothermal Venture Wells	County of Hawai‘i (Roy Takemoto)	2019	Digital (GIS) format
Electric Substations/Transfer Stations, Fuel (HSIP data)	Oak Ridge National Laboratory	2019	Digital (GIS) format
Fuel (HSIP data)	Oak Ridge National Laboratory	2017	Digital (GIS) format
Wastewater Facilities/Pumps	Hawai‘i County Department of Environmental Management (Waste Water Map)	2019	Digital (GIS) format
Debris Clearing and Disposal	Hawai‘i County Department of Environmental Management - Solid Waste	2019	Digital (GIS) format
Financial Institutions	State of Hawai‘i Department of Commerce and Consumer Affairs	2019	Digital (GIS) format
Schools	State of Hawai‘i Office of Planning,	2019	Digital (GIS) format
Assisted Living Centers	Hawai‘i County Civil Defense	2019	Digital (GIS) format
Emergency Shelters	Hawai‘i County Department of Education	2019	Digital (GIS) format
Emergency Shelters	Hawai‘i County Department of Parks and Recreation	2019	Digital (GIS) format
Facility Registry Service (FRS) - Toxic Release Inventory facilities	U.S. Environmental Protection Agency website	2019	Digital (GIS) format

6.5 LIMITATIONS

Loss estimates, exposure assessments and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Hawai‘i County will collect additional data to assist in estimating potential losses associated with other hazards.

7. CLIMATE CHANGE

7.1 HAZARD DESCRIPTION

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time.

The well-established worldwide warming trend of recent decades and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production and changes in land use. According to the National Aeronautics and Space Administration (NASA), carbon dioxide concentrations measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen dramatically since then, surpassing 400 ppm in 2013 for the first time in recorded history (see Figure 7-1).

Source: NASA, 2020

Figure 7-1. Global Carbon Dioxide Concentrations Over Time

7.1.1 How Climate Change Affects Hazard Mitigation

Climate change will affect the people, property, economy and ecosystems of Hawaiʻi County in a variety of ways. Consequences of climate change include increased flood vulnerability, and increased heat-related illnesses. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. Specifically, as hydrology changes, storms currently considered to be the 100-year flood might strike more often, leaving many communities at greater risk. The risks of landslide, severe storms, and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis.

7.1.2 Current Indications of Climate Change

Global Impacts

The major scientific agencies of the United States—including NASA and the National Oceanic and Atmospheric Administration (NOAA)—have presented evidence that climate change is occurring. NASA summarizes key evidence as follows (NASA, 2020a):

- Global Temperature Rise—The planet's average surface temperature has risen about 1.62 ºF since the late 19th century, a change driven largely by increased carbon dioxide and other human-made emissions into the atmosphere. Most of the warming occurred in the past 35 years, with the five warmest years on record taking place since 2010.
- Warming Oceans—The oceans have absorbed much of this increased heat, with the top 2,300 feet of ocean showing warming of more than 0.4 ºF since 1969.
- Shrinking Ice Sheets—The Greenland and Antarctic ice sheets have decreased in mass. Greenland lost an average of 286 billion tons of ice per year between 1993 and 2016, and Antarctica lost about 127 billion tons of ice per year during the same time period. The rate of Antarctica ice mass loss has tripled in the last decade.
- Glacial Retreat—Glaciers are retreating almost everywhere around the world—including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.
- Decreased Snow Cover—Satellite observations reveal that the amount of spring snow cover in the Northern Hemisphere has decreased over the past five decades and that the snow is melting earlier
- Sea Level Rise—Global sea level rose about 8 inches in the last century. The rate in the last two decades is nearly double that of the last century and is accelerating slightly every year.
- Declining Arctic Sea Ice—Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades

- Extreme Events—The number of record high temperature events in the United States has been increasing since 1950, while the number of record low temperature events has been decreasing. The U.S. has also witnessed increasing numbers of intense rainfall events.
- Ocean Acidification—Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year.

Impacts in Hawaiʻi

According to a briefing sheet produced by the University of Hawaiʻi Sea Grant College Program, Hawaiʻi is getting warmer. Data shows a rapid rise in air temperature in the past 30 years (averaging 0.3 °F per decade). The rate of temperature rise at elevations below 2,600 feet—0.16 °F per decade—is less than the global rate of 0.36 °F per decade. However, the rate of warming at elevations in Hawaiʻi above 2,600 feet—0.48 °F per decade—is faster than the global rate. Most of the warming is related to a larger increase in minimum temperatures compared to the maximum—a net warming about 3 times as large—causing a reduction of the daily temperature range.

Despite recent years where the rate of global warming was low, surface temperatures in Hawaiʻi have remained high. As temperatures rise, modeling results indicate to some extent that the State of Hawaiʻi should expect to see decreased rainfall in response to climate change. Studies over the past 20 years have confirmed this phenomenon, as rainfall in throughout the state has steadily declined about 15 percent over the past 20 years (Fletcher, 2010).

A University of Hawaiʻi study noted the following trends (University of Hawaiʻi, 2014):

- 70 percent of the beaches have eroded and over 13 miles of beach have been completely lost to erosion in the last century. Additionally, many of the state's coastlines are experiencing shoreline retreat, with an average of 1 foot lost per year, wetland migration, and cliff collapse.
- Low coastal areas have experienced more frequent flooding due to elevated groundwater tables, which have increased partially due to sea-level rise.
- Tropical cyclones are occurring more frequently, with more having developed from Pacific storms between 1991 and 2010 than in the last century
- Hawaiʻi has recorded a decrease of prevailing northeasterly trade winds in the last 40 years; these winds drive precipitation on windward coasts.
- There has been an overall decline in rainfall in the last 30 years, leading scientists to expect droughts and heavy rains more frequently leading to flash flooding, infrastructure damage, runoff and sedimentation. In addition, the decrease in rainfall levels has also led to a decline in stream base flow over the last 70 years, influencing aquatic and riparian ecosystems, local agriculture, and aquifer recharge and freshwater supplies.
- Global ocean acidification has also been noted, with a 30 percent increase of marine uptake of carbon dioxide or pH change of 0.1. Scientists expect this trend to continue, with pH levels increasing up to 0.4 by 2100. Higher levels of ocean acidity can negatively impact marine animals, such as by inhibiting shell and skeleton growth in corals, shellfish, and plankton.

7.1.3 Projected Future Impacts

Global Projections

Scientists project that Earth's average temperatures will raise between 5 ºF and 9 ºF by 2100 (Reuters, 2018). Some research has concluded that every increase of 2ºF in average global average temperature can have the following impacts (NRC, 2011):

- 3 to 10 percent increases in the amount of rain falling during the heaviest precipitation events, which can increase flooding risks
- 200 to 400 percent increases in the area burned by wildfire in parts of the western United States
- 5 to 10 percent decreases in stream flow in some river basins
- 5 to 15 percent reductions in the yields of crops as currently grown.

Sea level is rising at increasing rates due to global warming of the atmosphere and oceans and melting of the glaciers and ice sheets. Rising sea level and projections of stronger and more frequent El Niño events and tropical cyclones in waters surrounding Hawai‘i all indicate a growing vulnerability to coastal flooding and erosion. While the IPCC’s “business as usual” scenario, in which greenhouse gas emissions continue at the current rate of increase, predicts up to 3.2 feet of global sea level rise by 2100 (IPCC, 2014), recent observations and projections suggest that this magnitude of sea level rise could occur as early as 2060 under more recently published highest-end scenarios (Sweet et al., 2017). Figure 7-2 shows the projected rate of global sea level rise under different greenhouse gas scenarios (IPCC, 2014).

Source: IPCC 2014

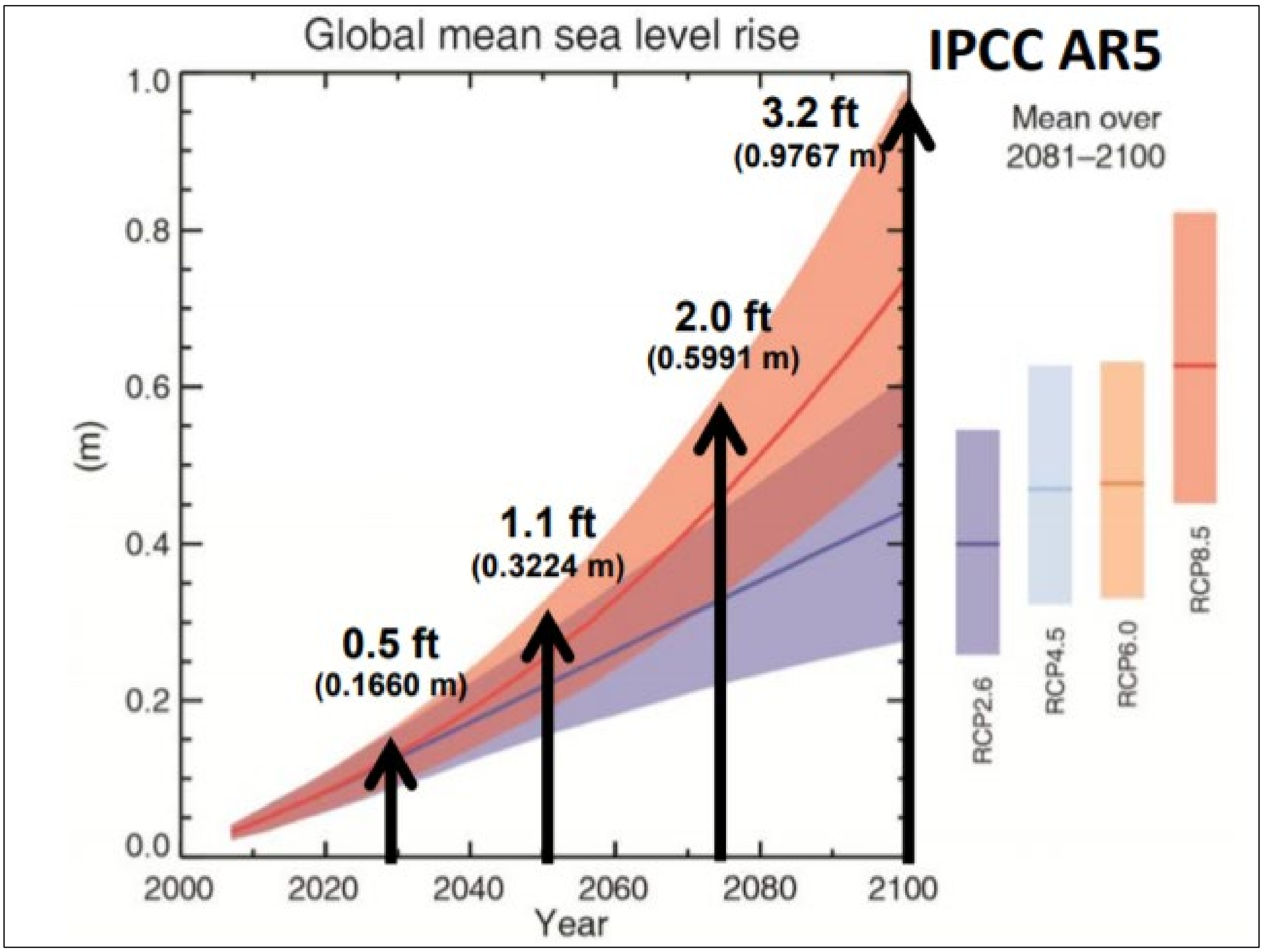


Figure 7-2. Projected Rate of Global Sea Level Rise under Different Emissions Scenarios

Projections for Hawai‘i

The University of Hawai‘i’s 2014 climate report summarizes the major expected impacts of climate change in Hawai‘i. These impacts concern five primary areas: the marine ecosystems (open ocean and coral reefs/near-shore habitats), coasts and the built environment, terrestrial eco-systems, freshwater resources, and public health. The study noted that the most likely changes to Hawai‘i include accelerated sea level rise, ocean and atmospheric warming, increased flooding, ocean acidification, changing distributions of terrestrial and marine biota, and changing intensity and frequency of storms. Specific projected changes with relevance to this hazard mitigation plan include the following:

- Sea surface temperatures will continue warming, increasing between 2.3 ºF and 4.9 ºF in the Pacific by 2100.
- Mean sea-level rise estimates by 2100 range from 1 foot to 3 feet.
- Portions of low-lying coastal areas may become submerged, including Hilo in Hawai‘i County.
- The island of Hawai‘i is expected to become wetter closer to 2100. This can lead to increased public health concerns.

Climate change impacts are not limited to just physical impacts, however; they can also create social, cultural, and economic impacts. The residents of Hawai‘i County need to implement climate change mitigation actions not just to prevent increased risk of hazards but also to prevent any negative impacts on the tourism economy or a coastal culture (University of Hawai‘i, 2014).

Threats to food and water security, infrastructure, health, and safety could lead to increased human migration away from the islands or towards higher land, decreasing tourism and making it more difficult for unique regional customs, beliefs and languages to endure. Additionally, native plants and animals, particularly those in high-elevation ecosystems or experiencing increased exposure to invasive species, face higher stresses and a greater risk of extinction (Leong et al., 2014).

7.1.4 Responses to Climate Change

Mitigation and Adaptation

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term “mitigation” can be confusing, because it’s meaning changes across disciplines:

- Mitigation in emergency management—as generally addressed in this hazard mitigation plan—is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters.
- Mitigation in climate change discussions is defined as a human intervention to reduce impacts on the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.

In this chapter, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

Adaptation refers to adjustments in natural or human systems in response to the actual or anticipated effects of climate change and associated impacts. These adjustments may moderate harm or exploit beneficial opportunities. Mitigation and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions.

Societies across the world are facing the need to adapt to changing conditions associated with natural disasters and climate change. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Most ecosystems show a remarkable ability to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines and recreation—can provide a buffer to societies in the face of changing conditions.

Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services. This plan is one way in which the County of Hawaiʻi intends to identify and achieve more mitigation projects.

Future Modeling Efforts

Current modeling efforts are unable to assess climate change at a resolution small enough to determine specific impacts for individual communities. However, generalized assessments of larger climatic regions can be used to determine impacts that are most likely to affect these communities. As these models are developed in the future, the risk assessment presented in this plan may be enhanced to better measure these impacts. The Pacific Islands Regional Climate Assessment (PIRCA), released in 2012, does contain some regional models and estimates. Since these data are not focused on the specific impacts to the County of Hawaiʻi, it has been included as a reference and was not utilized in overall vulnerability assessment ratings (Keener et al., 2012).

Hawaiʻi State Response

In 2014, the Hawaiʻi State Legislature passed Act 83, which formally established The Hawaiʻi Climate Adaptation Initiative to enable a coordinated approach among all agencies at all levels of government to plan for and address the effects of climate change to protect the state's economy, health, environment, and way of life. Act 83 established a coordinating body to carry out this mission known as the Interagency Climate Adaptation Committee composed of state and county government representatives. The committee's first tasks were to develop a report addressing the statewide impacts of sea level rise and to develop recommendations for action.

7.2 SEA LEVEL RISE ESTIMATES

Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change. Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and coastal erosion).

The *Sea Level Rise Vulnerability and Adaptation Report* prepared by Hawaiʻi's Interagency Climate Adaptation Committee provides a statewide assessment of Hawaiʻi's vulnerability to sea level rise. It outlines recommendations to reduce exposure and sensitivity to sea level rise and increase capacity to adapt. The report's recommendations are based on emerging good practices and framed through extensive stakeholder consultations. A sea-level-rise risk assessment for this hazard mitigation plan used data from the report for Hawaiʻi County. The data provide a preliminary, generalized overview of the potential impacts of one facet of climate change for the planning area.

Two areas of risk were identified for this analysis:

- Chronic Sea Level Rise Exposure Area (SLR-XA)—The chronic sea level rise exposure area is the area predicted to be inundated under ongoing normal conditions in the future, for various scenarios of sea level rise. The previous report assessed four possible scenarios. For this risk assessment, only the 3.2-foot rise was evaluated. The area of future chronic inundation for this estimate is shown on Figure 7-3; detailed area maps are provided in Appendix B.
- Event-Based Sea Level Rise Inundation Area—The event-based inundation area is the area that would be inundated under the 3.2-foot chronic sea-level-rise scenario if a 1 percent annual chance coastal flood event occurs (Coastal Flood + SLR). This area is shown in Figure 7-4; detailed area maps are provided in Appendix B.

The planning team overlaid this data on the population, land use, general building stock and critical facility and asset data developed for the hazard risk assessment for this plan. Detailed results by district are provided in Appendix F; results for the total planning area are presented in Table 7-1, and Figure 7-5 and Figure 7-6. This assessment assumes that these sea level rise impacts occur on present day Hawaiʻi County rather than occurring gradually over years or decades.

Table 7-1. Estimated Exposure for Coastal Flood + Sea Level Rise and Sea Level Rise Chronic Flooding

	Coastal Flood + SLR	SLR-XA
Population		
Population Exposed	5,170	68
% of Total Planning Area Population	2.7%	Less than 1%
Property		
Number of Buildings Exposed	2,543	40
Value of Exposed Structures	$6.126 billion	$100.723 million
Value of Exposed Contents	$5.747 billion	$52.535 million
Total Exposed Property Value	$11.873 billion	$153.259 million
Total Exposed Value as % of Planning Area Total	*20.40%*	*Less than 1%*

7.3 POTENTIAL CLIMATE CHANGE IMPACT ON HAZARDS

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches, the more subject to changing dynamics it becomes. Although quantitative estimates are subject to concerns about changing conditions, qualitative assessments can be made of potential impacts on hazard-related risks. Discussions of the potential impacts of climate change on each hazard are provided below.

7.3.1 Coastal Erosion

Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion. A study on increased storm wave heights from climate change indicated that coastal erosion and flooding may occur twice as fast from sea level rise alone and up to four times as fast as a doubling of the frequency of major El Niño events occurring. Should all these potential subsequent events from climate change occur simultaneously, there could be up to an order of magnitude increase in coastal erosion and flood frequency compared to current rates (Ruggiero, 2008).

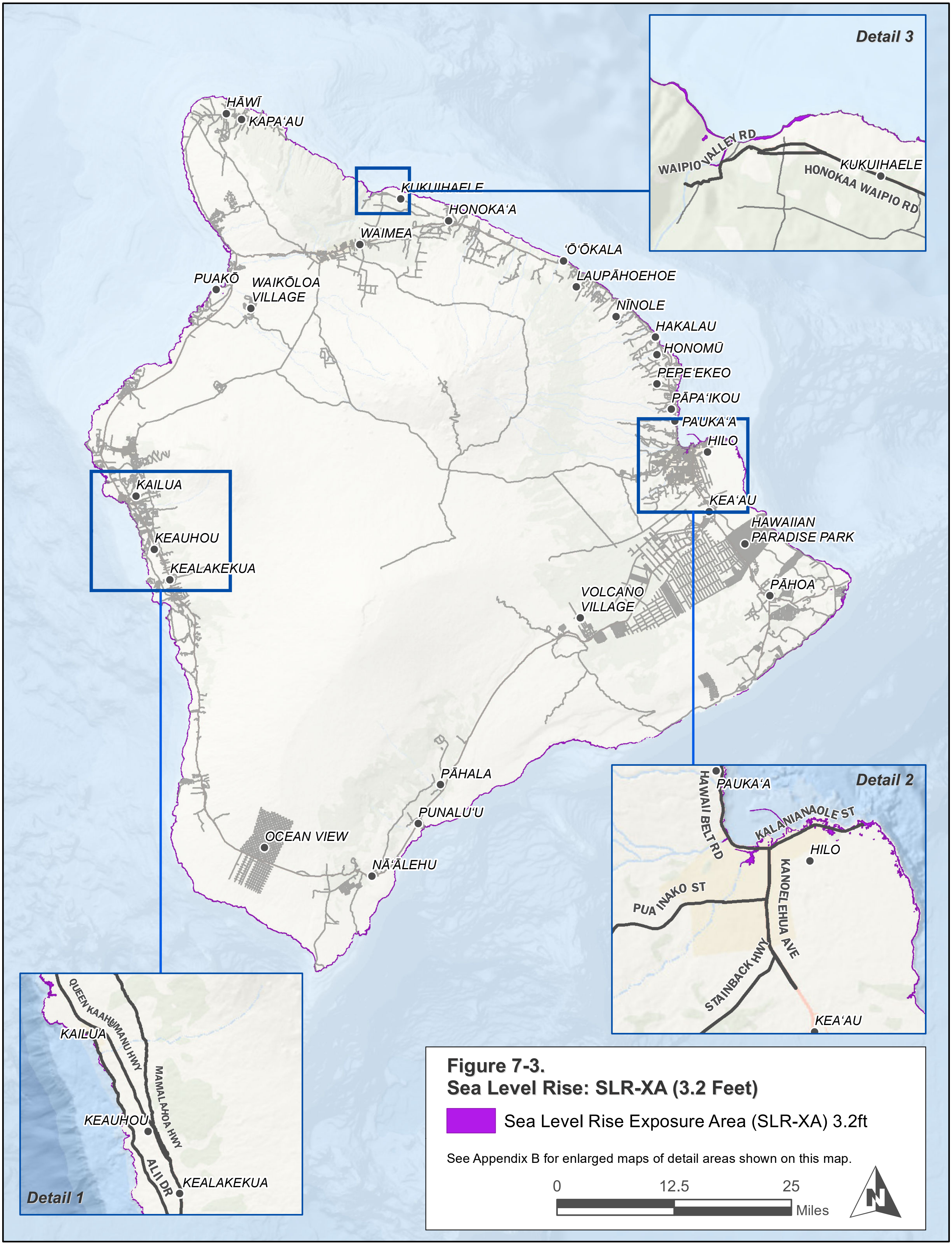


Figure 7-3.
Sea Level Rise: SLR-XA (3.2 Feet)

See Appendix B for enlarged maps of detail areas shown on this map.

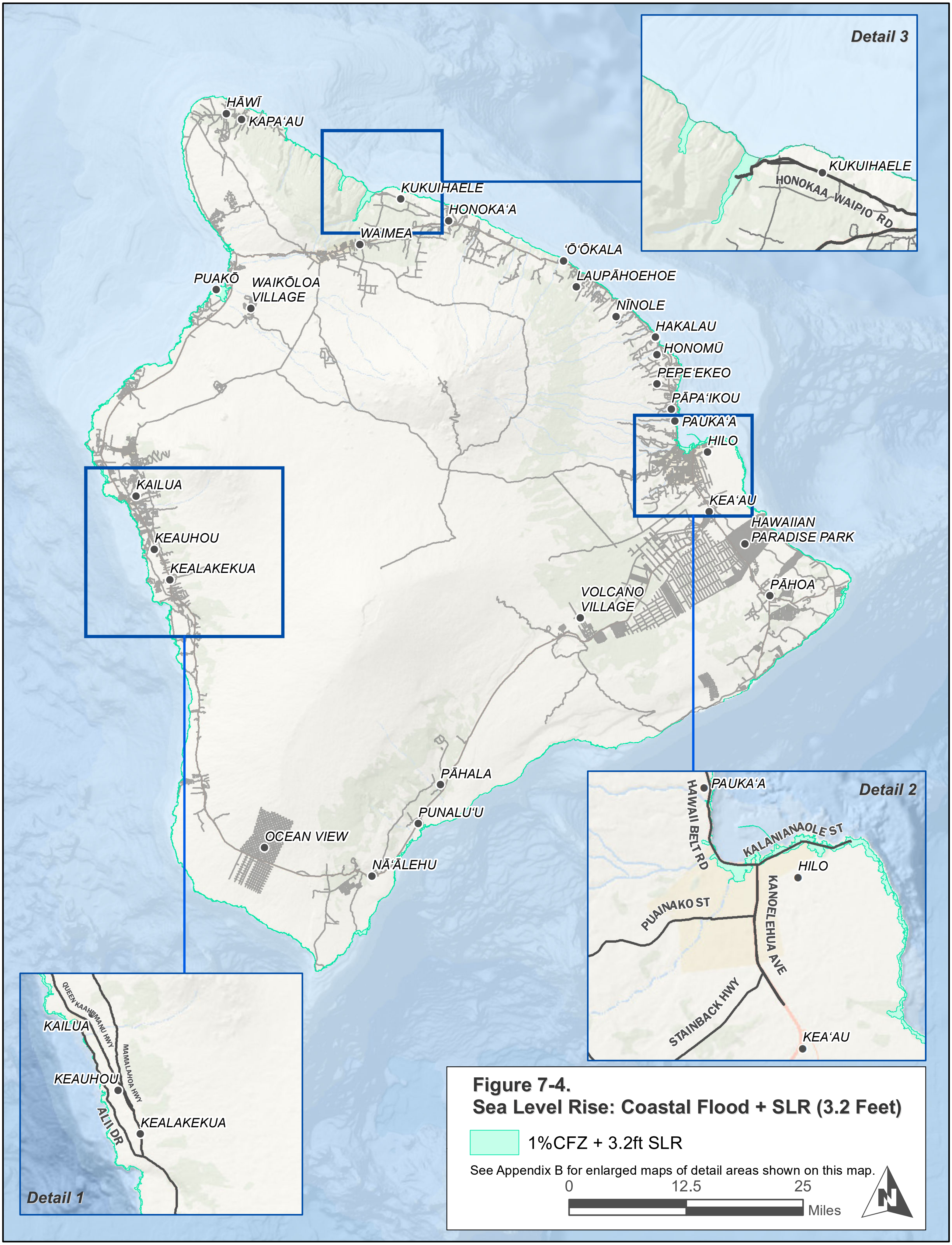


Figure 7-4.
Sea Level Rise: Coastal Flood + SLR (3.2 Feet)

See Appendix B for enlarged maps of detail areas shown on this map.

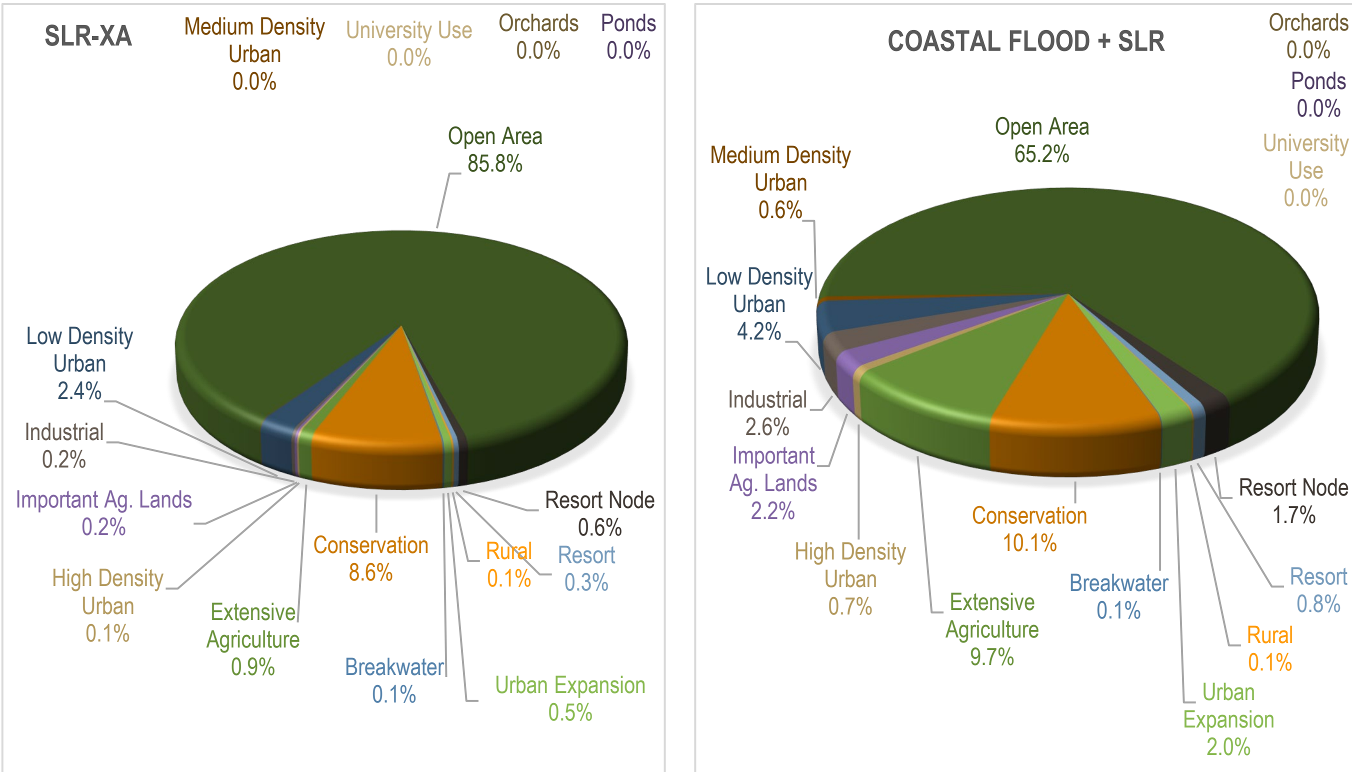


Figure 7-5. Land Use Distribution by Area in Sea Level Rise Inundation Areas

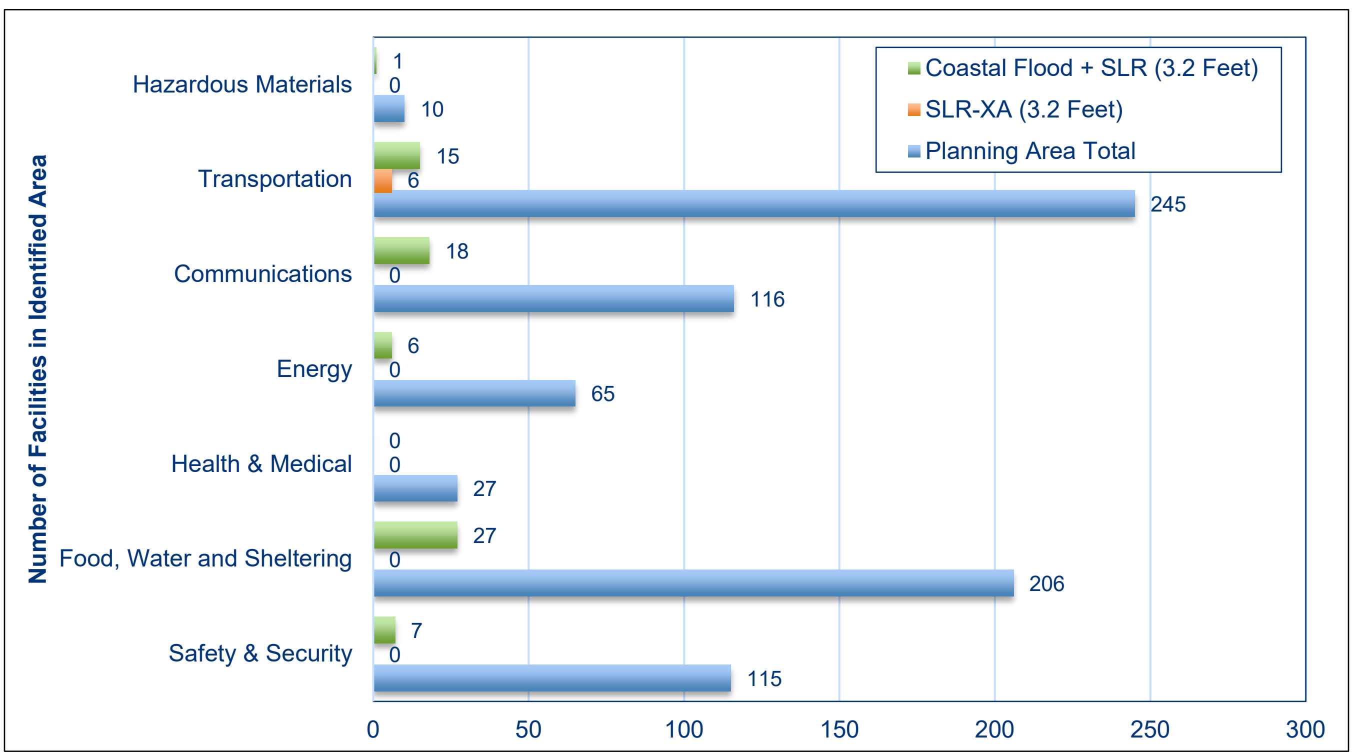


Figure 7-6. Critical Facilities in SLR-XA and Coastal Flood + SLR

As an island, Hawai'i County is particularly sensitive to the impacts of climate change on coastal erosion. According to the Intergovernmental Panel on Climate Change, small islands can anticipate the following effects of climate change:

- Inundated and displaced wetlands and lowlands
- Eroded shorelines
- Exacerbated coastal storm flooding
- Increase in salinity of estuaries, threatening freshwater aquifers and otherwise impair water quality
- Alteration of tidal ranges in rivers and bays
- Alteration of sediment depositional patterns.

As sea levels rise, so will the increase in pressure and strength of wave action against Hawai'i County's coastlines. Additionally, sewage and siltation are among the most significant contributions to human-caused degradation of coral-reef and other natural coastal systems in Hawai'i (Bijlsma et al., 1996).

7.3.2 Dam Failure

Dams are designed partly based on assumptions about a stream's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some of its designed margin of safety, also known as freeboard. If freeboard is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream.

Dams are constructed with safety features known as "spillways," which provide a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

7.3.3 Drought

As parts of the world get drier, the amount and quality of water available will decrease, impacting people's health and food supplies. With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. More frequent extreme droughts could result in decreased stream flows in local rivers, affecting water supplies for domestic and agricultural uses.

Between 2000 and 2009, approximately 30 to 60 percent of the United States experienced drought conditions at any one time (NRDC, n.d.). Hawai'i has experienced longer droughts on all the populated islands, as indicated by a comparison of the length of dry periods from 1980 to 2011 against 1950 to 1970 (University of Hawai'i, 2014).

An option for water resource managers regarding climate change is to start addressing current stresses on water supplies and build flexibility and robustness into any system. Flexibility helps to ensure a quick response to changing conditions, and robustness helps people prepare for and survive the worst conditions. With this approach to planning, water system managers will be better able to adapt to the impacts of climate change.

7.3.4 Earthquake

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity, according to research into prehistoric earthquakes and volcanic activity.

NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

7.3.5 Flood

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

High frequency flood events (e.g. 10-year floods) in particular will likely increase with a changing climate. Scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains. Additionally, rising sea levels, coupled with high water levels caused by tropical and extra-tropical storms, will incrementally increase coastal flooding and erosion, damaging coastal ecosystems, infrastructure, and agriculture, and negatively affecting tourism (Leong et al., 2014).

7.3.6 High Surf

Sea level rise, coupled with overall global warming and other climate change impacts, can lead to more frequent high surf events. It could result in currently high surf levels of 10 to 20 feet becoming normal. This change can create several secondary, negative impacts and vulnerabilities, including:

- Loss of important coastal habitats
- Increased beach and coastal erosion
- Increased life safety and property risks
- More frequent coastal flood events and greater damage from all coastal flood-related hazards.

Sea level has risen over the last century on each island in Hawai‘i at rates of 0.5 to 1.3 inches per decade. Globally, rates of sea-level rise have are projected to continue to accelerate, resulting in a 1- to 3-foot rise by the end of the century. Sea-level rise will exacerbate coastal inundation, erosion and hazards (University of Hawai‘i, 2014).

7.3.7 High Windstorm

Historical data shows that the probability for severe weather events such as high windstorms increases in a warmer climate.

7.3.8 Landslide

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

7.3.9 Tropical Cyclone

A tropical cyclone’s strong winds and intense low pressure can generate storm surge along coastal communities. While not all tropical cyclones have devastating impacts or create significant levels of storm surge, the surge index record shows a significant positive trend between warmer years and extreme events (i.e., Katrina-level events). One study found that Category 4 and 5 hurricanes could increase up to 81 percent in frequency with a temperature increase of only 2.5 ºC. While surge levels will vary because of situational factors, projected changes in hurricane surge levels above the mean sea level in Hawai‘i are more likely to increase than decrease with global warming (results range from a 10 percent reduction to 50 percent increase with a 2.8 ºC temperature increase).

Figure 7-7 provides a visual representation of the number of Katrina-magnitude surge events per decade in the past and projected changes. Each line shows the results based off different modeling techniques and data contributions. Although there is some variation depending on the model, the results show an overall positive correlation between temperature increase and storm surge frequency (Grinsted et al., 2013). Although this study focused on hurricanes and the Atlantic Ocean, which are not exactly comparable to the tropical cyclone events that impact Hawai‘i, the results still highlight how a small temperature change can significantly increase damage and vulnerability. Hawai‘i is expected to see an additional increase in tropical cyclone events unrelated to the increase from warmer temperatures, as the storm track may shift north toward the Central North Pacific (University of Hawai‘i, 2014).

The projected increase in sea level rise has the potential to increase risk of storm surge-related flooding along the coast; expand areas at-risk of coastal flooding; increase vulnerability of energy facilities located in coastal areas; flood transportation and telecommunication facilities; and cause saltwater intrusion into some freshwater supplies near the coasts. High water levels, strong winds, and heavy precipitation resulting from severe coastal storms already cause billions of dollars in damage and disrupt transportation and utility distribution systems. Sea level rise will lead to more frequent and extensive coastal flooding. Warming ocean waters raise sea level through thermal expansion and have the potential to strengthen the most powerful tropical cyclones.

Source: Grinsted et al., 2013

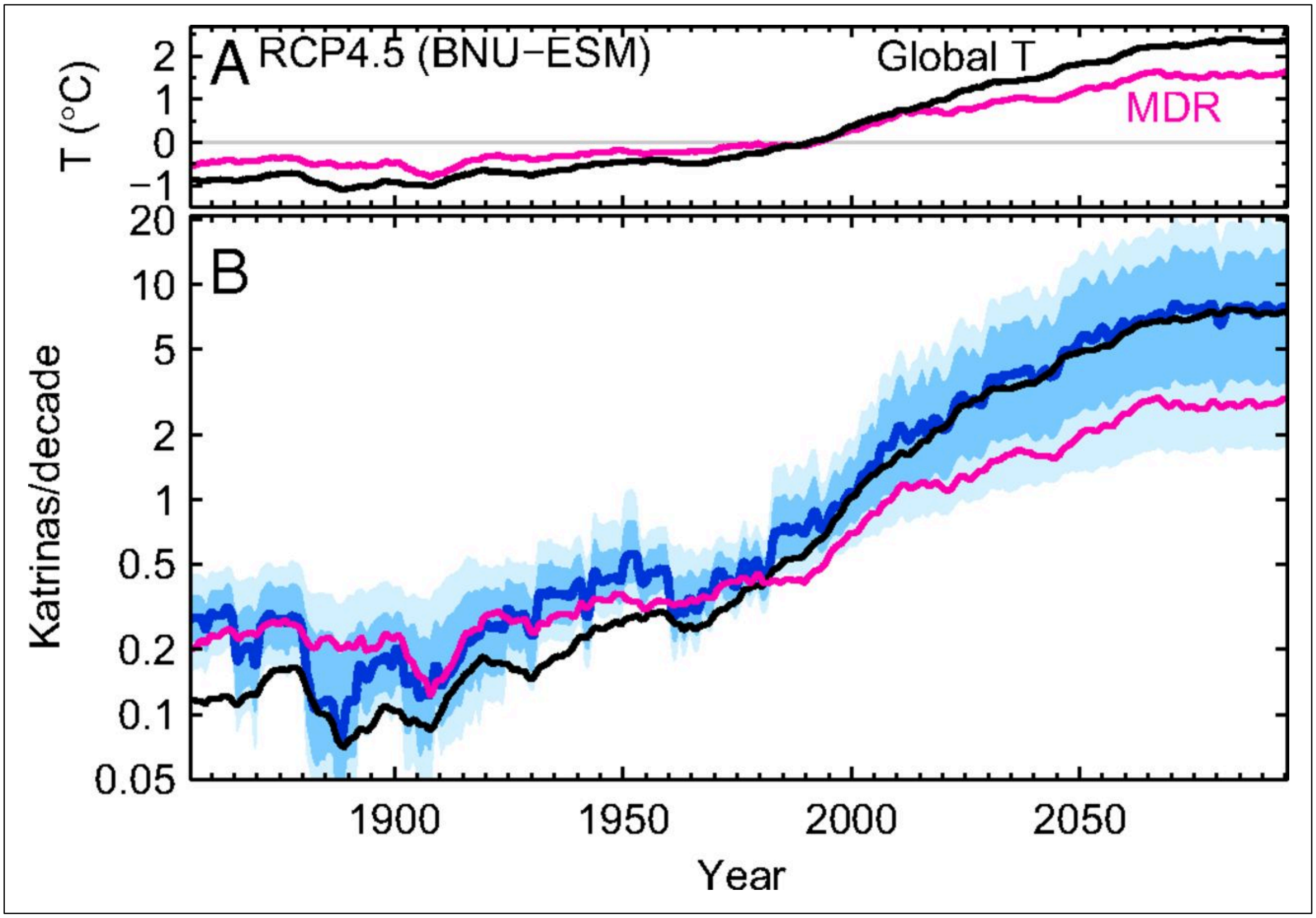


Figure 7-7. Surge Event Frequency over Time and Climate Changes

7.3.10 Tsunami

Any rise is sea level resulting from climate change could increase the risk to coastal communities exposed to the tsunami hazard. Oceanic waves and surge could reach further inland, resulting in more damage to infrastructure and increased life safety concerns.

7.3.11 Volcanic Hazards

Changing future conditions may impact the dispersion and areas of impact of the volcanic hazard. Any changes in wind and rainfall frequency and intensity may alter the dispersion of volcanic gas emissions, thus adversely impacting human health.

Climate change also could affect recovery of the environment after a volcanic event. For example, vegetation destroyed by volcanic activity takes time to recover, and the length of recovery is dependent on the amount of rain and changes in the climate that the area is experiencing (Oregon State University, no date). The landscape also becomes altered after lava inundation such as changes in infiltration capacity, which influences the type of species that grow after a volcanic event (National Academies of Sciences, Engineering, and Medicine, 2017). In an already dry or water-stressed environment that may be caused by changes in climate or rain frequency, reduced infiltration can cause increased runoff and sediment transport into water supplies, and reduce available soil-water content for the growth of vegetation to recover after a volcanic event.

7.3.12 Wildfire

Wildfire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. An increase in temperature coupled with a noticeable decrease in precipitation exacerbates droughts and has the potential to contribute to an increased frequency of wildfire. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

8. DAM FAILURE

8.1 HAZARD DESCRIPTION

8.1.1 Definition and Classification of Dams

Hawaiʻi Administrative Rules (Chapter 190.1) define a state-regulated dam as any artificial barrier, including appurtenant works that impounds or diverts water and has one of the following characteristics:

- Is 25 feet or more in height from the natural bed of the stream or watercourse or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse
- Has an impounding capacity at maximum water storage elevation of 50 acre-feet or more.
- Has two or more reservoirs that operate or function as a single facility or are connected together with an uncontrolled conduit, which shall be construed to be one dam or reservoir.
- Is a natural structure that retains water and has been altered by the addition of an outlet works and has a maximum storage volume greater than 50 acre-feet.

There are generally three types of dams:

- Detention dams minimize the effects of flood runoff by storing all or part of an anticipated flood runoff. The stored floodwater is released at a rate that does not exceed the carrying capacity of the channel downstream.
- Storage dams impound water during periods of surplus supply to be used during dry periods for crop irrigation, livestock watering, municipal or industrial water supply, or electricity generation.
- Diversion dams (not regulated) provide hydraulic head for diverting water from streams and rivers into ditches or canals.

8.1.2 Causes of Dam Failure

Partial or full failure of dams has the potential to cause massive destruction to the ecosystems and communities located downstream. Partial or full failure can occur as a result of one or a combination of the following reasons (FEMA, 2015):

- Overtopping caused by floods that exceed the dam capacity (inadequate spillway capacity)
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate or negligent operation, maintenance, and upkeep
- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides).

Many dam failures in the United States have been secondary results of other disasters. The most common causes are earthquakes, landslides, extreme storms, equipment malfunction, structural damage, foundation failures, and sabotage. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

The potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of every major dam in the country. The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect the lives and property of the public.

8.1.3 Regulatory Oversight

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency’s capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety.

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

State and federal initiatives have been established to reduce the potential of full or partial failures. The State of Hawai‘i’s 2010 Dam Safety Act (HAR, Title 13, Subtitle 7, Chapter 190.1) is administered by the Department of Land and Natural Resources (DLNR), which reviews and approves plans and specifications for the construction of new or modified dams. Any individual or entity seeking to construct, alter, repair or remove an existing dam must fill out the DLNR’s *Application for Approval of Plans and Specifications for Construction, Enlargement, Repair, Alteration, or Removal of Dam*.

8.2 HAZARD PROFILE

8.2.1 Past Events

There is no record of any major dam failures on the island of Hawai‘i resulting in significant loss of property or life. However, several dams showed signs of damage following the October 2006 Kīholo Bay earthquake. Some damage occurred to dams and irrigation ditches in the Waimea-Kamuela area where recorded peak ground acceleration exceeded 1.0g (soil depths are greater in that region than along the rocky coast nearest the epicenter). At least two dams experienced cracks along their crests, while at least two others showed clear evidence of incipient slope failure on their embankments. Two dams located above Waimea were drained after excessive seepage and “water boils” were observed five days following the earthquakes.

8.2.2 Location

List of High-Hazard Dams

Most dams in Hawai'i are old earthen berm reservoirs built during the plantation era originally for irrigation purposes. Hawai'i County has nine high-hazard dams, all of which are earth dams (see Table 8-1). Their locations are shown on Figure 8-1; detailed area maps are provided in Appendix B.

Table 8-1. Hawai'i County High Hazard Dams

Name	Drainage Area (square miles)	Owner[a]	Year Built	Spillway Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Use[b]
Hāwī #5 Reservoir		SHDA	1930	Pipe	1,500	20	55	MULTI
Keaīwa Reservoir	0.00294	Edmund C. Olson Trust No. II	1920	Channel	600	32	48	IRR
Pūnāwai Reservoir	0.02	Ponoholo Ranch, Ltd.	1970	Channel	650	38	30	IRR
Puu Pūlehu Reservoir	0.65	SHDA	1910	Channel	400	20	445	IRR
Pu'ukapu Watershed Retarding Dam R-1	3.05	HI DLNR	1965	Channel	4,340	12	1,450	FC
Waikoloa Reservoir # 1		HCDWS	1970	Channel	1,700	44	190	STO
Waikoloa Reservoir # 2	0.0114	HCDWS	1975	Tunnel	2,000	30.5	190	STO
Waikoloa Reservoir # 3	0.011	HCDWS	1985	Tunnel	1,500	54	190	STO
Waimea Reservoir	0.008	SHDA	1957	Channel	1,070	50	189	IRR

a. HCDWS = Hawai'i County Department of Water Supply, SHDA = State of Hawai'i Department of Agriculture, HI DLNR = Hawai'i Department of Land and Natural Resources

b. Use codes: DIV = Diversion; DOM = Domestic; IND = Industrial; IRR = Irrigation; MULTI = Multi-purpose; MUN = Municipal; POW = Power Generation; REC = Recreation; REG = Regulation; STO = Storage, FC = Flood Control

Source: HI DNLR, Dam Inventory System (http://132.160.239.52/daminventory/Default.aspx?qt=damhawaii)

Inundation and Evacuation Mapping

Following the catastrophic breach of the Ka Loko Dam on the island of Kaua'i in March 2006, dam owners in Hawai'i were mandated to prepare, maintain, and implement emergency preparedness plans for each dam or reservoir. A key element for each plan is a map defining the potential downstream inundation should the dam fail, and an assessment of the critical infrastructure and population at risk under these circumstances. For each dam inundation scenario modeled, it was assumed that:

- The dam failure occurred under sunny day, dry stream conditions
- The dam failure occurred while the dam was at maximum capacity
- Failure occurred by piping halfway up the dam face (or in a location designated by DLNR)
- The spillways or outlet works were inoperable at the time of the breach.

Working groups headed by representatives from county civil defense agencies determined evacuation boundaries using the dam inundation maps.

For this risk assessment, digital data suitable for a quantitative assessment of dam failure risk was available for all high hazard dams listed in Table 8-1.

8.2.3 Frequency

Given the increased monitoring procedures enacted following the 2006 Ka Loko Dam breach, the probability of a dam failure anywhere in the state of Hawai'i has been significantly reduced. A major dam failure is a rare event for which there is no defined recurrence interval. However, failure potential does exist during an extreme rainfall event or major earthquake at any unmaintained or under-maintained location.

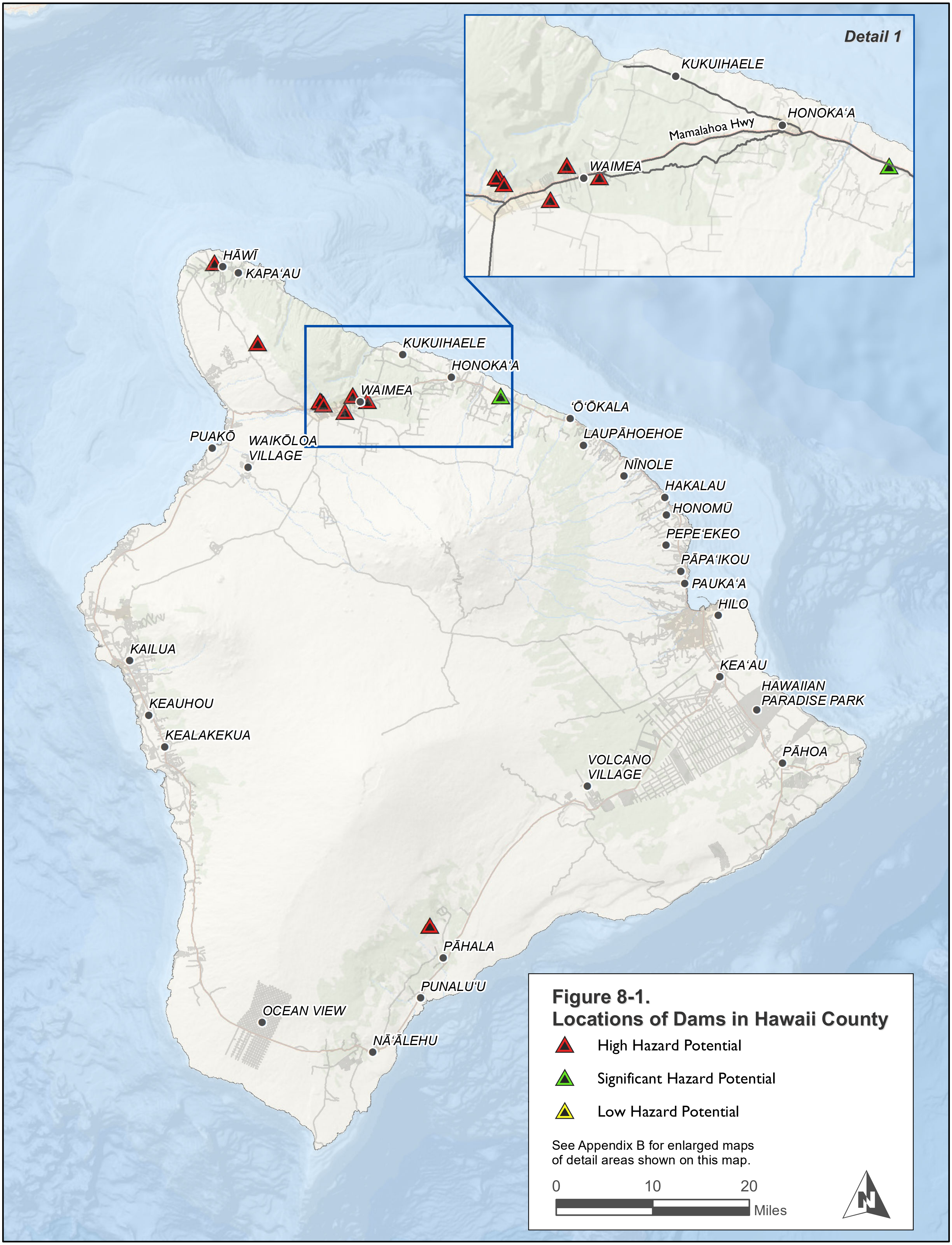


Figure 8-1.
Locations of Dams in Hawaii County

See Appendix B for enlarged maps of detail areas shown on this map.

8.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. The State of Hawai‘i classifies dams and reservoirs in a three-tier hazard rating system based on potential consequences to downstream life and property that could result from a failure of the dam (HAR Section 13-190.2-2):

- **High Hazard**—High hazard dams are those where failure would probably cause loss of human life.
- **Significant Hazard**—Significant hazard dams are those where failure would result in no probable loss of human life but could cause major economic loss, environmental damage, disruption of lifeline facilities, or other concerns. Significant hazard potential classification dams or reservoirs are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **Low Hazard**—Low hazard dams are those where failure would result in no probable loss of human life and low economic loss or environmental loss, or both. Economic losses are principally limited to the owner’s property.

DLNR has rated nine dams in Hawai‘i County as high-hazard, as listed in Table 8-1.

8.2.5 Warning Time

Warning time for dam failure depends on the cause of the failure. In events of extreme precipitation, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be little warning time. A dam’s structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until either the reservoir water is depleted or the breach resists further erosion. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

8.2.6 Secondary Hazards

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on streams, and destruction of downstream habitat. Dam failure may worsen the severity of a drought by releasing water that might have been used as a potable water source.

8.3 EXPOSURE

Five dams were chosen for an exposure and vulnerability analysis based on available data and probable impacts: Pūnāwai, Pu‘ukapu, Puu Pūlehu, Waikoloa, and Waimea dams. These dams were selected because they represent the largest, non-overlapping exposure areas. A quantitative assessment of exposure to the dam failure hazard was conducted using inundation mapping for these dams (see Figure 8-2; detailed area maps are provided in Appendix B) and the asset inventory developed for this plan. Appendix F provides results by district; results for the total planning area are presented below.

8.3.1 Population and Property

Table 8-2 summarizes the estimated population living in the evaluated dam failure evacuation areas and the estimated property exposure.

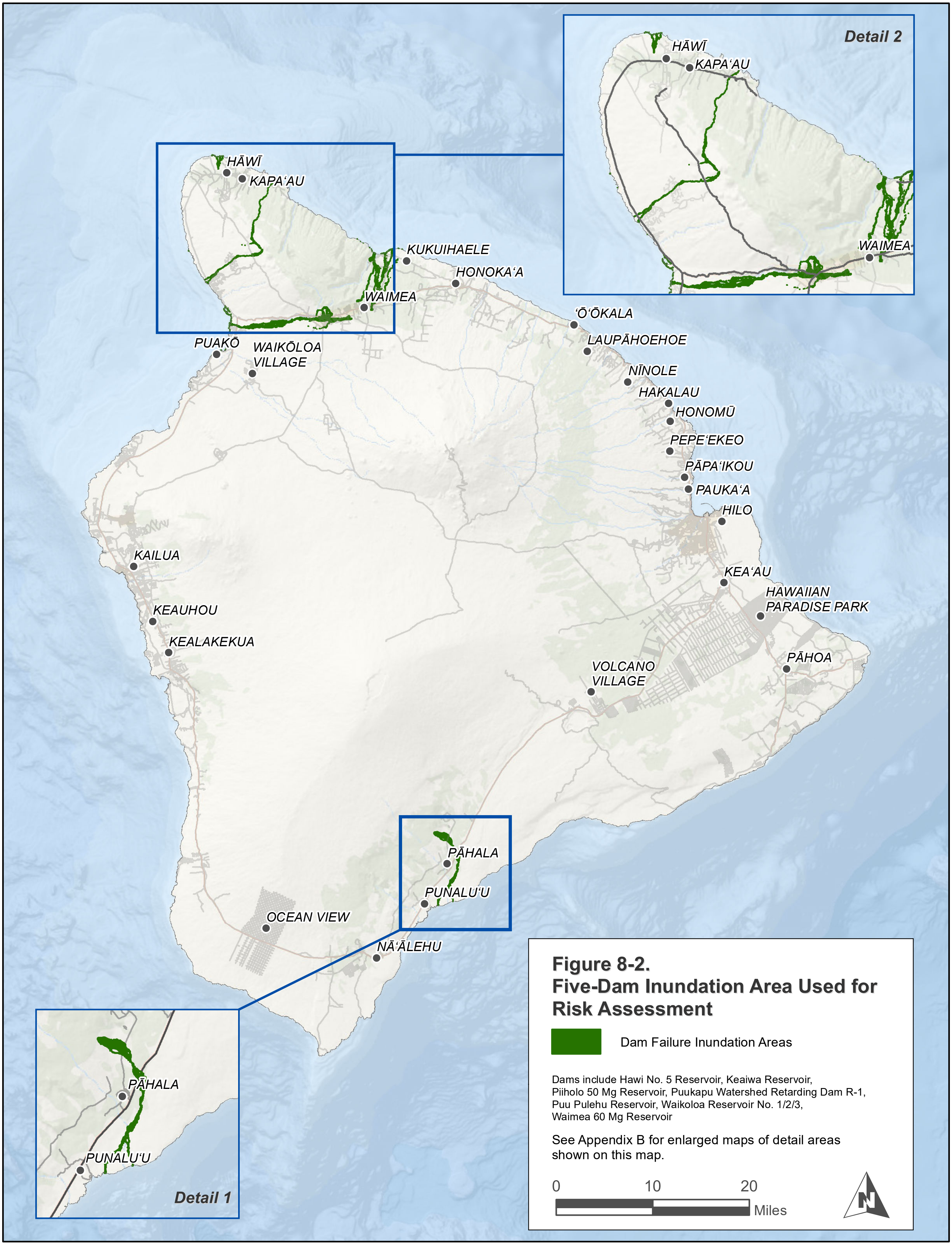


Figure 8-2.
Five-Dam Inundation Area Used for Risk Assessment

Dams include Hawi No. 5 Reservoir, Keaiwa Reservoir, Piiholo 50 Mg Reservoir, Puukapu Watershed Retarding Dam R-1, Puu Pulehu Reservoir, Waikoloa Reservoir No. 1/2/3, Waimea 60 Mg Reservoir

See Appendix B for enlarged maps of detail areas shown on this map.

Table 8-2. Exposed Population and Property in Evaluated Dam Failure Evacuation Areas

	Pūnāwai	Pu'ukapu	Puu Pūlehu	Waikoloa	Waimea
Population					
Population Exposed	26	260	59	652	9
% of Total Planning Area Population	Less than 1%	Less than 1 %	Less than 1%	Less than 1%	Less than 1%
Property					
Acres of inundation area	192	1,446	900	1,610	353
Number of Buildings Exposed	10	247	26	513	3
Value of Exposed Structures	$4.04 million	$324.5 million	$5.8 million	$444.7 million	$450,872
Value of Exposed Contents	$2.02 million	$302.4 million	$2.9 million	$379.9 million	$225,436
Total Exposed Property Value	$6.01 million	$626.9 million	$8.7 million	$824.7 million	$676,307
Total Exposed Value as % of Planning Area Total	Less than 1%	1.1%	Less than 1%	1.4%	Less than 1%

8.3.2 Critical Facilities and Assets

Figure 8-3 shows critical facilities located in the dam inundation zone by facility type and river system. The total count of critical facilities in the dam failure inundation zone (14) represents 1.8 percent of the planning area total of 784.

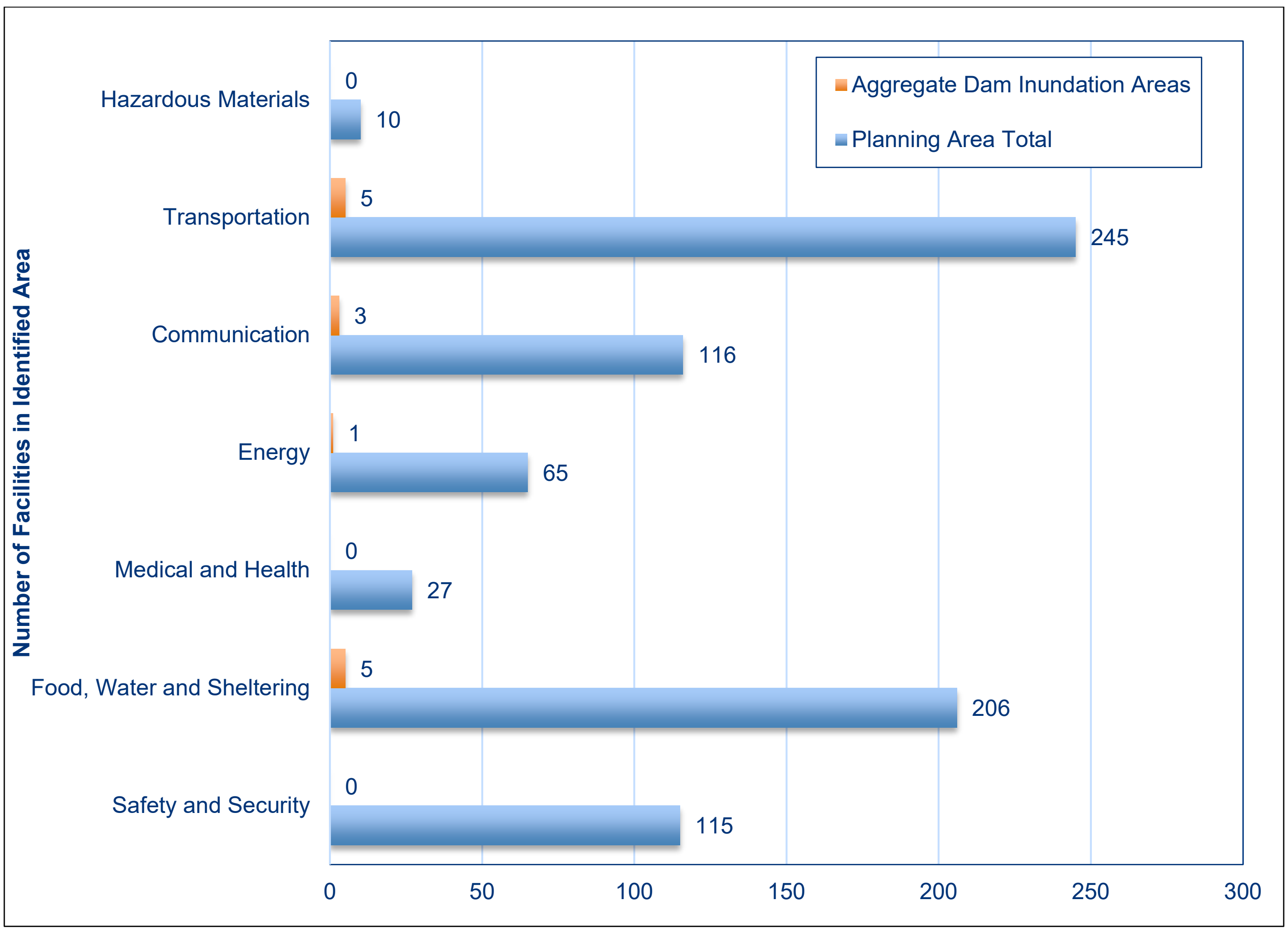


Figure 8-3. Critical Facilities in the Aggregate Dam Inundation Areas and Countywide

8.3.3 Environment

Reservoirs held behind dams affect many ecological aspects of a stream. Stream topography and dynamics depend on a wide range of flows, but streams below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of stream beds and banks.

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals and plants, especially endangered species or delicate coral ecosystems.

8.4 VULNERABILITY

Vulnerability is the effect of dam failure on the surrounding community and planning area as a whole. These effects can be felt beyond the immediately affected area.

8.4.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly, young, and individuals with disabilities, access, or functional needs who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. Population adversely affected by a dam failure may also include those beyond the disaster area that rely on the dam for providing potable water.

Impacts on persons and households for the five dams chosen for further analysis were estimated for each event through the Level 2 Hazus analysis. Table 8-3 summarizes the results.

Table 8-3. Estimated Dam failure Impacts on Persons and Households

	Number of Displaced Households	Number of Residents Requiring Short-Term Shelter
Pūnāwai	None	None
Pu‘ukapu	58	3
Puu Pūlehu	5	None
Waikoloa	276	17
Waimea	3	None

8.4.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Table 8-4 shows the Hazus loss estimates that could result from a failure of each of the five dams chosen for additional analysis. The methodology and/or scenarios utilized to develop the evacuation maps were utilized for the analysis.

Table 8-4. Loss Estimates for Dam Failure

Dam Name	Structures Impacted[a]	Estimated Loss			
		Structures	Contents	Total	Estimated Loss as % of Total Replacement Value
Pūnāwai	10	$152,079	$99,104	$251,183	Less than 1%
Puʻukapu	125	$2,148,690	$2,114,109	$4,262,799	Less than 1%
Puu Pūlehu	7	$148,853	$91,633	$240,486	Less than 1%
Waikoloa	216	$8,839,023	$10,759,612	$19,598,635	Less than 1%
Waimea	1	$20,122	$12,186	$32,308	Less than 1%

a. Calculated using a user-defined analysis in Hazus 4.2 SP03.

8.4.3 Critical Facilities and Assets

Hazus estimated damage to critical facilities and assets in the dam failure inundation zone as summarized in Table 8-5. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroad related facilities and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas. The methodology and/or scenarios utilized to develop the evacuation maps were utilized for the analysis.

Table 8-5. Estimated Damage to Critical Facilities from Dam Failure

	Number of Facilities Affected	Average % of Total Value Damaged	
		Building	**Contents**
Safety and Security	0	N/A	N/A
Food, Water and Sheltering	3	0.44	2.32
Health and Medical	0	N/A	N/A
Energy	1	0.06	0.00
Communications	1	0.00	0.56
Transportation	1	1.25	N/A
Hazardous Materials	0	N/A	N/A
Total	**6**	**0.44**	**0.96**

8.4.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species and delicate coral ecosystems. The extent of the vulnerability of the environment is the same as the exposure of the environment.

8.5 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by the general plan and community development plans adopted under state law. The distribution of general land use types in the dam inundation areas is shown in Figure 8-4. Agricultural lands make up most of the area (about 75 percent); urban uses make up about 20 percent.

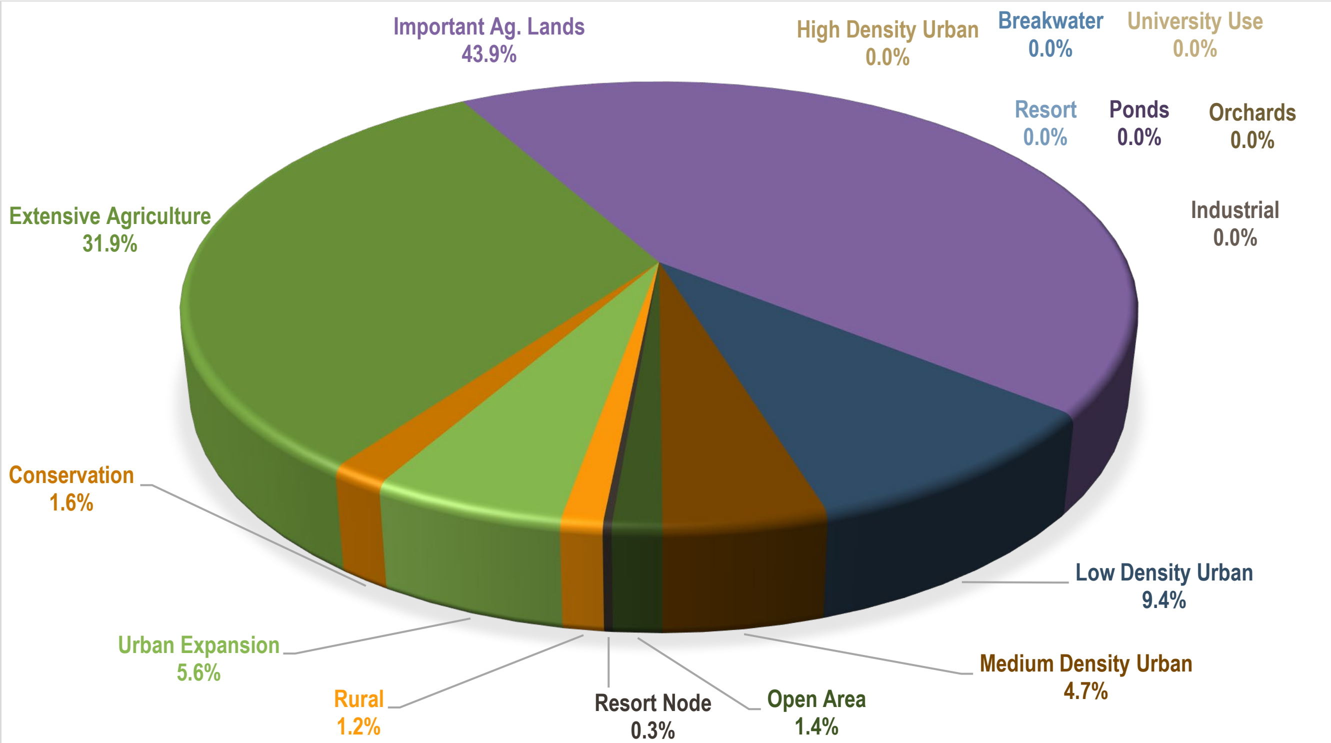


Figure 8-4. Land Use Distribution by Area in the Aggregate Dam Inundation Areas

The natural resource element of the general plan establishes standards and policies for the protection of the community from hazards. Dam failure is currently not explicitly addressed in the countywide policy plan or many of the older community plans. Many of these plans are currently in the update process and the results and recommendations on this hazard mitigation plan will be incorporated into updated policies and planning actions.

8.6 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a high hazard dam. This could occur without warning during any time of the day. While the probability of dam failure is very low, the probability of flooding associated with changes to dam operational parameters in response to climate change is higher. Dam designs and operations are developed based on hydrographs with historical record. If these hydrographs experience significant changes over time due to the impacts of climate change, the design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may need to be changed. This could result in increased discharges downstream of these facilities, thus increasing the probability and severity of flooding.

8.7 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation and evacuation zones. Flooding as a result of a dam failure could significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or tropical cyclones, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- **Residual Risk**—The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land-use regulations.
- **Security—**Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- **Climate Change impacts—**Dam infrastructure may require repair and improvement to withstand climate change impacts, such as changing in the timing and intensity of rain events.
- **Flood Insurance Coverage—**A significant number of the structures located in the dam inundation zone are located outside of special flood hazard areas, meaning that they are not constructed to withstand floodwaters and are less likely to be covered by flood insurance. Even structures that have been designed with flood hazards in mind may not be able to withstand the height and velocity of flow from a dam failure event.
- **Waikoloa Dam—**This dam experienced damage from the 2006 earthquake and is not currently being operated to full capacity.

9. DROUGHT

9.1 HAZARD DESCRIPTION

A drought is a period of abnormally dry weather. Drought diminishes natural stream flow and depletes soil moisture, which can cause social, environmental and economic impacts. In general, the term "drought" is reserved for periods of moisture deficiency that are relatively extensive in both space and time.

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

In Hawaiʻi, droughts and wildland fires can threaten all the islands in any given year, though the eastern portion of the Hawaiian Islands seem to have been most severely impacted by drought events since 1999. This includes Hawaiʻi County. The severity and duration of drought has not been as bad as in Kauaʻi and Oʻahu (CWRM, 2003).

9.1.1 Drought Impacts

Lack of rainfall is not the only factor defining drought. Drought can be characterized based on various impacts or measurements (State of Hawaiʻi, 2018):

- Meteorological measurements such as rainfall deficit compared to normal or expected rainfall
- Agricultural impacts due to reduced rainfall and water supply (e.g., crop loss, herd culling, etc.)
- Hydrological measurements of stream flows, groundwater, and reservoir levels relative to normal conditions
- Direct and indirect socio-economic impacts on society and the economy (e.g., increased unemployment due to failure of an industry because of drought).

Drought can affect a wide range of economic, environmental, and social activities. The demand that society places on water systems and supplies—such as expanding populations, irrigation, and environmental needs—also contributes to drought impacts. According to the most recent draft of Hawaiʻi's State Water Protection Plan, drought can lead to difficult decisions regarding the allocation of water, as well as stringent water use restrictions, water quality problems, and inadequate water supplies for fire suppression. There are also issues such as growing conflicts between agricultural uses of surface water and in-stream uses, surface water and groundwater interrelationships, and the effects of growing water demand on traditional and cultural uses of water.

The vulnerability of an activity to the effects of drought usually depends on its water demand, how the demand is met, and what water supplies are available to meet the demand. The impacts of drought vary between sectors of the community in both timing and severity:

- **Water supply—**The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes ground water supplies due to reduced recharge from rainfall.
- **Agriculture and commerce—**The agriculture and commerce sector includes the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover for grazing.
- **Environment, public health, and safety—**The environmental, public health, and safety sector focuses on wildfires that are both detrimental to the forest ecosystem and hazardous to the public. It also includes the impact of desiccating streams, such as the reduction of in-stream habitats for native species.

9.1.2 Monitoring Drought

Scientists and academics commonly use drought indices to monitor droughts. Some indices used for the continental United States are not suitable for use in Hawai‘i's highly variable climate. The sections below describe indices that are useful for drought monitoring in Hawai‘i.

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) considers only precipitation. An index value of zero represents the median precipitation amount, and the index is negative for drought and positive for wet conditions. SPI values can be generated for multiple time scales, which is useful for monitoring because the effects of droughts occur over wide ranges of time scales. SPI values are as follows:

- 2.00 and Greater Extremely Wet
- 1.50 to 1.99 Very Wet
- 1.00 to 1.49 Moderately Wet
- 0.99 to -0.99 Near Normal
- -1.00 to -1.49 Moderately Dry
- -1.50 to -1.99 Very Dry
- -2.00 and Less Extremely Dry

Selection of SPI Intervals

The following descriptions explain applicable SPI intervals and values for key sectors in Hawai‘i (State of Hawai‘i, 2017):

- **Water Supply Sector**—The water supply sector is typically affected by long sustained periods of drought that affect ground and surface water resources. For this reason, a 12-month SPI is typically the best interval to evaluate drought severity for this sector.
- **Agriculture and Commerce Sector**—The agriculture sector is usually the first sector to feel the effects of drought. Farmers and ranchers who depend on rainfall for irrigation may be severely affected by even short-term moderate drought events. Because the agriculture and commerce sector is affected by short-term drought events, a 3-month SPI drought interval is best suited to evaluate drought severity for this sector.
- **Environment, Public Health, and Safety Sector**—Drought can have a number of effects on the environment, public health and safety sector. However, focus is often given exclusively to the area of wildfire impacts. Prolonged periods of drought can create dry landscapes that are vulnerable to wildfire hazard. Since even short drought periods can increase the risk of wildfire hazards, the 3-month SPI is best suited to evaluate drought severity for this sector.

Table 9-1 describes SPI intervals values that can be used to evaluate drought severity for the three key sectors.

Table 9-1. Drought Stage and SPI Interval and Value per Sector

Drought Stage	SPI Time Interval and Value		
	Water Supply Sector	Agriculture & Commerce Sector	Environmental, Public Health, & Safety Sector
Normal	12-month SPI 0.99 to -0.99	3-month SPI 0.99 to -0.99	3- and 12-month SPI 0.99 to -0.99
Moderate	12-month SPI -1.00 to -1.49 for 2 consecutive months	3-month SPI -1.00 to -1.49 for 2 consecutive months	3- and 12-month SPI -1.00 to -1.49 for 2 consecutive months
Severe	12-month SPI -1.50 to -1.99 for 2 consecutive months	3-month SPI -1.50 to -1.99 for 2 consecutive months	3- and 12-month SPI -1.50 to -1.99 for 2 consecutive months
Extreme	12-month SPI less than -2.00 for 2 consecutive months	3-month SPI less than -2.00 for 2 consecutive months	3- and 12-month SPI less than -2.00 for 2 consecutive months

Source: State of Hawai'i, 2017.

SPI Monitoring in the County of Hawai'i

Figure 9-1 is an example SPI maps for the island of Hawai'i as of February 2020. The County at that time fell within the Near Normal to Moderately Wet categories, depending on the selected timeframe.

Source: https://www.weather.gov/hfo/fullspi

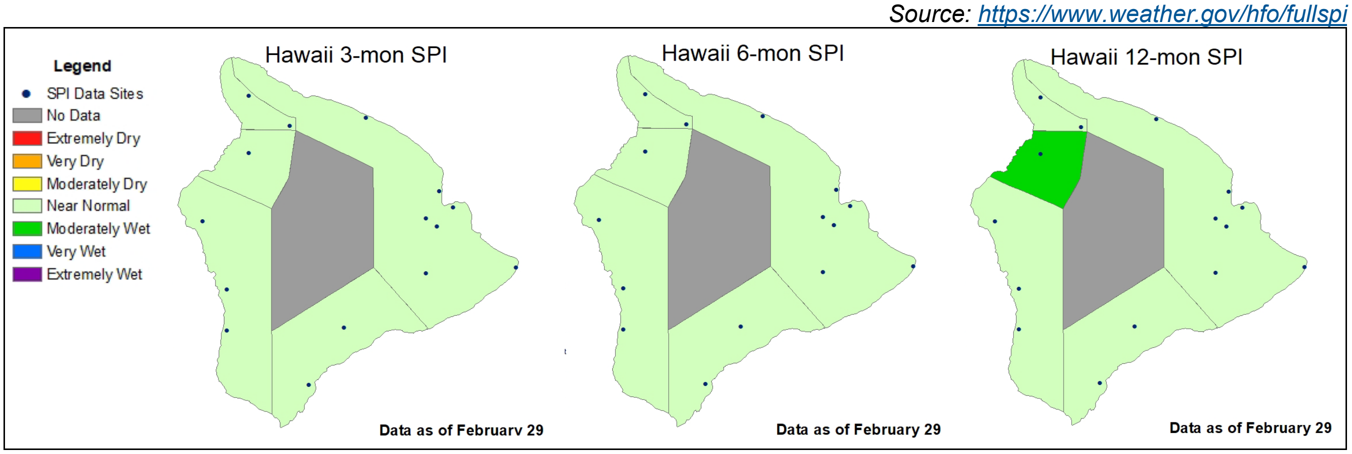


Figure 9-1. Island of Hawai'i SPI Maps, as of February 2020

The Honolulu Forecast Office (HFO) of the National Weather Service (NWS) has tailored SPI software for use in Hawai'i. Hawai'i's SPI monitoring network includes 58 rain gages, of which 15 are located in Hawai'i County (NWS, 2020):

- 17 quick-look sites use data from real-time reporting stations in the HFO flash flood monitoring network. They provide data immediately after the end of a month so that SPI values can be quickly determined. Table 9-2 provides SPI values at the four quick-look stations in Hawai'i County through the end of March 2020.
- 41 standard sites are locations from the NWS Cooperative Observer Network. Rainfall readings at these sites are taken manually and submitted via mail after the end of the month.

Table 9-2. SPI Values for Hawai'i County Quick Look Stations as of March 2020

Station	SPI Value						
	1-Month	2-Month	3-Month	6-Month	12-Month	18 Month	24-Month
Hilo AP	1.43	0.77	0.94	0.63	0.31	-0.12	0.78
Kahua Ranch	0.12	0.38	0.80	0.51	0.75	0.76	1.35
Kamuela	0.51	0.68	0.83	0.24	-0.23	0.22	0.95
Kapāpala	1.24	0.79	1.08	0.86	1.08	0.68	1.26

Source: NWS, 2020b

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a map that is updated weekly to show the location and intensity of drought across the country. The USDM uses a five-category system (NIDIS, 2020):

- D0—Abnormally Dry
  - Short-term dryness slowing planting, growth of crops
  - Some lingering water deficits
  - Pastures or crops not fully recovered
- D1—Moderate Drought
  - Some damage to crops, pastures
  - Some water shortages developing
  - Voluntary water-use restrictions requested
- D2—Severe Drought
  - Crop or pasture loss likely
  - Water shortages common
  - Water restrictions imposed
- D3—Extreme Drought
  - Major crop/pasture losses
  - Widespread water shortages or restrictions
- D4—Exceptional Drought
  - Exceptional and widespread crop/pasture losses
  - Shortages of water creating water emergencies

The USDM categories show experts' assessments of conditions related to drought. These experts check variables including temperature, soil moisture, water levels in streams and lakes, snow cover, and meltwater runoff. They also check whether areas are showing drought impacts such as water shortages and business interruptions. Associated statistics show what proportion of various geographic areas are in each category of dryness or drought, and how many people are affected. U.S. Drought Monitor data go back to 2000.

Figure 9-2 shows the categories in the County of Hawai'i as of June 9, 2020. On that date, no drought was indicated over most of the western half of the county, moderate drought affected most of the eastern half, severe drought affected coastal areas around Kawaihae Bay, and abnormally dry but non-drought conditions were present in the center of the island.

Source: https://www.drought.gov/drought/states/Hawai'i

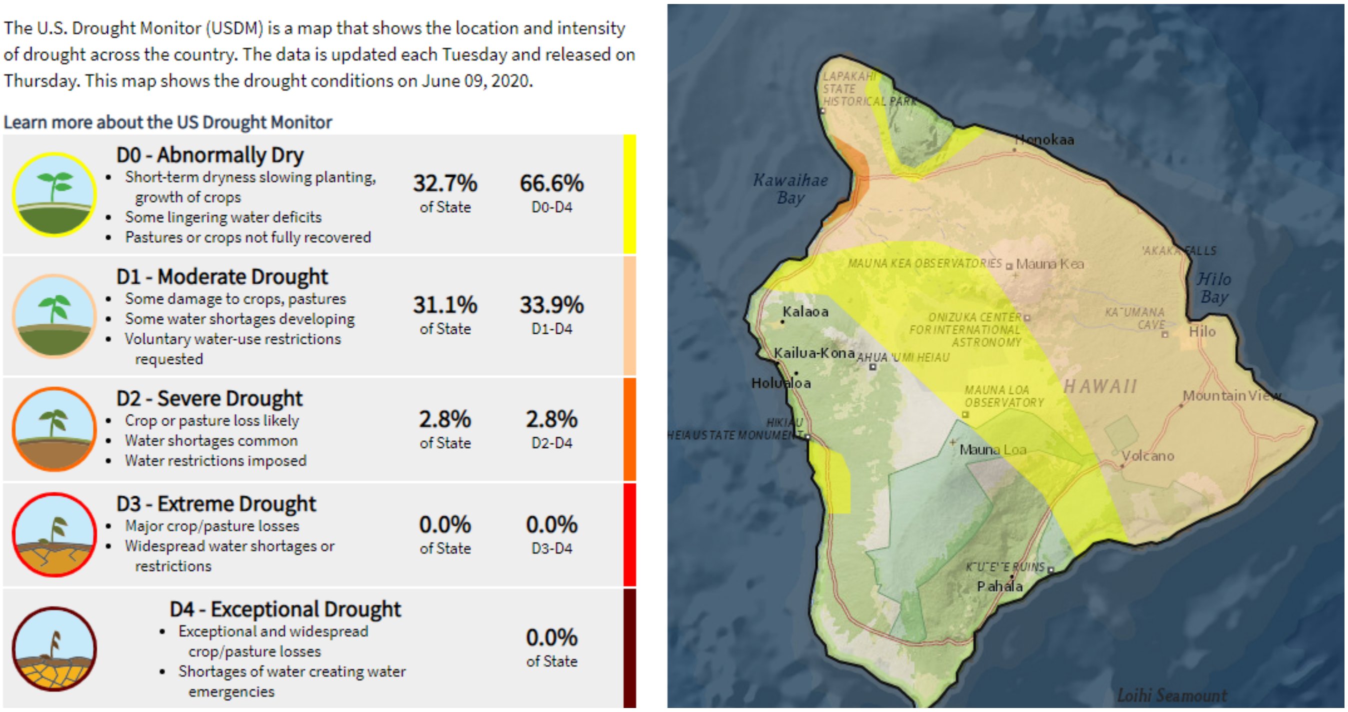


Figure 9-2. Island of Hawai'i U.S. Drought Monitor Map as of June 9,2020

The Drought Severity and Coverage Index (DSCI) is an experimental method for converting drought levels from the USDM map to a single value for an area. DSCI values are part of the U.S. Drought Monitor data tables. Possible values of the DSCI range from 0 to 500. The utility of the DSCI has not yet been widely tested but it provides a convenient way to convert USDM data from categorical to continuous, and to aggregate from spatially specific to geopolitical boundaries.

9.1.3 El Niño and Drought

El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle, which describes fluctuations in ocean and atmosphere temperature in the east-central Equatorial Pacific. La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These temperatures deviations can have large-scale impacts on global weather and climate. El Niño and La Niña episodes occur on average every two to seven years and typically last nine to 12 months, though some prolonged events may last for years.

El Niño is a large-scale ocean-atmosphere climate interaction linked to periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific. The presence of El Niño can significantly influence weather patterns, ocean conditions, and marine fisheries across large portions of the globe for an extended period of time (NOAA, 2020).

El Niño events are closely linked to drought in Hawai'i. Records show that there is an approximately 70 percent chance of drought in Hawai'i during the wet season following an El Niño event. Many severe Hawaiian drought events are associated with the El Niño phenomenon (Hawai'i Drought Monitor, 2020). The most severe droughts on record in Hawai'i (1982/1983 and 1997/1998) occurred during years associated with El Niño. According to the Pacific El Niño-Southern Oscillation Application Center, the dry conditions, in general, have been associated with persistent zones of high-pressure systems throughout the islands (County of Hawai'i, 2015).

During El Niño years, droughts in the State of Hawai‘i have occurred during what is normally the winter-spring wet season. For example, in January 1998, the National Weather Service's network of 73 rain gauges throughout the state did not record a single above-normal rainfall, with 36 gages recording less than 25 percent of normal (NWS Honolulu Forecast Office). The 0.14 inches of rain recorded for the city of Hilo was the lowest monthly total ever observed for any month since records have been kept. Normal January average rainfall for Hilo is 9.88 inches. Parts of the island of Hawai‘i continued to receive less than 10 percent of the normal rainfall until May 1998.

9.2 HAZARD PROFILE

9.2.1 Past Events

Table 9-3 summarizes the history of severe droughts affecting Hawai‘i County. Figure 9-3 shows cumulative USDM ratings for Hawai‘i County since the system began in 2000.

Table 9-3. Historical Drought in the Hawaiian Islands

Year	Areas	Remarks
1901	North Hawai‘i	Severe drought, destructive forest fires.
1905	Kona, Hawai‘i	Serious drought and forest fires.
1908	Hawai‘i and Maui	Serious drought.
1912	Kohala, Hawai‘i	Serious drought and severe sugarcane crop damage for two years.
1952	Kaua‘i	Long, severe dry spell
1953	Hawai‘i, Kaua‘i, Maui, O‘ahu	Water rationing on Maui water tanks in Kona almost empty; 867 head of cattle died; pineapple production on Moloka‘i reduced by 30%; rainfall in the
1962	Hawai‘i and Maui	State declared disaster for islands of Hawai‘i and Maui crop damage, cattle deaths, and severe fire hazards; losses totaled $200,000.
1965	Hawai‘i	State water emergency declared; losses totaled $400,000.
1971	Hawai‘i and Maui	Irrigation and domestic water users sharply curtailed.
1975	Kaua‘i and O‘ahu	Worst drought for sugar plantations in 15 years.
1977	Hawai‘i and Maui	State declared disaster for islands of Hawai‘i and Maui
1980-1981	Hawai‘i and Maui	State declared disaster; heavy agricultural and cattle losses; damages totaling at least$ 1.4 million
1983-1985	Hawai‘i	El Niño effect; State declared disaster; crop production reduced by 80% in Waimea/Kamuela area; $96,000 spent for drought relief projects.
1996	Hawai‘i, Maui, Moloka‘i	Declared drought emergency; heavy damages to agriculture and cattle industries; losses totaling at least $49.4 million
1998	Hawai‘i and Maui	State declared drought emergency for Maui County declared emergency for Hawai‘i due to water shortages.
2000 – 2002	Hawai‘i, Maui, Moloka‘i O‘ahu, Kaua‘i	Counties declare drought emergencies; Governor proclaims statewide drought emergency; Secretary of Agriculture designates all Counties as primary. On the island of Hawai‘i, most or all of the island experienced D1 or higher drought conditions from January through September 2000 and January through March 2001.
2003	Hawai‘i, Maui, Moloka‘i, O‘ahu, Kaua‘i	Secretary of Agriculture designates all Counties as primary disaster areas due to drought (2003); Governor proclaims statewide drought emergency. On the island of Hawai‘i, most or all of the island experienced D1 or higher drought conditions from February through December.
2007	Hawai‘i	USDA designates all Hawai‘i Counties as Primary Natural Disaster Areas due to losses caused by drought.
2008-2009	Hawai‘i	D0 (Abnormally dry) to D3 (Extreme drought) covered the entire state; D3 conditions on Maui, Big Island, and O‘ahu; 2008 all four counties are designated as Primary Natural Disaster Areas due to drought; 2009 USDA implements Livestock Disaster Assistance Programs.

Year	Areas	Remarks
2010	Hawai‘i, Honolulu, Kaua‘i, and Maui	El Niño drought conditions cause all four counties to be designated as Primary Natural Disaster Areas due to losses caused by drought; All four counties designated as farm disaster areas due to economic losses; Hawai‘i has the worst drought conditions in the country for 2010. Parts of the island experienced D4 drought conditions from March through November 2010
2012	Hawai‘i, Kaua‘i, Maui	Primary Natural Disaster Area due to drought declared for Maui, Kaua‘i, and Hawai‘i Counties.
2013-2014	Hawai‘i, Maui	Maui and Hawai‘i Counties Designated Drought Disaster Areas due to drought.
2015	Hawai‘i	Hilo and the island of Hawai‘i in moderate drought, receiving less than one-fifth the normal average of rainfall at Hilo Airport.
2016	Hawai‘i	On the island of Hawai‘i, most or all of the island experienced D1 or higher drought conditions from February through June.
2017 – 2018	Hawai‘i	On the island of Hawai‘i, 25 percent or more of the island experienced D1 or higher drought conditions from March 2017 through January 2018.

Sources: County of Hawai‘i, 2015. USDM, 2020a, State of Hawai‘i, 2017

Source: USDM, 2020b

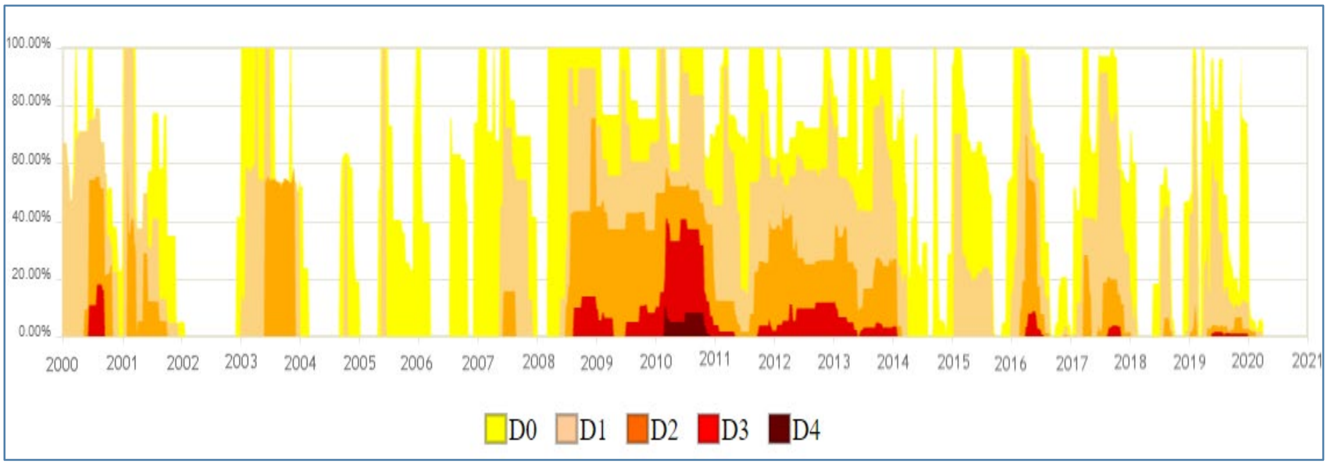


Figure 9-3. Percent of Hawai‘i County Affected by Each USDM Rating, 2000 – 2020

9.2.2 Location

The climate, and hence the amount of rainfall, of the Hawaiian Islands is directly influenced by the northeasterly trade winds. Typically, leeward locations (south and west shores) are much drier and sunnier than windward locations (north and east shores). Within leeward and windward locations, rainfall varies considerably according to elevation. All areas of Hawai‘i County are susceptible to drought, although the extent and severity of the drought will depend on the variance of rainfall throughout the planning area based on location (WRCC, 2015).

Droughts can occur at any time of the year in Hawai‘i County, though rainfall variability is far greater during winter, when occasional storms contribute to rainfall totals, than during summer, when trade-wind showers provide most of the rain. The severe drought years are the ones where the winter rains fail. Although such a deficit of winter storms can affect any portion of the state, it hits hardest in the normally dry areas that depend chiefly on winter rains and receive little rain from the trade wind showers. In these locations, the small amount of rainfall that occurs during the usual dry summer season is insufficient to prevent severe drought (WRCC, 2015).

The South Kohala District and portions of the North Kohala and North Kona Districts have the highest vulnerability to drought due to their already low normal rainfall conditions. The southern portion of the Ka‘ū District can also have significant drought but at a slightly lower frequency than the Kohala region. Drought can occur along the Kona slopes but the intensities generally do not reach the level of severity as in the Kohala region and the southern Kaʻū District. The east-facing slopes of the county can have drought, but it is much less frequent than the rest of the island and at a much lower intensity level. Droughts across the State of Hawaiʻi are highly influenced by the El Niño-Southern Oscillation cycle. The worst droughts will tend to occur during the winter months of a moderate to strong El Niño condition in the Pacific Ocean. The agriculture sector, and more specifically, ranching, is the most vulnerable to drought in Hawaiʻi County. This is followed by the water supply sector for areas dependent on water catchment or surface water flows.

According to Hawaiʻi's *Drought Risk and Vulnerability Assessment and GIS Mapping Project* most of the areas of concern for drought in Hawaiʻi County are on the western side, coinciding with low rainfall zones. Specific sector risks are as follows (CWRM, 2003):

- For the water supply sector, all drought stages produce significant risk on the western side of the island. The southern part of the island is also vulnerable to drought risk.
- For the agriculture and commerce sector, the western side of the island is at most risk, but the severe drought stage coincides with low rainfall areas on the west and southwest ends of the island, where various kinds of agricultural activities thrive.
- For the environment, public health and safety sector, areas of relatively high drought frequency coincide with past wildfire burn areas.

9.2.3 Frequency

Hawaiʻi's 2003 *Drought Risk and Vulnerability Assessment and GIS Mapping Project* used GIS mapping to identify areas at risk of drought and assess the environmental and socioeconomic impacts of drought. The assessment included the creation of drought frequency maps for all the main Hawaiian Islands. The maps are a graphical representation of the spatial distribution of historical drought occurrences in the islands. They are available for both a 3-month and 12-month SPI interval for moderate, severe, and extreme drought stages (six maps total).

Figure 9-4 shows the 3-month and 12-month moderate and severe drought frequency maps for the County of Hawaiʻi. Contours on the maps indicate the percent of time from 1972 through 2001 that the indicated level of drought occurred (CWRM, 2003).

9.2.4 Severity

The island of Hawaiʻi was given its first ever D4 (drought-exceptional) designation from March through November 2010. West Hawaiʻi rain gages showed that April 2010 rainfall was 50 percent of normal or less. January through April 2010 total rainfall was also 50 percent of normal or less for most rain gages on the island. October 2009 through April 2010 wet-season rainfall was the driest in 30 years of record; ranchers reported the worst drought conditions ever.

Hawaiʻi Department of Research and Development reported that in the Kona/Kaʻū districts, the production of coffee and macadamia nuts were down. The floriculture industry had problems with irrigation water supply. In May 2010, DLNR Division of Forestry and Wildlife closed four areas in the Mauna Kea Forest Reserve from the Hilo side of Pōhakuloa/Waikahaula to Puu Kemole due to extremely dry conditions.

Livestock deaths have been reported in Kawaihae. Parker Ranch actively manages pastures during drought by moving herds and culls as needed in response to the drought conditions. Kona coffee farmers have suffered from drought conditions. Coffee trees need steady rainfall beginning from the flowering period in order to produce fruit/berries. For proper growth, coffee tress need 1 inch of rainfall per week. Drought in the past has led to the loss of a third of coffee trees and entire harvested coffee crops refused by roasters due to poor berry conditions.

Source: CWRM, 2003

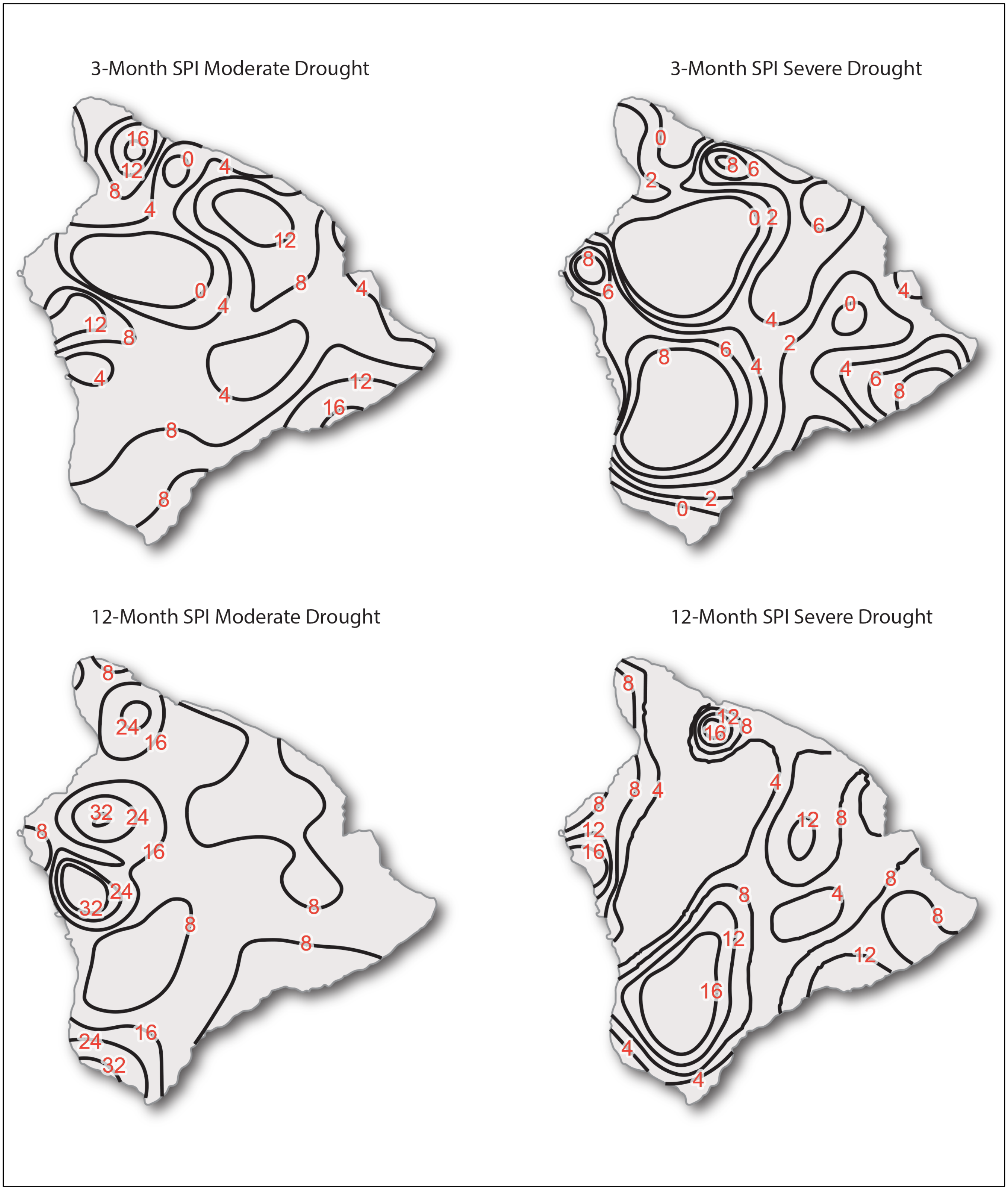


Figure 9-4. Percent of Time That Drought Was Experienced, 1972 – 2001

Farmers who have access to water irrigate intensively during drought. Producers that have no county water use rainfall catchments systems. These producers have to pay for water deliveries, which is a financial hardship. Additional drought impacts include feral animals (pigs) entering producers' fields and orchards, destroying crops and damaging irrigation systems.

9.2.5 Warning Time

Drought forecasting is necessary to help prepare the state for potentially devastating drought events, and forecasting tools have improved over the past few years. The National Oceanographic and Atmospheric Administration's Climate Prediction Center and National Integrated Drought Information System have developed drought forecasting tools and long-lead rainfall outlooks. The following are key resources for predicting drought (Hawaiʻi Drought Monitor, 2020):

- **U.S. Drought Information—**The National Weather Service Climate Prediction Center (CPC) develops operational predictions of climate variability, real-time monitoring of climate and required data bases, and assessments of the origins of major climate anomalies. The products cover time scales from a week to seasons, extending into the future as far as technically feasible, and cover the land, the ocean, and the atmosphere, extending into the stratosphere. The CPC's U.S. Monthly Drought Outlook and the U.S. Seasonal Drought Outlook include the Hawaiian Islands.
- **El Niño Diagnostic Discussion—**Many severe Hawaiian drought events are associated with the El Niño phenomenon. The CPC offers a monthly El Niño/Southern Oscillation (ENSO) Diagnostic Discussion and a weekly ENSO update.
- **Tropical Pacific Islands Rainfall Outlooks—**The CPC produces a suite of short and long-range precipitation forecasts for Hawaiʻi and the tropical Pacific islands, including maps showing estimates of rainfall anomalies.
- **The U.S. Drought Monitor**—The USDM provides current and recent history of areas and populations affected by drought.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Anomalies of precipitation and temperature may last from several months to several decades, depending on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale. However, meteorologists have made significant advances in understanding the climate system in the tropics. It is now known that a major portion of the atmospheric variability that occurs on time scales of months to several years is associated with variations in tropical sea surface temperatures.

The Tropical Ocean Global Atmosphere project has produced results that point to the possibility of predicting certain climatic conditions associated with ENSO events more than a year in advance. Since El Niño events are closely linked to drought conditions in Hawaiʻi, this project's results may help produce more reliable meteorological forecasts that can reduce risks in those economic sectors most sensitive to climate variability and, particularly, extreme events such as drought.

9.2.6 Secondary Hazards

The secondary hazard most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends.

9.3 EXPOSURE

All people, property and environments in the planning area would be exposed to some degree to the impacts of moderate to extreme drought conditions.

9.4 VULNERABILITY

9.4.1 Population

Hawaiʻi County has the ability to minimize the impacts on residents and water consumers should several consecutive dry years occur. No significant life or health impacts are anticipated as a result of drought within the planning area.

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past, as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation.

9.4.2 Property

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

9.4.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

9.4.4 Environment

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

9.5 FUTURE TRENDS IN DEVELOPMENT

Because of the nature of drought and its ability to affect the County as a whole, all future development will be vulnerable to the drought hazard. However, the *2017 Hawaiʻi Drought Plan Update* and the *2010 Hawaiʻi County Water Use and Development Plan Update* offer guidelines to future land use planning, water resource development, resource protection, water quality goals, and prioritizing water use. These plans provide the capability at the state and local level to respond to and develop long- and short-term mitigation strategies from the impacts of drought.

9.6 SCENARIO

An extreme drought with a combination of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout the planning area, increasing the need for water. If such conditions persisted for several years, the economy of Hawai‘i County could experience setbacks, especially in water dependent industries such as agriculture.

9.7 ISSUES

The planning team has identified the following drought-related issues:

- **Drought-tolerant landscape designs are not adequately encouraged—**Incorporating drought tolerant or xeriscaping practices into landscape ordinances, providing incentives for xeriscaping, and encouraging permeable driveways and surfaces will reduce dependence on irrigation.
- **Groundwater recharge techniques are not utilized**—During non-drought period, recharging groundwater to stabilize the groundwater supply should be a regular practice. By ensuring groundwater remain stable, impacts of future drought occurrences will be minimized.
- **Active water conservation even during non-drought periods needs to be promoted**—Active conservation during non-drought periods serves as a tool to anticipate how entities will use water during drought periods. If conservation is practiced during non-drought periods, needed conservation during drought periods will minimize the impact on the County and mitigate against overuse of minimal water supply. The con associated with this particular initiative is encouraging residents to adhere to water conservation. Public outreach initiatives regarding this issue must emphasize the need for water conservation during non-drought periods.

10. EARTHQUAKE

10.1 HAZARD DESCRIPTION

An earthquake is the vibration of the earth's surface following a release of energy in the Earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Dislocations of the crust cause most destructive quakes. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter.

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect resident's normal activities. This includes the following:

- **Surface Faulting—**Displacement that reaches the earth's surface during slip along a fault. Commonly occurs with shallow earthquakes, those with an epicenter less than 20 kilometers.
- **Ground Motion (shaking)—**The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.
- **Landslid**e—A movement of surface material down a slope.
- **Liquefaction—**A process by which water-saturated sediment temporarily loses strength and acts as a fluid. Earthquake shaking can cause this effect.
- **Tectonic Deformation**—A change in the original shape of a material due to stress and strain.
- **Tsunami**—A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or violent underwater volcanic eruptions.

10.1.1 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (M_W), the most common scale used today (USGS, 2017). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). The scale is as follows:

- Great—Mw > 8
- Major—Mw = 7.0 – 7.9

- Strong—Mw = 6.0 – 6.9
- Moderate—Mw = 5.0 – 5.9
- Light—Mw = 4.0 – 4.9
- Minor—Mw = 3.0 – 3.9
- Micro—Mw < 3

Intensity

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale as well as the perceived shaking and damage potential for structures are shown in Table 10-1. The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the variation of ground shaking in a region immediately following significant earthquakes (for technical information about shake maps see USGS, 2018).

Table 10-1. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X – XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA = peak ground acceleration. Measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

10.1.2 Ground Motion

Earthquake hazard assessment is also based on expected ground motion. During an earthquake when the ground is shaking, it also experiences acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground accelerations (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges).

10.1.3 USGS Earthquake Mapping Programs

ShakeMaps

The USGS Earthquake Hazards Program produces maps called ShakeMaps that map ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking caused by the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth’s crust.

A ShakeMap shows the extent and variation of ground shaking immediately across the surrounding region following significant earthquakes. Such mapping is derived from peak ground motion amplitudes recorded on seismic sensors, with interpolation where data are lacking based on estimated amplitudes. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. In addition to the maps of recorded events, the USGS creates the following:

- Scenario ShakeMaps of hypothetical earthquakes of an assumed magnitude on known faults
- Probabilistic ShakeMaps, based on predicted shaking from all possible earthquakes over a 10,000-year period. In a probabilistic map, information from millions of scenario maps are combined to make a forecast for the future. The maps indicate the ground motion at any given point that has a given probability of being exceeded in a given timeframe, such as a 100-year (1-percent-annual chance) event.

National Seismic Hazard Map

National probabilistic maps of earthquake shaking hazards have been produced since 1948. They provide information essential to creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning used in the U.S. Scientists frequently revise these maps to reflect new information and knowledge. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001). The USGS has not updated its National Seismic Hazard Map for Hawai‘i since 1998. Figure 10-1 shows the peak ground acceleration with 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas.

10.1.4 Liquefaction and Soil Types

Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

Source: USGS, 2020

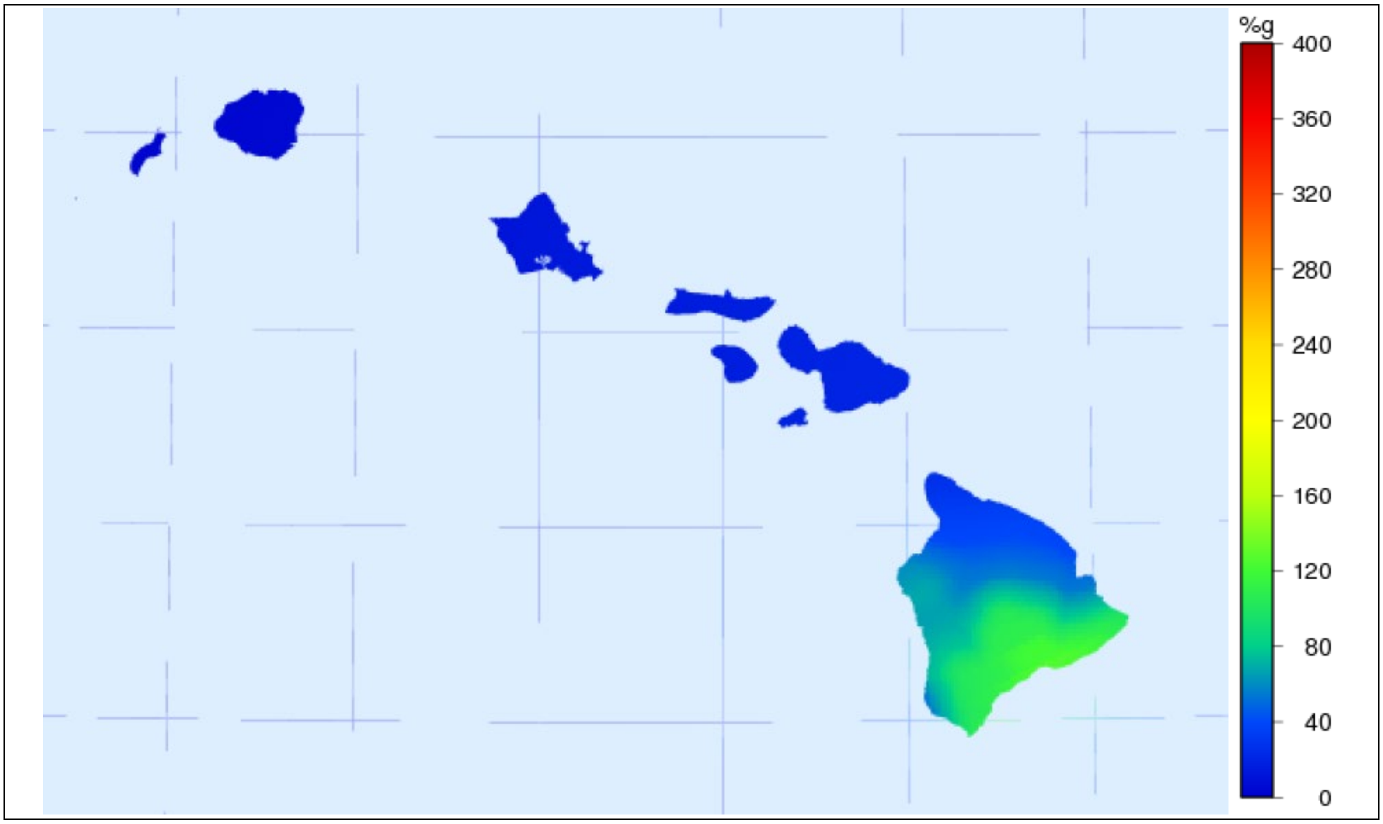


Figure 10-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years

A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 10-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction.

Table 10-2. NEHRP Soil Classification System

NEHRP Soil Type	Description	Mean Shear Velocity to 30 meters (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 meters thick)	

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. This is a vital need for assessing seismic risk within the planning area.

NOAA's Coastal Service Center sponsored a project in 2005 to identify areas with the potential for soil liquefaction in the Counties of Maui and Hawai'i. The results of the study showed small areas of high liquefaction susceptibility in Maui, but none in the County of Hawai'i (State of Hawai'i, 2018)

10.2 HAZARD PROFILE

In addition to posing a life safety hazard, earthquakes are destructive to the County's infrastructure, including buildings, roads, bridges, and utilities. Strong local earthquakes can trigger coastal subsidence as seen in 1868 and 1975. Damage is intensified in areas of water-saturated soils and on steep slopes. The seismic hazard is often characterized in terms of probability of peak ground acceleration (PGA) measured as a percent of Earth's gravitational acceleration (%g) within a fixed time period. The southeast part of the County has the highest expected ground acceleration at a 2 percent probability of exceeding 100%g over the next 50 years (see Figure 10-2). A PGA of 100%g can cause significant impacts as described in Table 10-3,. Engineers use this information to develop building codes and design earthquake resistant structures.

Source: USGS, https://volcanoes.usgs.gov/observatories/hvo/hazards_earthquakes.html

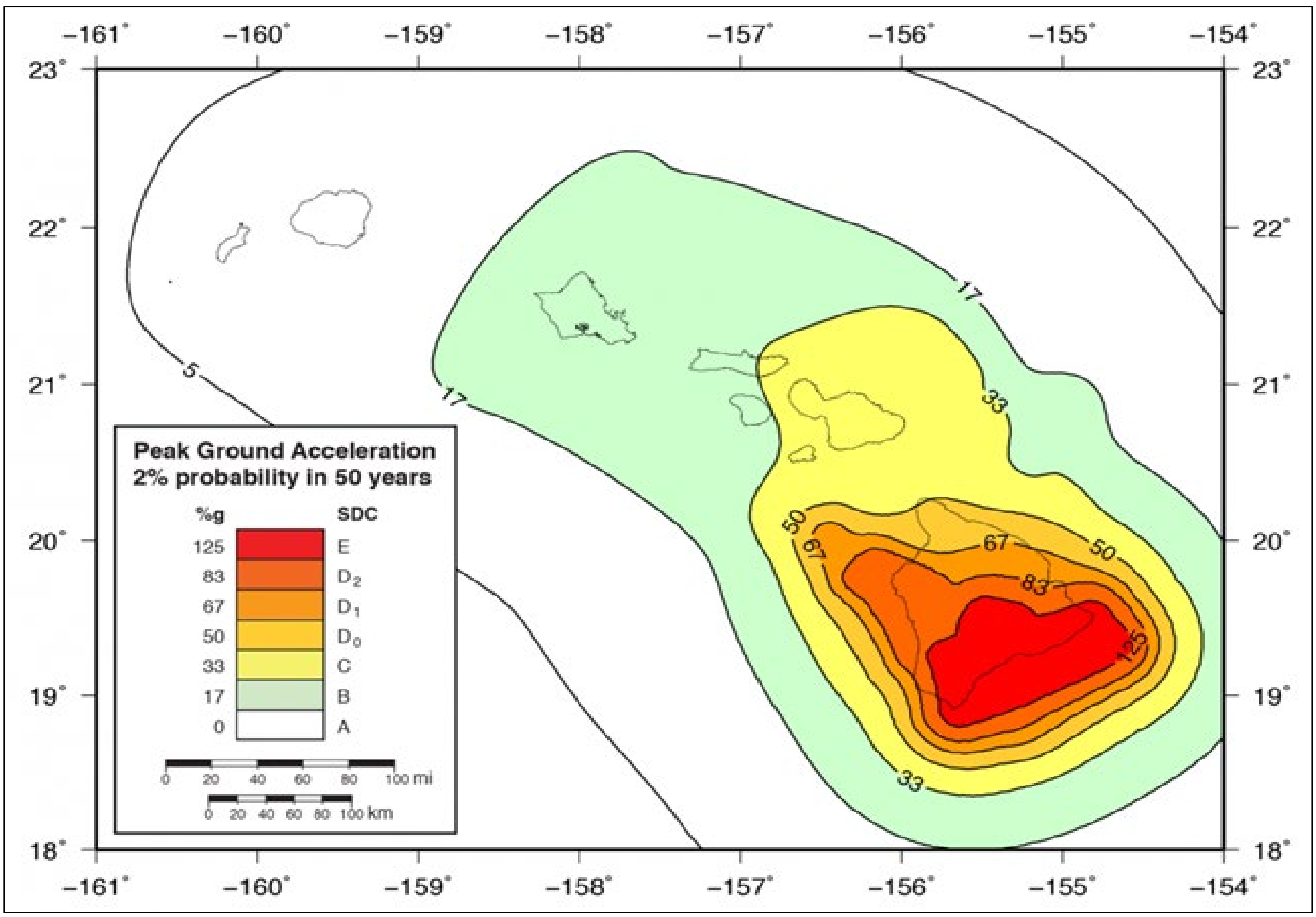


Figure 10-2. Seismic Hazards Across the County

Table 10-3. Seismic Hazard Zones Reflecting Intensity and Probability of Shaking

SDC[a]	Map Color	Earthquake Hazard	Potential Effects of Shaking[b]
A	White	Very small probability of experiencing damaging earthquake effects.	
B	Green	Could experience shaking of moderate intensity.	Moderate shaking—Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
C	Yellow	Could experience strong shaking.	Strong shaking—Damage negligible in buildings with good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built structures.
D0	Dark Yellow	Could experience very strong shaking (the darker the color, the stronger the shaking).	Very strong shaking—Da mage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures.
D1	Light Orange		
D2	Orange		
E	Red	Near major active faults capable of producing the most intense shaking.	Strongest shaking—Damage considerable in specially designed structures; frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations. Shaking intense enough to completely destroy buildings.

a. SDC = Seismic design categories
b. Abbreviated descriptions from the Modified Mercalli Intensity Scale

Most of the stronger earthquakes on the island of Hawai‘i are directly related to magma moving below the earth’s surface beneath the island’s two most active volcanoes, Mauna Loa and Kīlauea. These volcanic-related earthquakes can occur before or during eruptions, or as molten rock travels underground. The flanks of the volcanoes adjust to the intrusions of magma by storing compressive stresses and occasionally releasing it as earthquakes. Examples of such earthquakes are the M7.2 Kalapana earthquake beneath Kīlauea’s south flank in 1975 and the estimated M7.9 earthquake beneath the Ka’ū district on Mauna Loa’s southeast flank in 1868, the largest earthquake in recorded Hawaiian history.

Caldera collapse at the volcano summits can be a significant source of seismic activity. Such collapses occur as a result of the withdrawal of magma from the summit reservoirs after volcanic activity. During the 2018 Kīlauea caldera collapse events, tens of thousands of earthquakes occurred at the summit of Kīlauea, resulting in large ground fractures as well as large explosion clouds of rock and debris. Significant damage to infrastructure and structures occurred in the surrounding summit area, including Volcano Village.

A few earthquakes on the island are less directly related to volcanic activity and may occur in zones of structural weakness at the base of the volcanoes or deep in the earth under any part of the island (County of Hawai‘i, 2015).

10.2.1 Past Events

The island of Hawai‘i experiences thousands of earthquakes every year, but only a few are strong enough to be felt or cause minor to moderate damage. The USGS has compiled two catalogs of earthquakes for the Hawaiian Islands: a modern catalog of earthquakes registered by the seismic network maintained by the USGS Hawaiian Volcano Observatory (HVO) dating from 1959, and an historical catalog of earthquakes dating back to 1823 based on instrumental amplitudes from the Honolulu Magnetic Observatory and HVO, published reports from newspaper articles and other sources, and unpublished reports sent to HVO (County of Hawai‘i, 2015).

The modern USGS catalog lists 46 earthquakes on or near the island with magnitudes of 5.0 or greater since 1959, as listed in Table 10-4 and shown on Figure 10-3. Table 10-5 lists historical (pre-1959) earthquakes of magnitude 6.0 or greater. Events associated with caldera collapse are not included in these lists. The following sections describe significant earthquakes in the Island’s history.

Table 10-4. Earthquakes of Magnitude 5.0 or Larger in or near Hawai'i County—Modern (1959 – 2019)

		Epicenter Location (see Figure 10-3)		
Date[a]	Magnitude	Latitude (degrees)	Longitude (degrees)	Depth (miles)
4/14/2019	5.34	19.74	-155.79	8.3
3/13/2019	5.54	19.33	-155.20	4.3
5/4/2018	6.9	19.32	-155.00	3.6
5/4/2018	5.73	19.33	-155.02	4.0
5/3/2018	5.06	19.34	-155.07	4.0
6/8/2017	5.28	19.33	-155.12	4.4
6/28/2015	5.2	19.34	-155.21	5.3
6/5/2013	5.3	18.91	-155.06	25.0
4/14/2009	5.2	19.33	-155.21	6.2
8/14/2007	5.4	19.35	-155.07	6.0
11/23/2006	5.2	19.89	-155.97	23.4
10/15/2006	6.1	20.13	-155.98	11.7
10/15/2006	6.7	19.88	-155.94	24.2
7/17/2005	5.1	18.78	-155.45	20.3
7/15/2005	5.3	20.44	-155.13	11.1
9/13/2001	5.2	18.86	-155.24	7.8
4/17/1999	5.8	19.25	-155.49	6.8
6/30/1997	5.7	19.36	-155.07	4.7
2/1/1994	5.6	19.24	-155.29	20.4
6/8/1993	5.2	19.33	-155.22	2.3
5/8/1991	5.5	19.37	-156.27	22.6
8/2/1990	5	19.84	-155.62	12.9
12/28/1989	5	19.33	-155.21	5.3
6/26/1989	6.5	19.36	-155.08	5.8
7/4/1988	5.1	19.22	-155.46	6.8
2/22/1985	5	19.33	-155.21	5.9
11/16/1983	6.7	19.43	-155.45	7.5
9/9/1983	5.5	19.33	-155.12	5.6
1/21/1982	5.6	19.22	-155.55	8.5
1/21/1982	5.4	19.23	-155.59	6.3
11/10/1981	5.3	19.34	-155.21	6.3
9/22/1979	5.7	19.35	-155.07	5.6
3/6/1979	5	19.52	-155.27	17.4
12/18/1976	5	19.34	-155.12	5.6
11/29/1975	7.7	19.33	-155.00	5.6
11/29/1975	5.8	19.36	-155.05	5.0
1/5/1975	5.3	19.52	-155.69	6.2
1/1/1975	5.3	19.48	-155.58	6.2
12/31/1974	5.5	19.29	-155.36	3.1
12/16/1974	5	19.39	-155.42	5.0
11/30/1974	5.5	19.42	-155.40	4.3
6/19/1974	5.1	19.36	-155.40	5.0

Date[a]	Magnitude	Epicenter Location (see Figure 10-3)		
		Latitude (degrees)	Longitude (degrees)	Depth (miles)
4/26/1973	6.1	19.93	-155.10	31.1
12/10/1964	5.1	19.27	-155.14	5.0
10/23/1963	5	19.38	-155.42	5.6
6/28/1962	6.1	19.40	-155.45	6.2

a. Events associated with caldera collapse are not included in these lists.
Source: USGS, 2020a

Source: USGS, 2020a

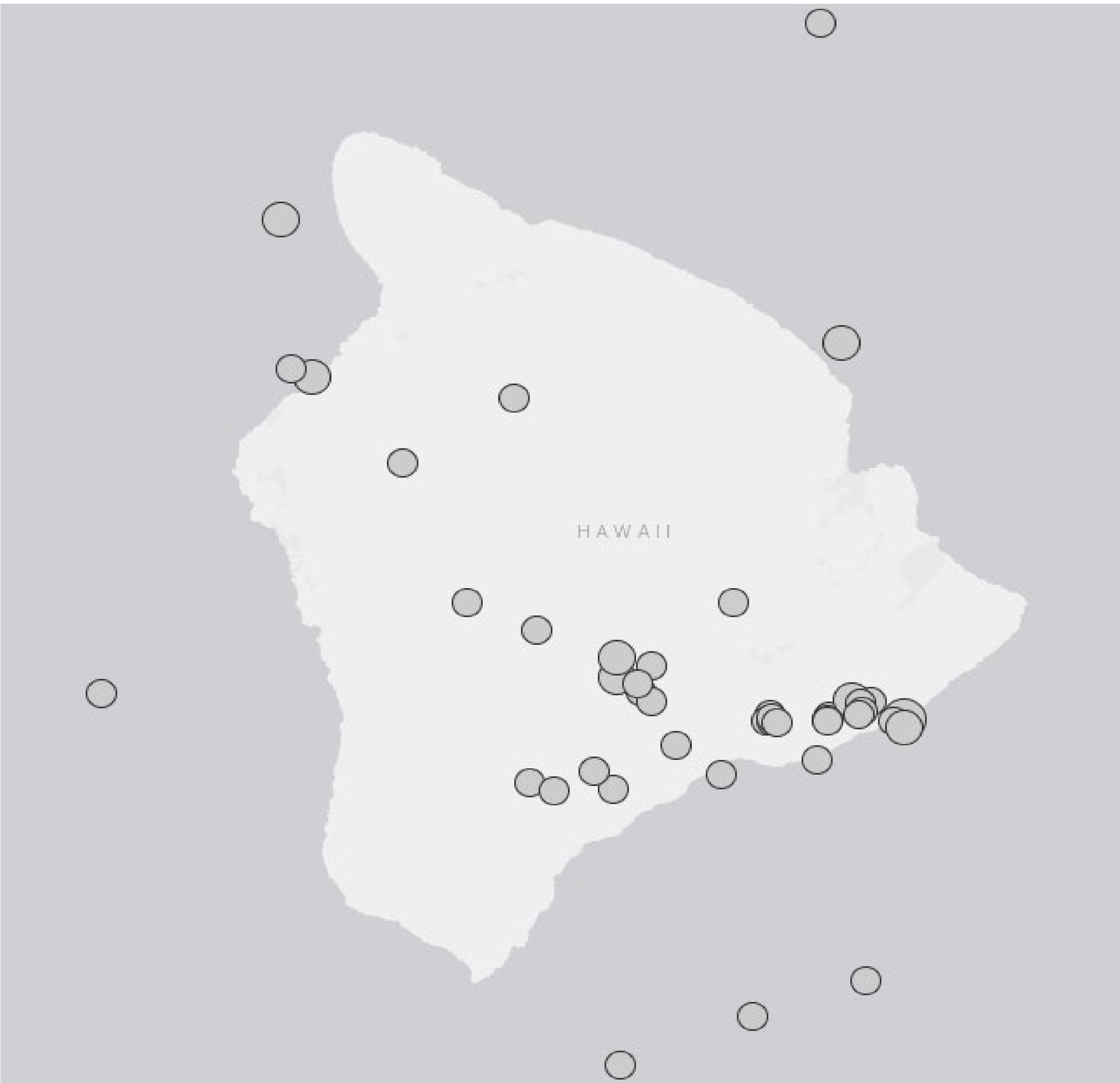


Figure 10-3. Earthquakes of Magnitude 5.0 or Greater on or Near the Island of Hawai‘i, 1959 – 2019

Table 10-5. Earthquakes of Magnitude 6.0 or Larger in or near Hawai‘i County—Historical (Pre-1959)

Date	Location	Magnitude	Depth (miles)
March 28, 1868	Mauna Loa south flank	6.5-7.0*	No data
April 2, 1868	Mauna Loa south flank	7.5-8.1*	No data
October 5, 1929	Hualālai	6.5*	No data
September 25, 1941	Kaoiki	6.0*	No data
May 29, 1950	Mauna Loa southwest rift	6.2	No data
April 22, 1951	Kīlauea	6.3	20
August 21, 1951	Kona	6.9	5
May 23, 1952	Kona	6.0	5
March 30, 1954	Kīlauea south flank	6.5	5

Source: USGS, 1990

1868 Ka’ū District Earthquake

An earthquake occurred in 1868 in the Ka’ū district on the southeast flank of Mauna Loa with an estimated magnitude of 7.5 to 8.0. Although the 1868 earthquake caused damage island-wide, the devastation was greatest in Ka’ū where the earthquake triggered a mudflow killing 31 people and coastal subsidence generated a tsunami that destroyed several villages. Approximately 79 people were killed, mostly due to the mudslide and the tsunami (County of Hawai‘i, 2015).

1973 South Hilo Earthquake

A large earthquake, unrelated to volcanic activity, was located 25 miles beneath Honomū in the South Hilo district in 1973. This earthquake had a magnitude of 6.2. It caused $5.6 million worth of damage and injured 11 people (County of Hawai‘i, 2015).

1975 Kīlauea Earthquake

The largest earthquake on the island during the 20th century occurred on the south flank of Kīlauea in 1975. This earthquake had a magnitude of 7.2. It caused coastal subsidence at Kalapana, generated a tsunami that killed two people in the Hawai‘i Volcanoes National Park, destroyed houses in the Ka’ū district, sank fishing boats in Keauhou Bay within the North Kona district, and damaged boats and piers in Hilo, within the South Hilo district (County of Hawai‘i, 2015).

2006 Kīholo Bay Earthquake

The most recent major earthquakes in the State of Hawai‘i were the Magnitude 6.7 Kīholo Bay and Magnitude 6.0 Māhukona earthquakes that occurred seven minutes apart on October 15, 2006. Both were centered near the Kona coastline of Hawai‘i. The largest ground shaking for this earthquake was at the northern end of the island at the towns of Waimea and Hāwī. These areas had amplified ground motion due to their softer soil conditions. The most heavily damaged buildings were concentrated in the Waimea and Hāwī areas, with some damage also in the Honoka‘a and Kona areas. There was very little damage at the south end of the island (County of Hawai‘i, 2015).

10.2.2 Location

NEHRP Soil Maps

NEHRP soil type maps define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Approximate NEHRP soil classifications in Hawai‘i County are shown on Figure 10-4.

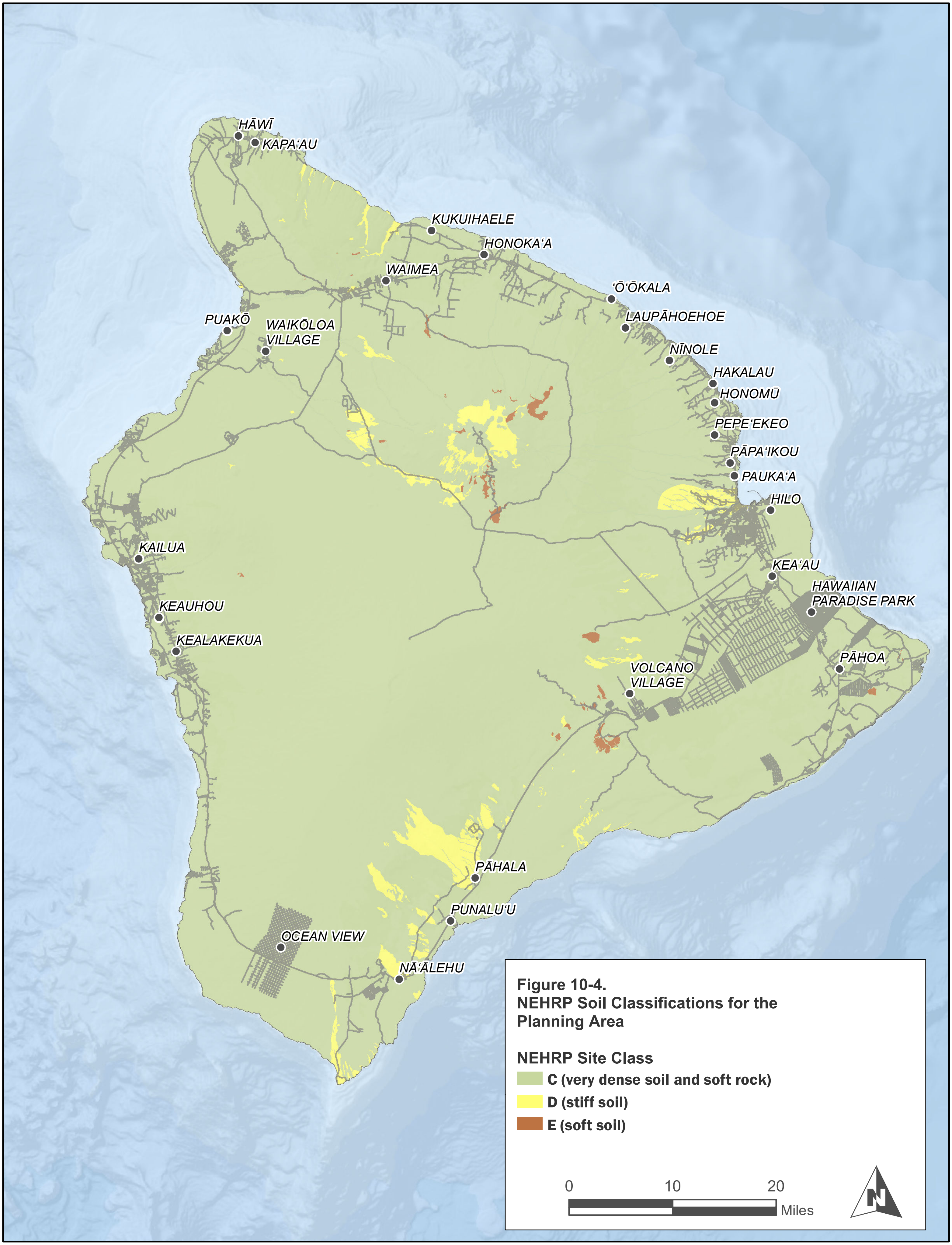


Figure 10-4. NEHRP Soil Classifications for the Planning Area

Fault Locations

The USGS maintains a map and database on faults that show evidence of seismic activity with the past 1.6 million years (the Quaternary period). Figure 10-5 shows the known fault complexes on the island of Hawai‘i. The southeastern part of the island has many small faults that have been active within the past 150 years and many more that have been active within the latest quaternary period (within the past 15,000 years). Fault areas in the north and western parts of the island are much older—from the middle to late quaternary period, from 130,000 to 750,000 years ago. Faults outside the planning area also can impact its people, property, and economy, but USGS mapping shows no faults on any of the other Hawaiian islands.

Source: USGS, 2020a

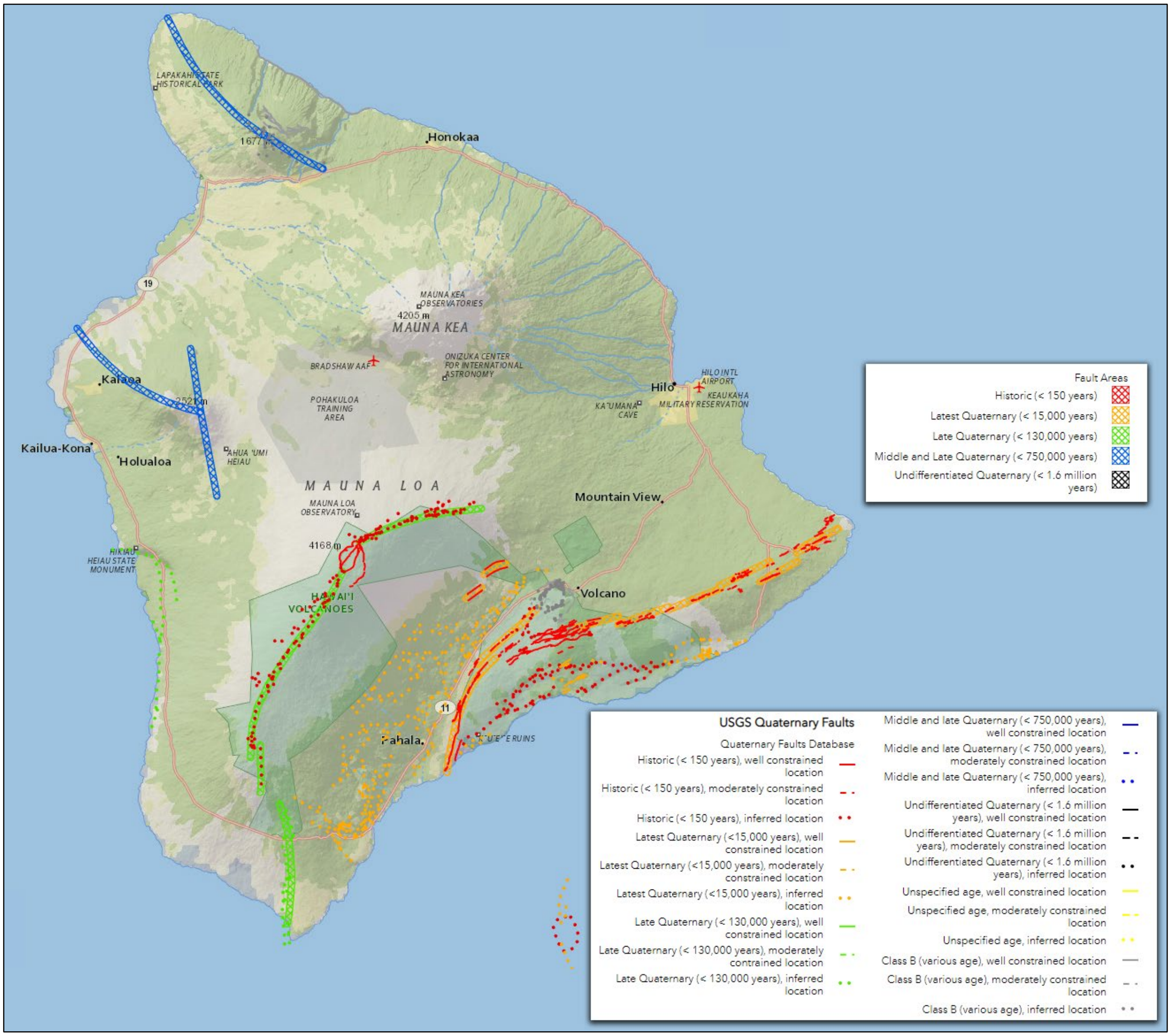


Figure 10-5. Mapped Faults in Hawai‘i County

10.2.3 Frequency

Due to its ongoing volcanic activity and the consistent historical occurrence of earthquakes, Hawaiʻi County can expect to continue to experience thousands of earthquakes per year, though only a few will be felt. The island of Hawaiʻi experienced 17 earthquakes of magnitude 6 or greater between 1868 and 2019, resulting in a return interval of every nine years on average. The USGS estimates a 50-percent probability of a 6.5 magnitude or greater earthquake occurring in the Hawaiʻi Islands in the next 10 years. (County of Maui, 2015).

10.2.4 Severity

Potential Earthquake Intensity in the Planning Area

USGS probabilistic mapping is an indication of potential earthquake intensity in an area. Figure 10-1 shows the intensity with a 10-percent exceedance chance in 50 years in Hawaiʻi. For Hawaiʻi County, this PGA varies across the island from 0 to 1.6g.

Potential Damage

The risks to property from earthquakes in the County of Hawaiʻi are among the highest in the nation, with only San Francisco and San Jose, California having a greater annual loss per million dollars of building value. Earthquake occurrence rates in the County of Hawaiʻi are as high as that near the most hazardous fault areas on the mainland United States (County of Hawaiʻi, 2015).

Strong earthquakes, while infrequent, may endanger people and property by shaking structures, causing ground cracks, ground settling and landslides. Strong earthquakes in Hawaiʻi's past have destroyed buildings, water tanks and bridges and damaged roadways, water, sewer and utility lines. Soil and topographic conditions may exacerbate potential earthquake hazards where steep slopes and water saturated soils may be susceptible to mudflows or landslides. Large earthquakes may also generate tsunamis.

10.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

10.2.6 Secondary Hazards

Earthquakes can cause landslides. River and stream valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction can turn the ground into a pudding-like liquid. Building and road foundations can lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

Earthen dams and levees are highly susceptible to seismic events and their failures can be considered secondary risks for earthquakes. Fire may also occur from broken gas lines or downed electric wires. Additionally, tsunamis and run-ups may result from earthquakes, leading to potential coastal flooding and coastal erosion.

10.3 EXPOSURE

10.3.1 Population

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors, including the age and construction type of the structures people live in, the soil types their homes are constructed on, the intensity of the earthquake, etc. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

10.3.2 Property

According to an estimate based on Hawai'i County assessor records, there are 82,796 buildings in the planning area. These structures are estimated to have a total replacement value of $58.2 billion. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the countywide property exposure to seismic events. Most of the buildings (95 percent) are residential.

10.3.3 Critical Facilities and Assets

All critical facilities in the planning area, as listed in Table 4-5 are exposed to the earthquake hazard. Critical facilities constructed on NEHRP Type D and E soils are particularly at risk from seismic events. Figure 10-6 shows the number of critical facilities built on these soils in the planning area, by type of facility.

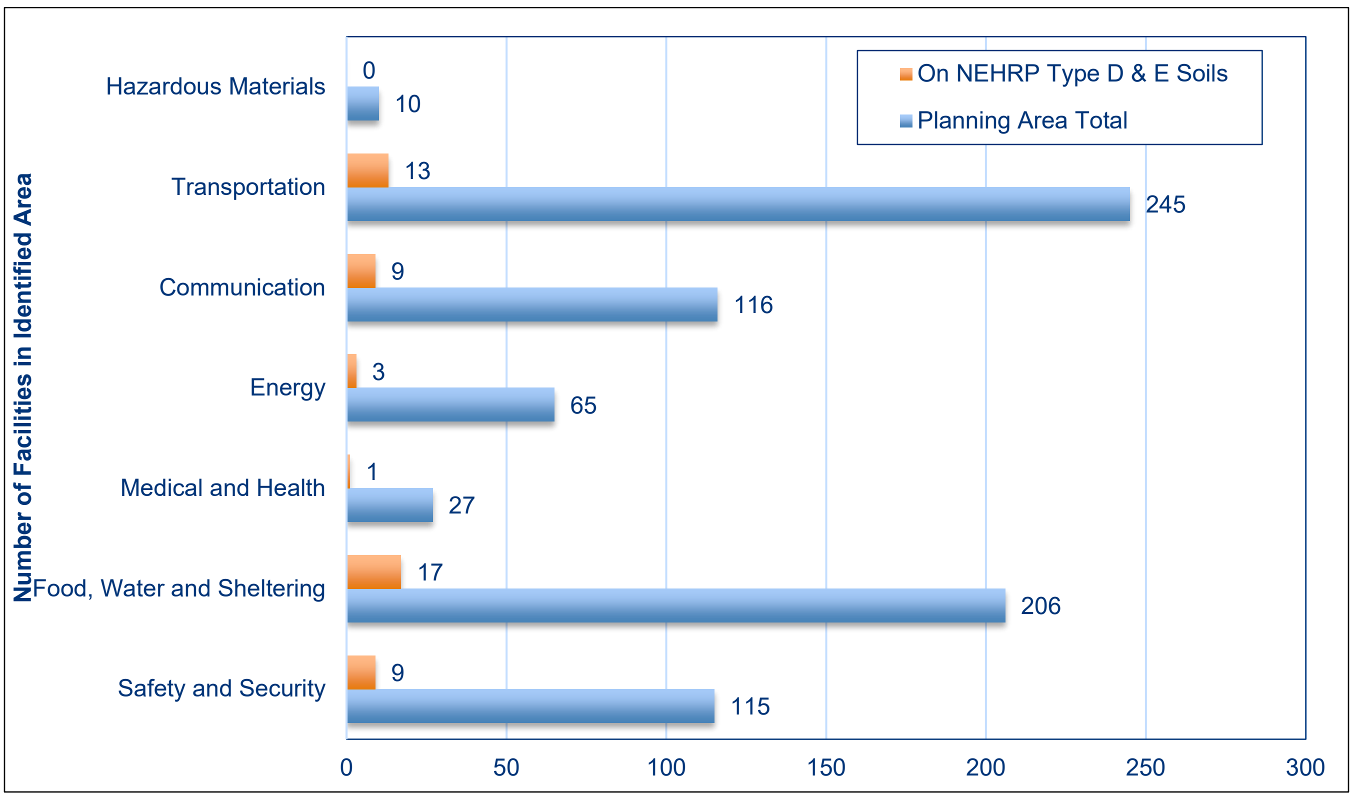


Figure 10-6. Critical Facilities Constructed on NEHRP Type D and E Soils, and Countywide

Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment.

10.3.4 Environment

Secondary hazards associated with earthquakes will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat including coral reefs. Earthquakes can result in underwater avalanches, which can potentially damage the reefs surrounding the island. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

10.4 VULNERABILITY

Earthquake vulnerability data for the risk assessment was generated using a Hazus Level 2, user-defined analysis for the for the events listed in Table 10-6.

Table 10-6. Earthquakes Modeled for Risk Assessment

Event	Magnitude	Focal Depth	Epicenter Location	PGA
100-year probabilistic	N/A	N/A	N/A	Figure 10-7
Hawai'i (South Kohala)	6.7	24 miles	17 miles north-northeast of Kailua-Kona (19.88ºN 155.94ºW)	Figure 10-8
Kalapana 1975	7.7	6 miles	26 miles south-southeast of Hilo (19.34°N 155.00°W)	Figure 10-9
Ka'ū	8.0	6 miles	3.64 miles northwest of Pāhala (19.25°N 155.50°W)	Figure 10-10

Scenario events were modeled using fault data pre-loaded in the Hazus program. Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up. The analysis results are summarized in the sections below, and more detailed information, broken down by district, can be found in Appendix F.

10.4.1 Population

High-Risk Populations

Three groups are identified as being particularly vulnerable to the earthquake hazard:

- **Population Living on Seismically Sensitive Soils**—People whose homes are on NEHRP Class D or E soils
- **Population Below Poverty Level**—Households on NEHRP D and E soils that are listed as earning less than $20,000 in annual income. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Poorer residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population Over 65 Years Old**—This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

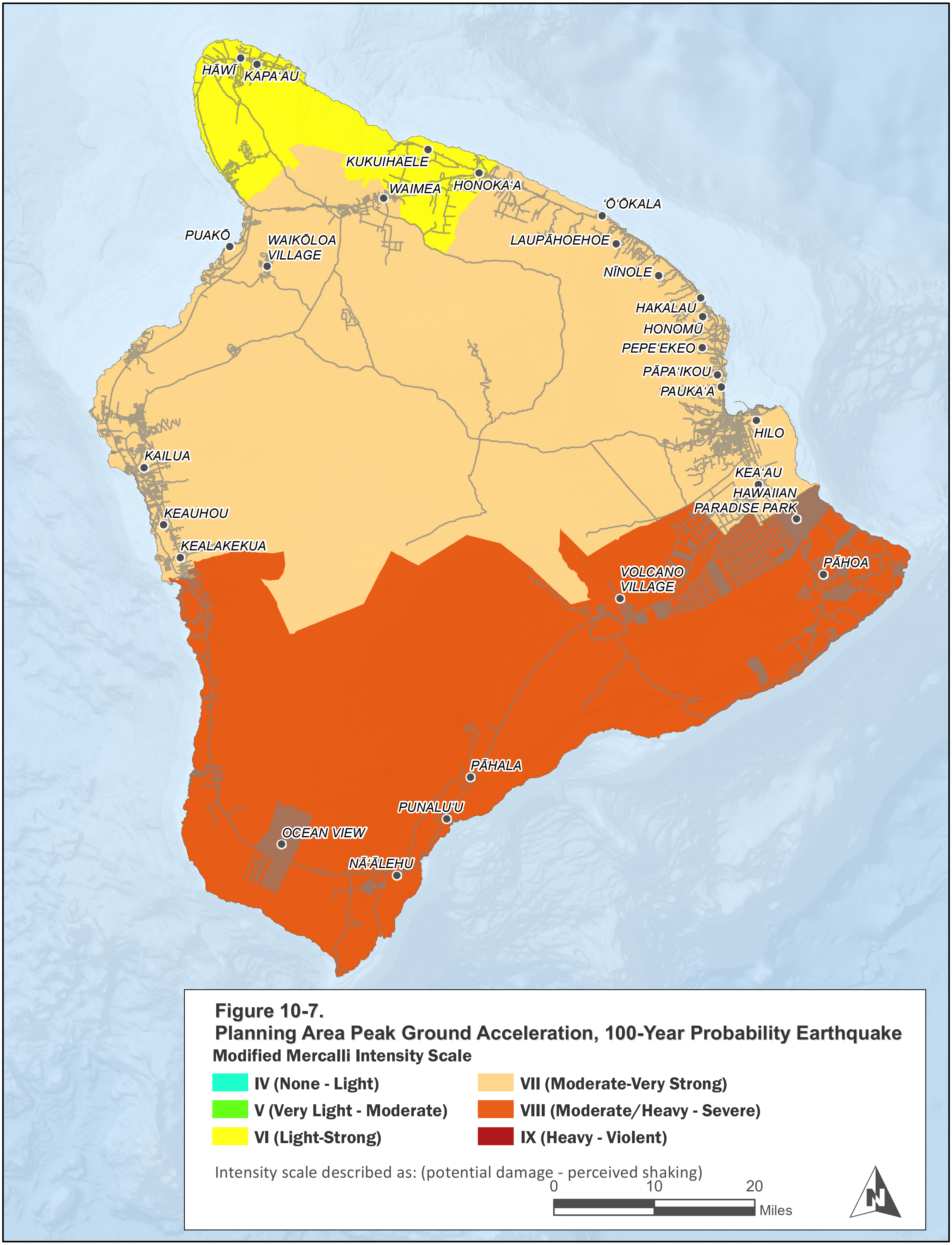


Figure 10-7.
Planning Area Peak Ground Acceleration, 100-Year Probability Earthquake

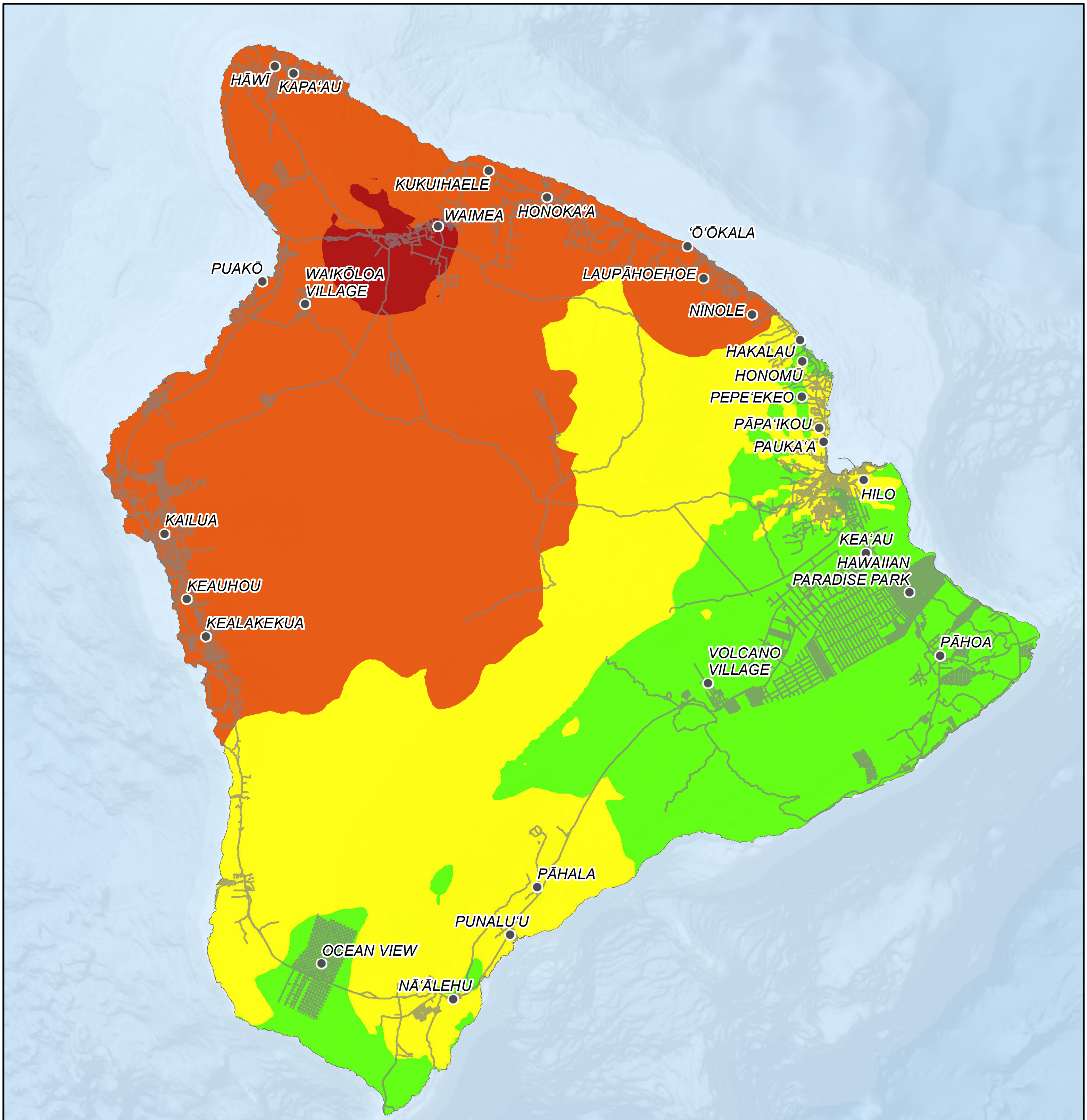


Figure 10-8.
Planning Area Peak Ground Acceleration, South Kohala M6.7 Earthquake

Modified Mercalli Intensity Scale

- IV (None - Light)
- V (Very Light - Moderate)
- VI (Light-Strong)
- VII (Moderate-Very Strong)
- VIII (Moderate/Heavy - Severe)
- IX (Heavy - Violent)

Intensity scale described as: (potential damage - perceived shaking)

0 10 20 Miles

N

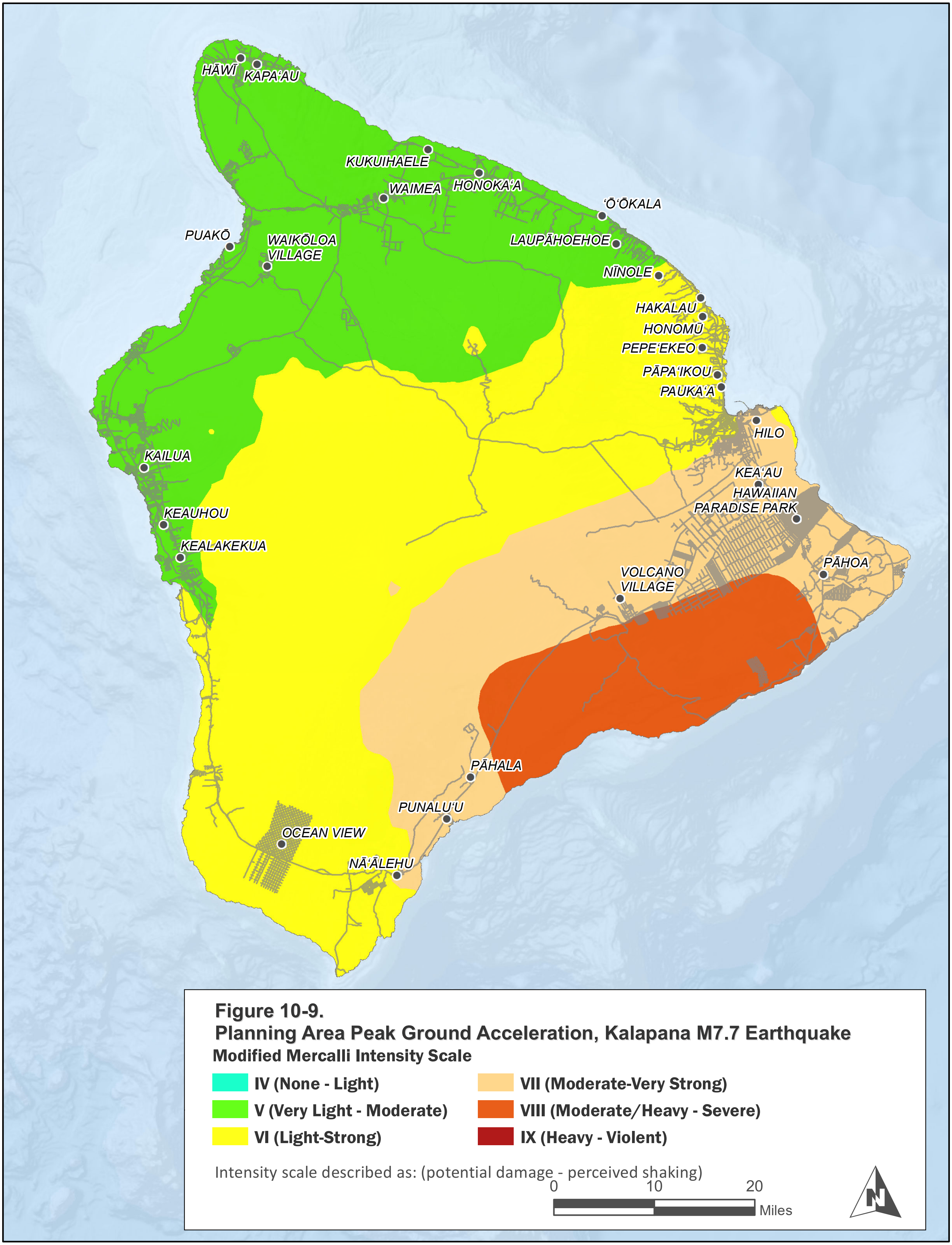


Figure 10-9.
Planning Area Peak Ground Acceleration, Kalapana M7.7 Earthquake

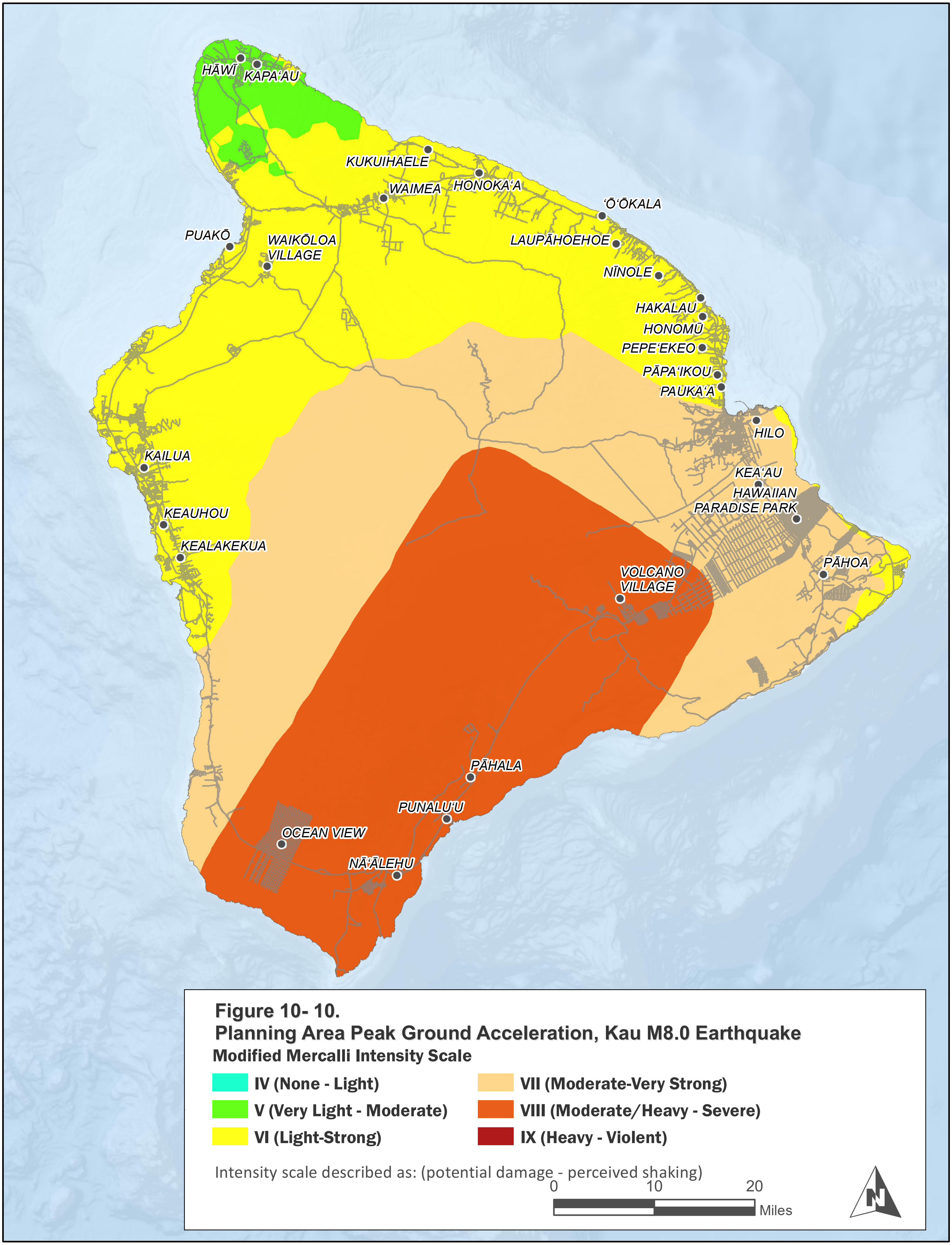


Figure 10- 10.
Planning Area Peak Ground Acceleration, Kau M8.0 Earthquake

Estimated Impacts on Persons and Households

Impacts on persons and households in the planning area were estimated for the 100-year and the three scenario events through the Level 2 Hazus analysis. Table 10-7 summarizes the results.

Table 10-7. Estimated Earthquake Impact on Persons and Households

Earthquake Event	Number of Displaced Households	Number of Residents Requiring Short-Term Shelter
100-Year Earthquake	953	647
Hawai‘i (South Kohala) M-6.7	167	93
Kalapana 1975 M-7.7	32	24
Ka‘ū M-8.0	39	29

10.4.2 Property

Building Age

Table 10-8 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using U.S. Census estimates of housing stock age, estimates were developed of the number of housing units constructed before each of these dates. Over 36 percent of the planning area’s housing units were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Housing units built before 1933 when there were no building permits, inspections, or seismic standards, account for 1 percent. Many of the housing units in the planning area are detached, single-family residences of wood construction, which generally perform well during earthquake events.

Table 10-8. Age of Housing Units in Planning Area

Time Period	Number of Current Planning Area Housing Units Built in Period	% of Total Housing Units	Significance of Time Frame
Pre-1933	865	1.0%	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	1,566	1.9%	In 1940, the first strong motion recording was made.
1941-1960	5,244	6.3%	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	13,954	16.9%	In 1975, significant improvements were made to lateral force requirements.
1976-1994	30,736	37.1%	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 – present	30,431	36.8%	Seismic code is currently enforced.
Total	**82,796**	**100%**	

Source: 2019 County tax parcel and real property data.

Estimated Damage

Table 10-9 summarizes Hazus estimates of earthquake damage in the planning area for the four scenarios. The debris estimate includes only structural debris; it does not include additional debris that may accumulate, such as from trees. In addition, these estimates do not include losses that would occur from any local tsunamis or fires stemming from an earthquake.

Table 10-9. Estimated Impact of Earthquake Scenario Events in the Planning Area

	100-Year Probabilistic	Hawai‘i (South Kohala) M-6.7	Kalapana 1975 M-7.7	Ka‘ū M-8.0
Estimated Loss				
Total (Structure and Contents)	**$6.72 billion**	**$3.46 billion**	**$2.68 billion**	**$3.18 billion**
% of Total Planning Area Replacement Value	*11.6*	*5.9*	*4.6*	*5.5*
Structural Debris				
Tons	452,390	196,560	67,900	98,010
Truckloads	18,096	7,862	2,716	3,920

10.4.3 Critical Facilities and Assets

Hazus classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a vulnerability category to each critical facility in the planning area except hazardous material facilities and “other infrastructure” facilities, for which there are no established damage functions. The analysis was performed for all scenario events. Table 10-10 summarizes the results.

10.4.4 Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater wells can dry up because of changes in underlying geology.

10.5 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by the Hawai‘i County general plan and seven Community Development Plans that encompass Kona, Puna, North Kohala, South Kohala, Ka‘ū, Hāmākua and Hilo. The protective and preventative elements of these plans, from building height to transportation and environmental aspects, establish standards and plans for the protection of the community from hazards.

The information in this plan provides a tool to ensure that there is no increase in exposure in areas of high seismic risk. A key element to exposure can be the land use on vulnerable soil classes, which for this analysis have bee identified as NEHRP soil classes D and E. Figure 10-11 shows the land uses classifications for parcels that intersect NEHRP Soil classes D and E.

Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The International Building Code establishes provisions to address seismic risk. Due to regular occurrence of seismic activity in Hawai‘i County, all future development will become vulnerable to the earthquake hazard.

SCENARIO

Any seismic activity of 6.0 or greater felt within the planning area would have significant impacts throughout the planning area. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides that would further damage structures.

Table 10-10. Estimated Damage to Critical Facilities from Earthquake Scenario Events

Category	# of Facilities Affected	Number of Facilities with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
100-Year						
Safety and Security	115	14	25	43	31	2
Food, Water and Sheltering	206	25	39	80	51	11
Health and Medical	27	5	18	3	1	0
Energy	65	8	13	34	10	0
Communications	116	5	26	40	35	10
Transportation	245	234	7	4	0	0
Hazardous Materials	10	0	2	5	3	0
Total	**784**	**291**	**130**	**209**	**131**	**23**
Hawai'i (South Kohala) M-6.7						
Safety and Security	115	82	14	14	4	1
Food, Water and Sheltering	206	151	29	24	2	0
Health and Medical	27	21	6	0	0	0
Energy	65	38	7	18	1	1
Communications	116	80	20	11	4	1
Transportation	245	237	6	1	1	0
Hazardous Materials	10	9	1	0	0	0
Total	**784**	**618**	**83**	**68**	**12**	**3**
Kalapana 1975 M-7.7						
Safety and Security	115	74	22	18	1	0
Food, Water and Sheltering	206	150	27	26	3	0
Health and Medical	27	25	2	0	0	0
Energy	65	56	1	7	1	0
Communications	116	72	22	21	1	0
Transportation	245	242	3	0	0	0
Hazardous Materials	10	8	0	2	0	0
Total	784	627	77	74	6	0
Ka'ū M-8.0						
Safety and Security	115	70	19	18	6	2
Food, Water and Sheltering	206	151	25	17	12	1
Health and Medical	27	24	1	2	0	0
Energy	65	56	1	4	4	0
Communications	116	67	23	19	6	1
Transportation	245	242	3	0	0	0
Hazardous Materials	10	7	0	1	2	0
Total	**784**	**617**	**72**	**61**	**30**	**4**

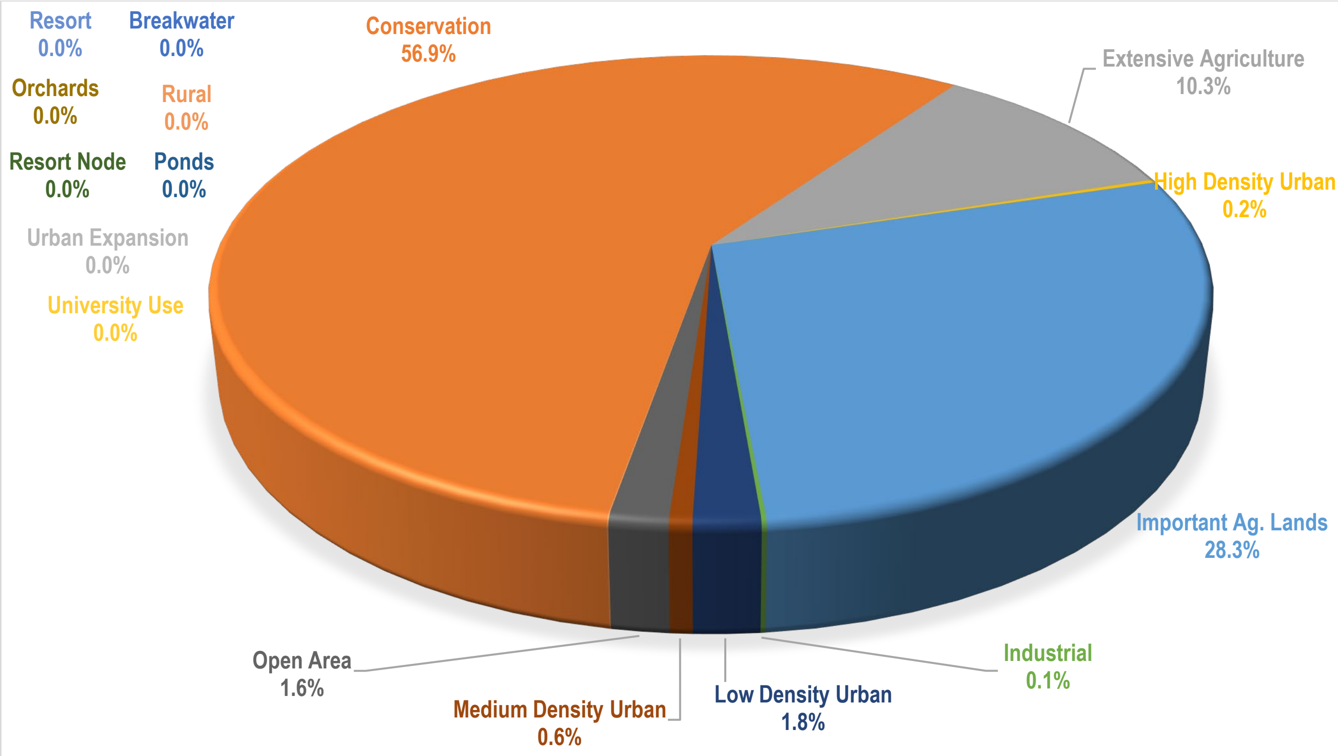


Figure 10-11. Land Use Distribution by Area in NEHRP Soils D and E

10.6 ISSUES

Important issues associated with an earthquake include but are not limited to the following:

- **Facility Retrofit**—Based on the modeling of critical facility performance performed for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- **Continuity of Operations**—Critical facility owners should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- **Standardization of Future Development**—Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- **Continued Public Education**—Citizens are expected to be self-sufficient up to 7 days following a major earthquake without government response agencies, utilities, private sector services and infrastructure components. Education programs are currently in place to facilitate the development of individual, family, neighborhood, and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.

11. FLOOD

11.1 HAZARD DESCRIPTION

Floods are one of the most common natural hazards in the U.S. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states). A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood.

11.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability for river systems. The discharge probability is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for different discharge levels and storm surge levels. These measurements reflect statistical averages only; it is possible for multiple floods with a low probability of occurrence (such as a 1-percent-annual-chance flood) to occur in a short time period. For riverine flooding, the same flood event can have flows at different points on a river that correspond to different probabilities of occurrence.

The extent of flooding associated with a 1-percent annual probability of occurrence (also called the base flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

11.1.2 FEMA Regulatory Flood Zones

According to FEMA, flood hazard areas are defined as areas that are shown on a map to be inundated by a flood of a given magnitude. These areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on FEMA's FIRM, which are official maps of a community on which the Federal Insurance and Mitigation Administration has delineated both the Special Flood Hazard Areas (SFHA) and the risk premium zones applicable to the community. These maps identify the SFHAs; the location of a specific property in relation to the SFHA; the base flood elevation (1-percent annual chance) at a specific site; the magnitude of flood a flood hazard in a specific area; the undeveloped coastal barriers where flood insurance is not available and locates regulatory floodways and floodplain boundaries (1-percent and 0.2-percent annual chance floodplain boundaries).

The land area covered by the floodwaters of the base flood is the SFHA on a FIRM. It is the area where the NFIP floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. This regulatory boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities since many communities have maps showing the extent of the base flood and likely depths that will be experienced.

The 1-percent annual chance flood is referred to as the base flood. As defined by NFIP, the base flood elevation on a FIRM is the elevation of a base flood event, or a flood which has a 1-percent chance of occurring in any given year. The base flood elevation describes the exact elevation of the water that will result from a given discharge level, which is one of the most important factors used in estimating the potential damage to occur in a given area. A structure located within a 1-percent annual chance floodplain has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage. The 1-percent annual chance flood is a regulatory standard used by federal agencies and most states, to administer floodplain management programs. The 1-percent annual chance flood is used by the NFIP as the basis for insurance requirements nationwide. FIRMs also depict 0.2-percent annual chance flood designations.

Digitized Flood Insurance Rate Maps (DFIRM), FIRMs, and other flood hazard information can be used to identify the expected spatial extent of flooding from a 1-percent and 0.2-percent annual chance event. DFIRMS and FIRMS depict SFHAs - those areas subject to inundation from the 1-percent annual chance. Those areas are defined as follows:

- **Zones A1-30 and AE:** SFHAs that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base Flood Elevations are shown within these zones.
- **Zone A (Also known as Unnumbered A-zones**): SFHAs where no Base Flood Elevations or depths are shown because detailed hydraulic analyses have not been performed.
- **Zone AO:** SFHAs subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.
- **Zone VE, V1-30:** SFHAs along coasts that are subject to inundation by the base flood with additional hazards due to waves with heights of 3 feet or greater. Base Flood Elevations derived from detailed hydraulic analysis are shown within these zones.
- **Zone B and X (shaded):** Zones where the land elevation as been determined to be above the Base Flood Elevation, but below the 500-year flood elevation. These zones are not SFHAs.
- **Zones C and X (unshaded):** Zones where the land elevation has been determined to be above both the Base Flood Elevation and the 500-year flood elevation. These zones are not SFHAs.

11.1.3 Floodplain Ecosystems

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

Connections between a water source and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick growing compared to non-riparian trees.

11.1.4 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream’s capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. As a result, FIRMs delineate regulatory floodways where development is minimized or prohibited. Development projects within floodways are highly regulated and proceed on a case by case basis.

11.2 HAZARD PROFILE

11.2.1 Federal Flood Program Participation

National Flood Insurance Program (NFIP)

Hawai‘i County participates in the NFIP and has adopted and enforced floodplain management regulations that meet or exceed the requirements of the NFIP. At the time of the preparation of this plan, the County is in good standing with NFIP requirements (FEMA Community Status Book Report, accessed 03/10/2020). Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.

In participating communities, structures permitted or built in the planning area before NFIP and related building code regulations went into effect are called “pre-FIRM” structures, and structures built afterwards are called “post-FIRM.” The insurance rate is different for the two types of structures. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent. The Hawai‘i County Municipal Code requires new construction to be elevated to 1 foot above the base flood elevation.

The first FIRMs in the planning area were available in May 1982.The most recent preliminary FIRMs in the County are dated September 29, 2017. These effective FIRMs form the basis of the risk assessment outlined later in this chapter. Table 11-1 lists flood insurance statistics for Hawai‘i County.

Table 11-1. Flood Insurance Statistics

Date of Entry Initial FIRM Effective Date	5/3/1982
# of Flood Insurance Policies as of 07/31/2019	4,582
Insurance In Force	$1,128,209,000
Total Annual Premium	$3,465,523
Claims, 11/1978 to 07/31/2019	695
Value of Claims Paid, 11/1978 to 07/31/2019	$18,534,602
Average Payment per Claim, 11/1978 to 07/31/2019	$26,668

Levees

For the NFIP, FEMA only recognizes levee systems that meet minimum design, operation, and maintenance standards. CFR 44 (Section 65.10) describes the information needed for FEMA to determine if a levee system provides protection from the 1 percent annual chance flood. This information must be supplied to FEMA by the community or other party when a flood risk study or restudy is conducted, when FIRMs are revised, or upon FEMA request. FEMA reviews the information for the purpose of establishing the appropriate FIRM flood zone.

FEMA coordinates its programs with the U.S. Army Corps of Engineers, who may inspect, maintain, and repair levee systems. The Corps has authority under Public Law 84-99 to supplement local efforts to repair flood control projects that are damaged by floods. Like FEMA, the Corps provides a program to allow public sponsors or operators to address levee system maintenance deficiencies. Failure to do so within the required timeframe results in the levee system being placed in an inactive status in the Corps’ Rehabilitation and Inspection Program. Levee systems in an inactive status are ineligible for rehabilitation assistance under Public Law 84-99.

FEMA coordinated with the Corps, the local communities, and other organizations to compile a list of levees that exist within Hawai‘i County. Table 11-2 lists all levees shown on the FEMA FIRM. Corps of Engineers Levee ID numbers listed are from the Corps’ National Levee Database; they may not match numbers based on other identification systems listed in previous FIS reports.

Table 11-2. Levees in Hawai‘i County

Flood Source	Levee Location	Levee Owner	Corps of Engineers Levee ID	FIRM Panels	Levee Status
Kamuela Stream	Left Bank	Hawai‘i County Public Works Department	1911051001	1551660168E	Accredited
Lanimaumau Stream	Left Bank	Hawai‘i County Public Works Department	1911051002	1551660168E	Accredited
‘Alenaio Stream (south bank downstream of Komohana St)	South Bank	Hawai‘i County Public Works Department	1911051014	1551660904F	Accredited
‘Alenaio Stream (south bank downstream of previous levee)	South Bank	Hawai‘i County Public Works Department	1911051014	1551660904F	Accredited
‘Alenaio Stream (north bank upstream of Kapiolani St)	North Bank	Hawai‘i County Public Works Department	1911051014	1551660904F	Accredited

The Community Rating System

Hawai‘i County is currently participating in the CRS program. Its CRS status is as follows:

- NFIP Community #—155166
- CRS Entry Date—5/1/2011
- Current CRS Classification—7
- Premium Discount—15% (SFHA) /5% non-SFHA

Many of the mitigation actions identified in this plan are creditable activities under the CRS program. Therefore, successful implementation of this plan offers the potential to enhance the CRS classification.

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000

- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. Studies have found that many of these properties are outside any mapped 1 percent annual chance (100-year) floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

FEMA-sponsored programs, such as the Community Rating System (CRS), require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

Repetitive loss properties and areas in Hawaiʻi County are described in Section 11.2.6.

11.2.2 Typical Flood-Causing Events

Prolonged rainfall may result in an accumulation of water creating flooding conditions that last several days, or even weeks. Factors influencing flooding conditions include rainfall intensity and duration, topography, soil type, antecedent soil moisture, and ground cover. In Hawaiʻi, major floods typically occur during the rainy winter, accounting for approximately 84 percent of the floods in the islands. Four types of storms produce heavy precipitation, and therefore floods:

- **Kona Storms**—These storms occur during the wettest period of the year, from November to April. Trade winds from the northeast slack during this time, allowing storms from the south to more easily approach the islands. Kona winds are generally warmer and carry moisture that is dropped evenly as rain over the entire islands. The low-elevation and southern, drier sides of the islands get most of their rainfall (approximately 25 to 30 inches each season) during Kona storms. Because of the potential combination of high winds and heavy rains, these events can cause coastal and inland flooding over larger geographic areas.
- **Frontal Storms**—Frontal storms usually occur from December through March. They originate over the Pacific Ocean as a result of the intersection of polar and tropical air masses and move eastward over the islands. Heavy continuous rainfall over a period of several hours can create disaster conditions in high sloping areas of the islands. Low-lying areas with poor drainage are prone to landslides and flash floods during these storms.
- **Upper Level Lows**—Upper level lows and troughs can occur any time of the year. In many instances, upper level lows have little or no effect on the lower levels of the atmosphere. However, these lows are sometimes able to tap into the marine layer and induce heavy showers that sometimes produce flash flooding.
- **Tropical Cyclones**—The various categories of tropical cyclones—tropical depressions, tropical storms, and hurricanes—hitting or passing near the Hawaiian Islands cause heavy rains, storm surge, high winds and surf. Impacts from these events include severe coastal and inland flooding. Tropical cyclones also cause severe damage due to high surf.

11.2.3 General Flooding Types

Riverine Floods

Small rivers and streams, such as those found in Hawaiʻi County, are susceptible to flooding from large-scale and more localized weather systems that cause intense rainfall over small areas. Riverine floods occur along a channel and include overbank and flash flooding. Channels are defined ground features that carry water through and out of a watershed. They may be rivers, creeks, streams, or ditches. Channel overflow occurs when the carrying capacity of the channel is exceeded, which can be exacerbated by development changes within the drainage basin or clogging by debris or overgrown streambed vegetation. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas.

Flash Floods

Intense rainfall may trigger "flash-floods" which provide little warning (less than six hours) before the affected area experiences flood conditions. Flash floods are "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (NOAA, 2012).

Flash floods are capable of tearing out trees, undermining buildings and bridges, and scouring new channels. In urban areas, flash flooding is an increasingly serious problem due to the removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots. The greatest risk from flash floods is that they occur with little to no warning. The major factors in predicting potential damage are the intensity and duration of rainfall and watershed and stream steepness.

Overland Sheet Flow

Poorly drained low-lying areas are a problem when flooding occurs even when rainfall is not heavy. Overland sheet flow occurs primarily in areas with undefined drainage ways, such as Puna and the leeward side of the island (e.g., Kona, Waikoloa, and Kawaihae).

11.2.4 Principal Flooding Sources

The cause of flooding as a result of stream overflow may be due to various reasons: debris-clogged streams, flash floods, undefined stream flow patterns, isolated depressions in topography, inadequate drainage facilities, and changed drainage conditions because of development. Principal flooding sources on the island of Hawaiʻi, as identified on FEMA flood maps, include the following streams; for descriptions of each of these areas, please refer to Volume I of the Hawaiʻi County Flood Insurance Study (FEMA, 2017):

- Ainako Stream
- ʻAlenaio Stream
- ʻAuwaiakeakua Gulch
- Captain Cook Watercourse
- Four Mile Creek
- Gulch 2—Hāpuna
- Gulch 3—Hāpuna
- Gulch 4—Puakō
- Hienaloli Drainageway
- Hōlualoa Drainageway
- Hōlualoa Drainageway Tributary
- Honokaʻa Drainage
- Horseshoe Bend Drainageway
- Kaluiiki Branch
- Kamakoa Gulch
- Kamuela Stream
- Kaumalumalu Drainageway
- Keōpū Drainageway
- Lower Lanimaumau Stream
- Mohouli Street Drainage
- Nīnole Gulch
- Palai Stream
- South Kona Watercourses #1 to #25
- Tributaries to Ainako Stream
- Waiʻaha Drainageway Waiākea Stream
- Waikoloa Stream
- Waipāhoehoe Stream

The sections below summarize historical flooding issues in specific local areas across the island.

North Kohala Area

The North Kohala area is subject to occasional heavy rainfall that creates heavy runoff. Streams collect water from the upper watershed and convey most flows safely through the urban centers. Most of the 15 gulches within the district are heavily vegetated and well-defined at the lower reaches below Māhukona-Niuli‘i Road. Above Māhukona-Niuli‘i Road, the gulches are less defined and less densely vegetated. The gulches generally have adequate capacity to handle storm flows.

No major flood problems have been identified, and only minimal damage by sheet runoff has been reported in the Hāwī and Kapa‘au areas. Other than damage to highway culverts, there is no record of any flood damage to structures. Specific past flood problems include the following:

- The town of Hāwī has experienced surface sheet flows concentrating along the highway within the town, the highway and road culverts at Lipoa Gulch, and Halelua and Pueka gulches.
- In the community of Kapa‘au, the existing highway culverts are inadequate to handle peak flood flows and have caused minor flooding problems in the past. On each side of the highway, the Makapala area is relatively flat and is susceptible to flooding by the Niuli‘i and Waikani streams.

South Kohala Area

The South Kohala area can be divided into two watershed areas:

- The Waimea Village watershed extends into the Kohala Mountains. Heavy rainfall occurs in these mountains and several intermittent streams flow through the Waimea area. Upon reaching the Waimea plains, these streams tum to the west and flow toward Kawaihae across the extremely permeable lava flows of Mauna Kea. The Waikoloa stream has caused flooding within the town of Waimea during high intensity storms when waters overflow due to sharp stream bends and generally inadequate flow-carrying capacities. In addition, there is some flooding concern around the area abutting the Kawaihae road.
- The watershed area above the Kawaihae to ‘Anaeho‘omalu shoreline extends from the coast to the peaks of Mauna Kea to Mauna Loa. The area is semi-arid with few well-defined channels and infrequent stream flows. High intensity storms have caused flooding along the Queen Kaahumanu Highway from Kawaihae to Puakō, and at Puakō. These storms are very infrequent and tend to create flash floods. High flows have been experienced in the Hāpuna Beach and Spencer Beach Park areas due to the flash floods. The Puakō Beach lots have also been subject to flooding. During the evening of September 8, 1996, heavy rains generated a flash flood along Auwaiakeakua Stream. The floodwaters overtopped the existing drainage ways, causing damage to private properties, particularly the Fairway Terrace Condominium at Waikoloa Village, County roads and drainage facilities.

South Hilo Area

South Hilo is divided into two watershed study areas divided by the Wailuku River.

- North of the river, the coastline has abrupt cliffs 30 to 80 feet high that are broken by deep stream channels. Usable land areas have a ground slope of 6 to 12 percent. Above the 4,000-foot elevation, the stream channels diminish in number and depth and have all but disappeared above the 7,000-foot elevation. Flooding problems in this area are primarily caused by local water runoff from former sugar cane fields situated above the communities.
- South of the Wailuku River is a relatively flat plain of less than 1 percent slope that extends toward Highway 11. Above Highway 11, the slope steepens to approximately 6 to 12 percent. Stream channels are poorly defined and disappear at elevations above 2,500 feet. Development in the upper section of the Waiākea Stream Watershed has been susceptible to flooding.

Ka'ū Area

Ka'ū can be divided into three regions:

- The northeastern region is dominated by the Ka'ū desert, where the average annual rainfall is approximately 20 inches. There are few defined stream channels, none of which are perennial. The soils are very shallow, covering rough lava flows that are extremely permeable.
- The southwestern region that extends west from the South Point Road is characterized by moderate slopes, extremely permeable soils, and relatively young lava flows. The median annual rainfall varies from less than 20 inches at South Point to 75 inches at the 5,000-foot elevation. There is little evidence of stream flow within this region and no record of damage from flood flows other than the flooding of roads within the Hawaiian Ocean View Estates subdivision.
- The central region contains the communities of Pāhala, Nāʻālehu, and Waiʻōhinu. There are several streams within the region, none of which are perennial. Flooding occurs when the soils are saturated and rainfall intensity exceeds the rate of infiltration. Storm runoff descends steep slopes behind the communities and causes flooding and deposition of sediment and debris in the communities.

Flash flooding occurs along the Hawaiʻi Belt Road. The Piʻikea, Keaīwa, Pāʻauʻau, Punaluʻu, Hīlea, Kawaa, and Honuʻapo streams often exceed the capacity of the existing bridges and culverts and flood the roadway. This temporarily closes the road and effectively cuts off Ka'ū from the Puna, Hilo and Kona districts.

Hāmākua Area

The Hāmākua area can be divided into two watershed areas: the northern watershed, which affects the Waipio Valley area and extends upward into the Kohala Mountains; and the southern watershed, which extends to the peak of Mauna Kea and affects the communities of Kukuihaele, Honokaʻa, Pāʻauhau, Paʻauilo, and Kūkaʻiau. Historical flooding problems have included the following:

- Streams originating above and flowing through Honokaʻa have caused flooding in the town. The existing culverts within the town do not have adequate capacity to handle volume flows.
- Occasional flooding along the Hawaiʻi Belt Road between ʻAhualoa and Waimea occurs when rainwater comes down from the pastures and overtops the road.
- Localized drainage problems exist within the limits of Paʻauilo. These problems are caused by allowing surface waters to collect from large areas within the town and flow down narrow roadways.

Puna Area

The climate of Puna varies considerably, from the rocky shoreline to the rain forest areas in the upper elevation. Rainfall amounts are generally heavy and most of the district receives over 100 inches per year, resulting in severe flooding. Currently, the lack of development and the extremely permeable soils have helped to minimize major damage to life and property. However, as the amount of development increases within the area, flood problems will also increase. The conversion of land historically planted in sugar to other crops also may increase runoff. Moreover, topographical changes from the 2018 lava flows will require further studies to determine changes in flood patterns in affected areas.

Some of the flood hazard areas in Puna are difficult to delineate due to the lack of defined drainage ways. Significant flooding has occurred along the Belt Highway and the highway from Keaʻau to Pāhoa, but highway improvements have done much to alleviate this flooding. Recorded flood damage has mainly been caused by surface sheet flows that are likely to occur anywhere when heavy storms strike. Examples of this are found in Fern Forest, Eden Roc, Fern Acres, Orchidland, and Hawaiian Paradise Park. Other areas, such as Hawaiian Acres, may be more defined. The flooding below Mountain View may be the result of diversion of the Mountain View watershed into some of the substandard subdivisions.

Waiākea Area

Many culverts in upper Waiākea are inadequate. Roadside ditches, though small in cross-sectional area, are aided by the highly porous ground and are fairly effective even during heavy storms. One of the most serious problems faced by County maintenance crews is the frequent washout of cinder gravel shoulders along road pavements. Another problem is the accumulation of vegetation growth and debris in waterways, which causes overflow.

In the lower Waiākea area, storm damage is minimal due to the effectiveness of the Wailoa and Waiākea-Uka Flood Control Projects.

Kaūmana-Ainako-Wailuku River Area

Kaūmana's drainage system consists of roadside ditches, culverts, and narrow channels. Except for the Ainako Avenue area, all of upper Kaūmana's stormwater runoff is discharged either through the Waipāhoehoe or the ʻAlenaio Streams. The Chong Street Diversion No. 3 and the Wailuku-'Alenaio Diversion No. 4 along ʻĀkōlea Road serves to reduce flooding in the lower areas and the Ainako Avenue sections.

The drainage system in the Ainako-Wailuku River area consists of box culverts that pass the discharge of the Ainako River across Kokea, Kōʻula, and Kapaʻa Streets. The residential areas bordering the Wailuku River have a system of collection ditches. Except during very intense storms, there are few problems in the area.

Hilo Urban Area

Prior to the completion of the Waiolama Canal in 1924 and the Ponahawai Storm Drain System in 1926, this area was severely inundated during heavy rain. The construction of the canal and the storm drain system has since provided some degree of protection for the area.

Except for the northern section of the business district, all of downtown Hilo falls within the Wailoa River basin and within the area tributary to the ʻAlenaio stream. The State Department of Transportation has indicated that there are periodic shifts of beach material along the Hilo bay front shoreline. In addition, occasional storm events will close the roads at bay front due to storm surge.

The Paukaʻa, Pāpaʻikou, Pepeʻekeo, Honomū, and Hakalau communities have no serious flood problems, although Honomū and Pāpaʻikou have experienced minor flooding. These result from runoff from the areas above the communities.

North Hilo Area

North Hilo is characterized by an average ground slope of approximately 10 percent with scores of deep intermittent and perennial streams. Other than runoff from former cane lands, there is little record of flooding in urban areas. Each community is close to one or more gulches that carry flow from the upper watershed areas, and high-intensity storms can produce localized flooding in almost any area. Specific flood histories are as follows:

- The community of ʻŌʻōkala has not experienced heavy flooding although there are minor problems due to surface waters from the former cane fields above the town.
- There is no record of any flooding within the community of Nīnole.
- The community of Laupāhoehoe has not experienced any extreme flood flows. However, there will be a need to supply flood protection for the community since Laupāhoehoe School, which is located just to the south of the urban center, has experienced some flooding. Water flows from the former cane fields, when the natural vegetation does not form a complete cover.
- The community of Pāpaʻaloa has not experienced any serious flooding problems. With the projected expansion of the community, there will be a need to provide flood protection for the area.

North Kona Area

North Kona can be divided into two watershed areas:

- The area north of Keāhole Point and the summit of Hualālai have very low rainfall and runoff. Rainfall for this area reaches a maximum average of 40 inches per year, but most of the area receives less than 20 inches per year. The soils in the area are extremely permeable and there is no record of hazardous flooding in this area.
- The southern area, extending southward from Keāhole Point, contains most of the urban development and is subject to increasing hazards from floodwater damages as land is more intensively utilized. The area is characterized by dry vegetative growth along the coastal areas and thick tropical vegetation in the upper forest reserves. The ground slope is steep, averaging approximately 15 percent.

The steep slopes, shallow soils, frequent high intensity rains, and the lack of well-defined drainageways make many areas in the North Kona district susceptible to flooding and overland flows. Flash floods result primarily from overflows of the Keōpū/Hienaloli, Waiʻaha, Kaumalumalu and the Hōlualoa/Horseshoe Bend drainage ways. Floodwater and sediment damage occur along the entire coffee belt, with the Kainaliu, Hōlualoa and Kailua village areas experiencing the heaviest damage.

Historically, several flood problems have been noted in the North Kona District. Floods in Kailua-Kona result primarily from Waiʻaha Springs. Sheet runoff from the steep slopes of the Hōlualoa Watershed has also caused some flood problems. Records indicate that Kainaliu also has been subject to flood hazards. Storms in the area occur in a few drainageways, not the whole study area, resulting in storm damage that is concentrated in specific drainageways.

South Kona Area

This district has few well-defined drainage ways. Overland and stream flows are rare and can only be detected when the rainfall intensity exceeds the rate of infiltration. The area is subject to sudden high-intensity rainstorms that can strike anywhere and cause localized flooding. Coffee and other agricultural lands are subject to erosional damage, and roads and culverts are sometimes damaged by high flows and sediment deposition.

There are also records of minor flooding from Kiʻilae, South Kēōkea, Hōnaunau and Wailapa streams. In general, an area within 150 feet of the stream channels can be considered subject to flooding. Other areas with records of minor flooding include the areas along the Belt Highway in the area of the 1950 lava flows and at Hoʻokena Road.

Flooding problems have been largely a result of localized high-intensity rainfall from about 1,000 to 5,000 feet in elevation. Such storms can occur anywhere along the mountain slopes of South Kona. In addition, a few general storms have affected the entire study area. Accurate data on rainfall and flood flows are not available, but general accounts from storm damage reports are available.

11.2.5 Past Events

Table 11-3 summarizes flood events in the County of Hawaiʻi since 1960, as recorded in the National Climatic Data Center’s Storm Events Database. The sections below describe some of the more severe occurrences of flooding in the City.

Table 11-3. History of Flood Events

Date	Event	Date	Event	Date	Event
11/3/2018	Flash Flood [a, c]	9/17/1992	Flash Flood	10/1/1987	Flash Flooding
8/22/2018	Flash Flood [b]	9/14/1992	Flash Flood	7/21/1987	Flash Flooding
2/18/2018	Flash Flood [a, b]	2/13/1992	Flash Flood	5/5/1987	Flash Flooding
1/21/2017	Flash Flood [a, b]	1/14/1992	Flash Flood	11/10/1986	Flash Flooding
9/14/2015	Flash Flood [a, b]	9/22/1991	Flash Flood	9/26/1986	Flash Flooding
12/19/2012	Flash Flood [a, b]	8/3/1991	Flash Flood	4/8/1986	Flash Flooding
7/10/2011	Flash Flood [a, b, c]	3/9/1991	Flash Flood	4/3/1986	Flash Flooding
3/14/2004	Flooding	1/27/1991	Flooding	3/16/1986	Flash Flooding
10/24/2001	Flooding	12/18/1990	Flash Flooding	2/16/1986	Flash Flooding
11/1/2000	Flash Flood	11/18/1990	Flash Floods	11/19/1985	Flood
9/9/2000	Flooding	2/28/1990	Flash Flooding	9/29/1985	flash flood
9/8/1996	Flash Flood	1/14/1990	Flash Flooding	9/25/1985	flash flooding
3/3/1996	Flash Flood	12/9/1989	Flash Flood	3/11/1985	Flash Flooding
9/19/1994	Flash Flooding	10/7/1989	Flash Flooding	12/24/1984	Flood
9/18/1994	Flash Flooding [c]	8/20/1989	Flash Floods	11/26/1984	Flood
8/12/1994	Flash Flooding	4/28/1989	Flash Flooding	11/3/1984	Flood
3/23/1994	Flash Flooding	4/24/1989	Flash Flooding	4/1/1982	Flooding
2/14/1994	Flash Flooding	4/4/1989	Flash Flooding	3/30/1982	Flooding
2/11/1994	Flash Flooding	2/10/1989	Flash Flooding	3/17/1982	Rain/Hail/Flooding
2/8/1994	Flash Flooding [c]	2/3/1989	Flash Flooding	10/27/1981	Flooding
10/3/1993	Flash Flooding	1/10/1989	Flash Flooding	11/14/1979 [b]	Flooding
11/29/1992	Flash Flood	11/4/1988	Wind/ Flood	10/9/1979	Flash Flood
11/19/1992	Flash Flood	9/26/1988	Flash Flooding	2/19/1979 [c]	Heavy Rain/ Flood
11/19/1992	Flash Flood	3/14/1988	Flash Flooding	4/26/1976	flash flood
10/16/1992	Flash Flood	12/11/1987	Flash Flooding	5/13/1960	Local Flooding

a. No property damage recorded for this event.
b. Fatalities resulted from this event.
c. Injuries were reported.
Source: NCEI, 2020

November 2000

Intense, prolonged rainfall caused flooding on November 1 – 2, 2000. Although maximum 1-hour rainfall totals were not extreme (recurrence interval of 1 to 2 years, except for Kapāpala Ranch and Hilo Airport gages at 5 to 10 years recurrence interval), the severity was in the prolonged nature of the storm. A recurrence interval for a 24-hour period was 100 years or more at several rain gages. Over 30 inches of rain fell in Waiākea and Kapāpala. Somewhat less rain fell in most of East Hawaiʻi (5 to 25 inches). The highest rainfall total was at Kapāpala Ranch in Ka'ū, where more than 36 inches was recorded within a 24-hour period. In Hilo, the Waiākea-Uka area was inundated with 29 inches, the Piʻihonua area had 24 inches, Mountain View had nearly 29 inches, and Glenwood had 26 inches. The National Weather Service reported 27 inches of rainfall at the Hilo International Airport.

The recurrence interval for peak stream discharges ranged from 50 to 100 years for streams south of Wailuku River in the Waiākea area. Most other streams in East Hawaiʻi had recurrence intervals between 5 and 30 years.

The resulting flood damage to homes, roads, bridges, businesses, and farms exceeded $70 million, among the highest totals associated with flooding in the state's history. State and federal disaster declarations were issued for the island. More than 1,131 Big Island flood victims registered for FEMA assistance.

December 2007

A complex storm system developed in the northwest Pacific Ocean and moved southeast toward Hawaiʻi on December 3, 2007. As the system moved southeast, the associated cold front intensified and approached the island chain from the west. Lingering atmospheric instability behind a previous frontal system, combined with warm, moist conditions ahead of the cold front, led to extremely heavy rains across the state. The storm weakened and drifted northeast, but a surface trough remained, keeping conditions unsettled until December 11.

Maui and the Big Island experienced the heaviest rainfall during the event. Two-day totals were between 10 and 12 inches at the Kapāpala Ranch and Hawaiʻi Volcanoes National Park Headquarters gauges. High winds and snow showers created white-out conditions on the summits. Snow levels dropped down to around 11,000 feet. Seven-foot snow drifts and icing forced park rangers to shut down the Mauna Kea access road. Conditions did not allow for the road to be reopened until the end of the storm period.

Widespread property damage was reported all across the state during this event. Up to 2 feet of water covered portions of Highway 11 in the Kaʻū district. Roofs were blown off of houses in downslope areas and downed power lines created widespread power outages. Estimates compiled from local authorities placed the damage cost for the event in the area of $3.4 million.

August 2018

With Hurricane Lane just west of the island of Hawaiʻi and south of Maui and Oʻahu, torrential rain fell over parts of the state, especially the Big Island. Flash flooding was the most serious problem, with parts of the Big Island seeing total rainfall of 40 to 56 inches. Strong winds downed trees and power lines, leading to power outages. Flash flooding continued for about two days for much of the east half of the island of Hawaiʻi. From near Hāwī in the north to the Kawa Flats area in the south, almost continuous heavy rain and thunderstorms associated with Hurricane Lane affected the isle. There were no reports of serious injuries, but at least $20 million in damage to public infrastructure on the Big Island was reported. Damage reports included the following:

- Flooding waters closed Bayfront Highway in Hilo.
- Highway 19 in multiple areas was closed due to debris flows and deep water on the roadway.
- Akoni Pule Highway became impassable near Hāwī.
- Kaʻalāiki Road northeast of Nāʻālehu was closed because of deep ponding.
- Water rescues and evacuations were undertaken in the Hilo area at Kaiulani Street, with water levels running at 5 feet.
- A resident in Keaʻau had to evacuate the home because of flooding on N. Wilder Road.
- A portion of Saddle Road upslope from Hilo was closed because of a debris flow and large rocks on the roadway.
- Route 130 was closed from Keaʻau High School to Hawaiian Paradise Park due to flooding.
- Both lanes of Highway 11 in the Kawa Flats area were closed because of deep water over the roadway.

11.2.6 Location

Annual rainfall on the island of Hawaiʻi ranges between 300 inches on the slopes of Mauna Kea above Hilo, to below 10 and 20 inches in the arid regions around Kawaihae and South Point. Flooding is common on the wet, windward side of the island where annual rainfall is high. Most of the flooding that has caused damage has been flash flooding during extreme rainfall events that bring about sheet flow between stream channels. The Hilo and Puna areas are probably the most frequently flooded and hardest hit by flash floods on the Big Island and perhaps in the state. The Kohala and Kona districts have a long and active history of flooding largely due to flash flooding and intense storms.

Area Within the Mapped Floodplain

Flooding that has occurred in portions of the County has been documented by gage records, high water marks, damage surveys, and personal accounts. This documentation was the basis for the floodplains mapped by FEMA on FIRMs for Hawai'i County (see Figure 11-1; detailed area maps are provided in Appendix B). All of the principal flooding sources are incorporated in the currently effective FIRMs. The FIRMs are the most detailed and consistent data source available for determining flood extent. The 2017 Flood Insurance Study is the sole source of data used in this risk assessment to map the extent and location of the flood hazard.

Only 0.3 percent of the entire County (7,358 acres) is located within the mapped 1 percent annual chance floodplain. Table 11-4 shows the area of mapped floodplain in each of the County's nine districts.

Table 11-4. Area in the 1-Percent-Annual-Chance (100-Year) Floodplain

	Area in the 1 Percent Annual Chance (100-Year) Floodplain	
	Area (acres)	% of Total Floodplain Area
Hāmākua	921	12.4%
Ka'ū	154	2.1%
North Hilo	0	0.0%
North Kohala	203	2.7%
North Kona	1,030	13.9%
Puna	335	4.5%
South Hilo	2,391	32.2%
South Kohala	1,519	20.5%
South Kona	868	11.7%
Total	**7,421**	**100.0%**

Repetitive Loss Properties and Areas in the Planning Area

FEMA has identified 45 repetitive loss properties in the planning area as of January 31, 2017, based on information provided to the County by the CRS program. Sixty-nine percent of these structures are residential, and the rest are commercial. None of these properties have been identified as being mitigated according to the CRS Activity 501 protocol. Using the CRS protocol for analyzing repetitive loss areas, the County has identified 221 properties in areas subject to repetitive flooding. All of these properties are within or immediately adjacent to the FEMA-mapped SFHA; most are residential. The probable causes of flooding for all properties in identified repetitive loss areas has been determined to be commensurate with the risk reflected in the SFHA mapping.

All of the identified repetitive loss properties were geocoded for spatial analysis, which provided the following conclusions:

- Eight of the 45 repetitive loss properties have average loss claims of less than $10,000 dollars. Such losses are generally associated with localized flood events resulting from urban drainage issues or other smaller scale occurrences such as a water main break.
- Fifteen of the properties incurred flood damage on two occasions prior to the 1990s but have not filed a claim since.
- The remainder of the properties appear to have losses that correlate to the flood depths reflected in the FEMA mapping, so the losses are likely associated with the flood risk reflected in the mapping.

Repetitive loss area in the County are shown in Figure 11-2; detailed area maps are provided in Appendix B.

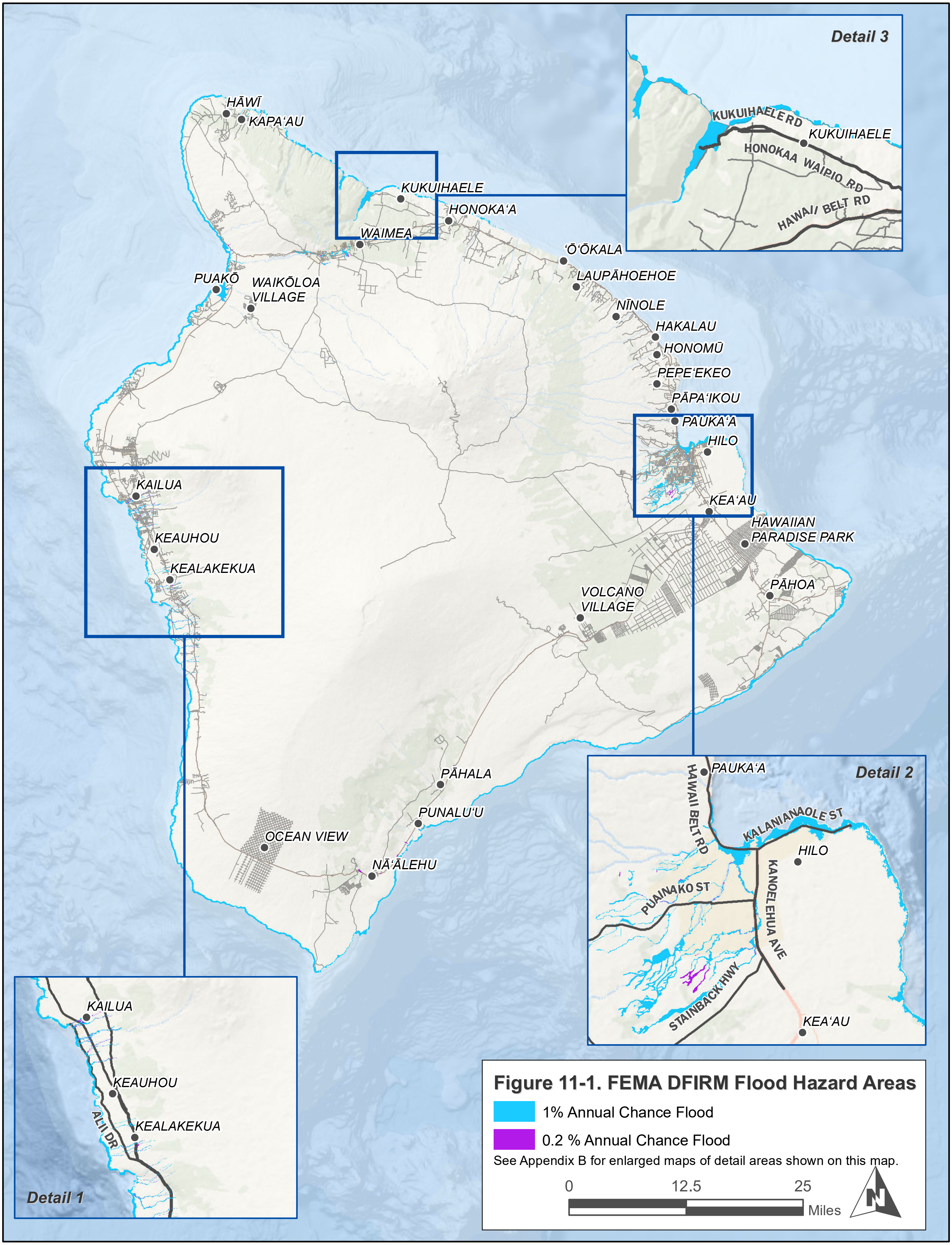


Figure 11-1. FEMA DFIRM Flood Hazard Areas

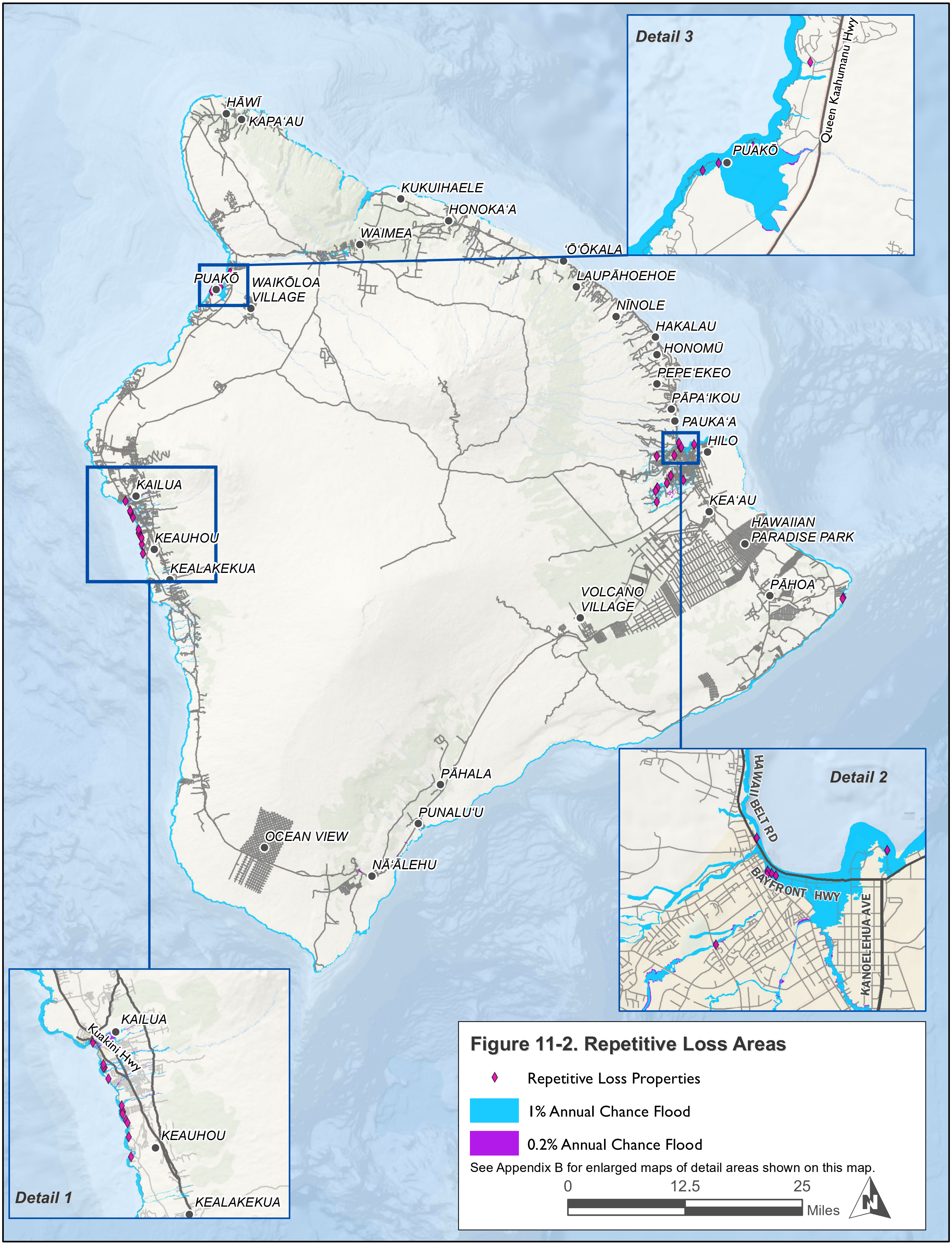


Figure 11-2. Repetitive Loss Areas

11.2.7 Frequency

There have been 10 federal disaster declarations for non-tsunami flooding in the Hawaiian Islands since 1963. This equates to a major, non-tsunami, non-tropical-cyclone-related flood event every six years on average. More localized flood events can be expected to happen annually. Data compiled over the last 50 years indicate that, on average, a damaging flood event occurs on the Big Island with an annual probability of 0.5 percent.

The planning area can expect an average of one episode of minor river flooding each winter. Large, damaging floods typically occur every 10 years. The frequency of flooding in smaller streams and basins can be expected to increase somewhat as a result of increased development, increasing the amount of impervious surface.

11.2.8 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges. Peak flows used by FEMA to map the floodplains of the planning area are listed in Table 11-5.

Table 11-5. Summary of Peak Discharges Island of Hawaiʻi

Source/Location	Discharge (cubic feet/second)			
	10-Year	50-Year	100-Year	500-Year
Ainako Stream at Waiānuenue Avenue	N/A	N/A	1,850	N/A
ʻAlenaio Stream at Confluence with Wailoa River	N/A	N/A	6,000	9,840
Auwaiakeakua Gulch at Mouth	1,550	6,400	10,500	29,000
Four Mile Creek at Kanoelehua Avenue	3,380	5,975	7,165	9,740
Four Mile Creek Upstream of Tributary No. 1	935	1,535	1,840	2,605
Four Mile Creek Shallow Flooding Downstream of Ainalako Avenue	N/A	N/A	1,205	N/A
Four Mile Creek Shallow Flooding Upstream of Ainalako Avenue	N/A	N/A	1,205	N/A
Four Mile Creek Tributary No. 1 at Confluence with Four Mile Creek	3,545	5,475	6,565	8,950
Four Mile Creek Tributary No. 1 at Kulaloa Road	N/A	N/A	3,533	N/A
Four Mile Creek Tributary No. 3 at Ainalako Drive	N/A	N/A	915	N/A
Gulch 2- Hāpuna at Confluence with Hāpuna Bay	420	1,300	1,950	4,400
Gulch 2- Hāpuna at Confluence with Waialea Bay	210	570	800	1,650
Gulch 4—Puakō at Mouth	215	565	790	1,650
Hienaloli Drainageway at Mouth	1,550	2,690	3,690	5,180
Hienaloli Drainageway Split flow at Hawaiʻi Belt Road	N/A	N/A	830	N/A
Hōlualoa Drainageway at Mouth	900	1,750	2,590	4,070
Honokaʻa Drainage A at Mamane Street	N/A	N/A	582	N/A
Honokaʻa Drainage B at Mamane Street	N/A	N/A	253	N/A
Honokaʻa Drainage C at Mamane Street	N/A	N/A	271	N/A
Honokaʻa Drainage D at Downstream Limit of Detailed Study	N/A	N/A	271	N/A
Honokaʻa Drainage No. 1 at Mamane Street	N/A	N/A	609	N/A
Honokaʻa Drainage No. 2 at Mamane Street	N/A	N/A	560	N/A
Honokaʻa Drainage No. 3 at Mamane Street	N/A	N/A	370	N/A
Horseshoe Bend Drainageway at Mouth	650	960	1,310	1,910

Source/Location	Discharge (cubic feet/second)			
	10-Year	50-Year	100-Year	500-Year
Kainaliu Drainageway 4,300 Feet Upstream of the Pacific Ocean	N/A	N/A	610	N/A
Kaluiiki Branch Approximately 1,500 Feet Upstream of Confluence with Waipāhoehoe Stream	N/A	N/A	2,740[a]	N/A
Kawanui-Lehuula Drainageway 4,000 Feet Upstream of the Pacific Ocean	*b*	*b*	590	*b*
Kamuela Stream at Waipāhoehoe Stream	1,320	2,510	3,150	4,950
Kamuela Stream at Kaluiiki Branch	1,150	2,200	2,750	4,340
Kamuela Stream at Confluence with Waikoloa Stream	N/A	N/A	919	N/A
Kamuela Stream at Kamuela Stream	N/A	N/A	645	N/A
Kamuela Stream Point 10 at Kinohou Street	323	538	644	817
Kamuela Stream Point 11 Before Confluence with Lanimaumau Stream	343	586	707	899
Kaumalumalu Drainageway at Mouth	1,040	2,750	4,040	4,840
Kawanui-Lehuula Drainageway Approximately 4,000 Feet Upstream of the Pacific Ocean	N/A	N/A	590	N/A
Keōpū Drainageway at Hawaiʻi Belt Road	560	1,120	1,610	2,460
Kupulau Flood Ditch at Divergence From Palai Stream A	N/A	N/A	2,144	N/A
Kupulau Flood Ditch Downstream of Divergence From Palai Stream C	N/A	N/A	1,263	N/A
Lower Lanimaumau Stream Point 12 at Māmalahoa Highway	19	27	33	41
Lower Lanimaumau Stream Point 13 at Entrance to Kūhiō Village	307	615	775	1,017
Mohouli Street Drainage at 6.200 Feet Upstream of Komohana Street	N/A	N/A	750	N/A
Mohouli Street Drainage at Komohana Street	N/A	N/A	750	N/A
Nīnole Gulch at Confluence with Nīnole Gulch	6,900	9,200	10,800	14,800
Nīnole Gulch at USGS Station	4,300	6,800	7,900	11,000
NRCS Diversion Channel Point 3 at Highway	838	1,803	2,027	2,402
Palai Stream at Mouth[c]	760	1,330	1,550	2,220
Palai Stream at Puainako Street	1,275	1,960	2,265	3,120
Palai Stream at Kanoelehua Avenue	1,070	1,600	1,860	2,530
Palai Stream at Golf Course Near Kehaulani Street	1,020	1,525	1,775	2,410
Palai Stream A 1,940 Feet Downstream of Kaulike Street	N/A	N/A	294	N/A
Palai Stream A at Ainaola Drive	N/A	N/A	470	N/A
Palai Stream A Split Flow No. 3 at Confluence with Palai Stream A	N/A	N/A	112	N/A
Palai Stream C at Confluence with Kupulau Flood Ditch	N/A	N/A	173	N/A
Palai Stream C at Divergence From Kupulau Flood Ditch	N/A	N/A	411	N/A
Palai Stream C at Haihai Street	N/A	N/A	563	N/A
Palai Stream D at Mouth	N/A	N/A	280	N/A
Palai Stream E at Alaloa Street	N/A	N/A	240	N/A
Palai Stream F at Confluence with Palai Stream	N/A	N/A	3,445	N/A
Gulch No. 4—Puakō at Mouth	215	565	790	1,650
South Kona Watercourse No. 1 at Mouth	715	2,389	3,512	6,780
South Kona Watercourse No. 2 at Confluence with No. 3	251	792	1,149	2,190
South Kona Watercourse No. 3 at Mouth	266[d]	887[d]	1,304[d]	2,497[d]
South Kona Watercourse No. 4 at Confluence with No. 3	170	580	859	1,720
South Kona Watercourse No. 5 at Mouth	141[d]	585[d]	854[d]	1,612[d]

Source/Location	Discharge (cubic feet/second)			
	10-Year	50-Year	100-Year	500-Year
South Kona Watercourse No. 5 at Māmalahoa Highway	94[d]	354[d]	508[d]	926[d]
South Kona Watercourse No. 5a Approximately 90 Feet Upstream of Confluence with No. 5	72[d]	284[d]	413[d]	765[d]
South Kona Watercourse No. 6 at Mouth	399[d]	1,348[d]	1,976[d]	3,858[d]
South Kona Watercourse No. 7 at Confluence with No.8	402	1,382	2,056	4,070
South Kona Watercourse No. 8 at Mouth	413[d]	1,417[d]	2,103[d]	4,157[d]
South Kona Watercourse No. 9 at Confluence with No. 11	217[d]	832[d]	1,211[d]	2,225[d]
South Kona Watercourse No. 10 at Confluence with No. 11	128[d]	508[d]	742[d]	1,393[d]
South Kona Watercourse No. 11 at Confluence with No. 12	1,105[d]	3,573[d]	5,162[d]	9,879[d]
South Kona Watercourse No. 12 at Mouth	1,160[d]	3,731[d]	5,392[d]	10,367
South Kona Watercourse No. 13 at Mouth	650	2,730	2,960	4,470
South Kona Watercourse No. 13 at Confluence with No. 17	334	1,280	1,410	2,040
South Kona Watercourse No. 14 at Confluence with No. 13	9	45	109	582
South Kona Watercourse No. 15 at Confluence with No. 17	199	918	939	1,310
South Kona Watercourse No. 16 at Confluence with No. 15	228	950	971	1,340
South Kona Watercourse No. 17 at Confluence with No. 13	316	1,410	1,500	2,300
South Kona Watercourse No. 18 at Confluence with No. 17	80	411	458	737
South Kona Watercourse No. 19 at Confluence with No. 20	332	1,700	1,780	2,840
South Kona Watercourse No. 20 at Mouth	673	3,760	4,040	6,790
South Kona Watercourse No. 21 at Mouth	494	2,035	3,021	5,854
South Kona Watercourse No. 22 at Confluence with No. 21	111	494	723	1,319
South Kona Watercourse No. 23 at Confluence with No. 21	425	1,707	2,530	4,927
South Kona Watercourse No. 24 at Confluence with No. 25	138	569	865	1,769
South Kona Watercourse No. 25 at Mouth	211	855	1,276	2,504
Tributary 1 to Ainako Stream at Confluence with Ainako Stream	N/A	N/A	1,850	N/A
Tributary 2 to Ainako Stream at Confluence with Ainako Stream	N/A	N/A	1,680	N/A
Tributary 3 to Ainako Stream at Confluence with Ainako Stream	N/A	N/A	1,380	N/A
Tributary 4 to Ainako Stream at Confluence with Ainako Stream	N/A	N/A	1,285	N/A
Tributary 1 to Waiākea Tributary No. 3 at Confluence with Waiākea Tributary No. 3	N/A	N/A	41	N/A
Tributary 2 to Waiākea Tributary No. 3 at Confluence with Waiākea Tributary No. 3	N/A	N/A	48	N/A
Tributary 3 to Waiākea Tributary No. 3a	N/A	N/A	72	N/A
Tributary 4 to Waiākea Tributary No. 3a at Confluence with Waiākea Tributary No. 3a	N/A	N/A	119	N/A
Tributary 1 to Waiākea Tributary No. 3b at Confluence with Waiākea Tributary No. 3b	N/A	N/A	39	N/A
Tributary 2 to Waiākea Tributary No. 3b at Confluence with Waiākea Tributary No. 3b	N/A	N/A	40	N/A
Tributary 1 to Waipāhoehoe Stream 2,510 Feet Upstream of Confluence with Waipāhoehoe Stream	N/A	N/A	376	N/A
Tributary to Mohouli Street Drainage at Confluence with Mohouli Street Drainage	N/A	N/A	320	N/A
Unnamed Stream No. 1 Point 4 at Māmalahoa Highway	285	432	493	594
Unnamed Stream No. 1 Point 5 Downstream Confluence Point with Unnamed Stream No. 2	524	803	927	1,135
Unnamed Stream No. 1 Point 6 at Confluence with Unnamed Stream No. 3	1,726	3,409	3,900	4,774

Source/Location	Discharge (cubic feet/second)			
	10-Year	50-Year	100-Year	500-Year
Unnamed Stream No. 1 Point 7 at Hawaiian Farms Subdivision	N/A	81	155	256
Unnamed Stream No. 2 Point 8 Upstream of Confluence with Unnamed Stream No. 1	235	351	411	511
Unnamed Stream No. 3 Point 9 Upstream of Confluence with Unnamed No. 1	371	745	884	1,136
Unnamed Tributary to 'Alenaio Stream	N/A	N/A	1, 450	N/A
Upper Lanimaumau Stream Point 1 Upstream of Confluence with Lower Lanimaumau Stream	668	1,455	1,623	1,902
Upper Lanimaumau Stream Point 2 at Confluence with Lower Lanimaumau Stream	685	1,510	1,687	1,907
Wai'aha Drainageway at Mouth	2,770	5,190	7,110	10,650
Waiākea Stream 1,000 Feet Upstream of Komohana Street	2,010	4,580	6,230	12,000
Waiākea Tributary No. 1 at Confluence with	N/A	N/A	355	N/A
Waiākea Tributary No. 1 at Kawailani Street	N/A	N/A	150	N/A
Waiākea Tributary No. 2 at Kawailani Street	N/A	N/A	875	N/A
Waiākea Tributary No. 3 at Confluence with	N/A	N/A	1,650	N/A
Waiākea Tributary No. 3 at Kawailani Street	N/A	N/A	390	N/A
Waiākea Tributary No. 3a at Confluence with Waiākea Tributary No. 3	N/A	N/A	3,440	N/A
Waiākea Tributary No. 3a at Confluence with Tributary 1 to Waiākea Tributary No. 3a	N/A	N/A	2,881	N/A
Waiākea Tributary No. 3a at Confluence with Tributary 2 to Waiākea Tributary No. 3a	N/A	N/A	2,840	N/A
Waiākea Tributary No. 3a at Confluence with Tributary 3 to Waiākea Tributary No. 3a	N/A	N/A	2,792	N/A
Waiākea Tributary No. 3a at Confluence with Tributary 4 to Waiākea Tributary No. 3a	N/A	N/A	2,720	N/A
Waiākea Tributary No. 3b at Confluence with Waiākea Tributary No. 3a	N/A	N/A	3,440	N/A
Waikoloa Stream at Downstream Limit of Detailed Study	N/A	N/A	3,652	N/A
Waikoloa Stream at Lindsay Road	N/A	N/A	4,500[e]	N/A
Waikoloa Stream at Upstream Limit of Detailed Study	N/A	N/A	2,094	N/A
Waikoloa Stream Overland Flow at Divergence From Waikoloa Stream	N/A	N/A	375	N/A
Waikoloa Stream Split Flow at Divergence From Waikoloa Stream	N/A	N/A	936	N/A
Waikoloa Stream Tributary at Confluence with Waikoloa Stream	N/A	N/A	521	N/A

a. Discharge determined from Floodway Data Table
b. Computed from split flow
c. Discharge based on HEC-HMS results combined with linear decreasing of flows due to lava tubes
d. Hydraulic model includes lateral structure reduction of flow
e. Discharge decreases in the downstream direction due to the presence of split/overland flow and the use of updated regression equations.

Discharges were not available for the coastline, Four Mile Creek, Gulch 3–Hāpuna, Hōlualoa Drainageway Tributary, Kamakoa Gulch, Keōpū Drainageway Overflow, Keōpū Drainageway Overflow Tributary, Palai Stream (Above Haihai Street), Wai'aha Drainageway Tributary, Wai'aha Split flow No. 1, Wai'aha Split flow No. 2, Wai'aha Split Flow No. 3, Waikoloa Stream Tributary, and Waipāhoehoe Stream.

Source: FEMA, 2017

11.2.9 Warning Time

Due to the sequential pattern of weather conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

The duration of a flood event means the time between the start and end of the flood or the event that caused it. This can be difficult to define for floods, particularly inland floods, as they recede slowly and do not vanish completely; flood water moves from one area to another. Flash flooding occurs within six hours of a rain event, while other types of flooding are longer-term events and may last a week or more.

Flood warnings and watches are issued by the local NWS office. The NWS updates watches and warnings and notifies the public when they are no longer in effect. Watches and warnings for flooding in the State of Hawai'i are as follows:

- Coastal Flooding:
  - **Coastal Flood Advisory**—Issued when minor or nuisance coastal flooding is occurring or imminent.
  - **Coastal Flood Watch**—Issued when moderate to major coastal flooding is possible. Such flooding could pose a serious risk to life and property.
  - **Coastal Flood Warning**—Issued when moderate to major coastal flooding is occurring or imminent. This flooding will pose a serious risk to life and property.
- Inland Flooding:
  - **Flood Advisory**—Issued when nuisance flooding is occurring or imminent. A flood advisory may be upgraded to a flash flood warning if flooding worsens and poses a threat to life and property.
  - **Flash Flood Watch**—Issued when heavy rain leading to flash flooding is possible. People in the area of a flash flood watch should be prepared for heavy rains and potential flooding. Flash flood watches may be issued up to 12 hours before flash flooding is expected.
  - **Flash Flood Warning**—Issued when flooding is occurring or will develop quickly. If a flash flood warning is issued for an area, the population needs to take shelter and/or move to high ground as necessary.

The USGS also provides real time information on stream flows in Hawai'i County through its Water Watcher program. This program provides real-time stream flow information as well as flood and high flow information for six gages throughout Hawai'i County. An example image from this online tool is shown in Figure 11-3.

11.2.10 Secondary Hazards

The most problematic secondary hazard for riverine flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers.

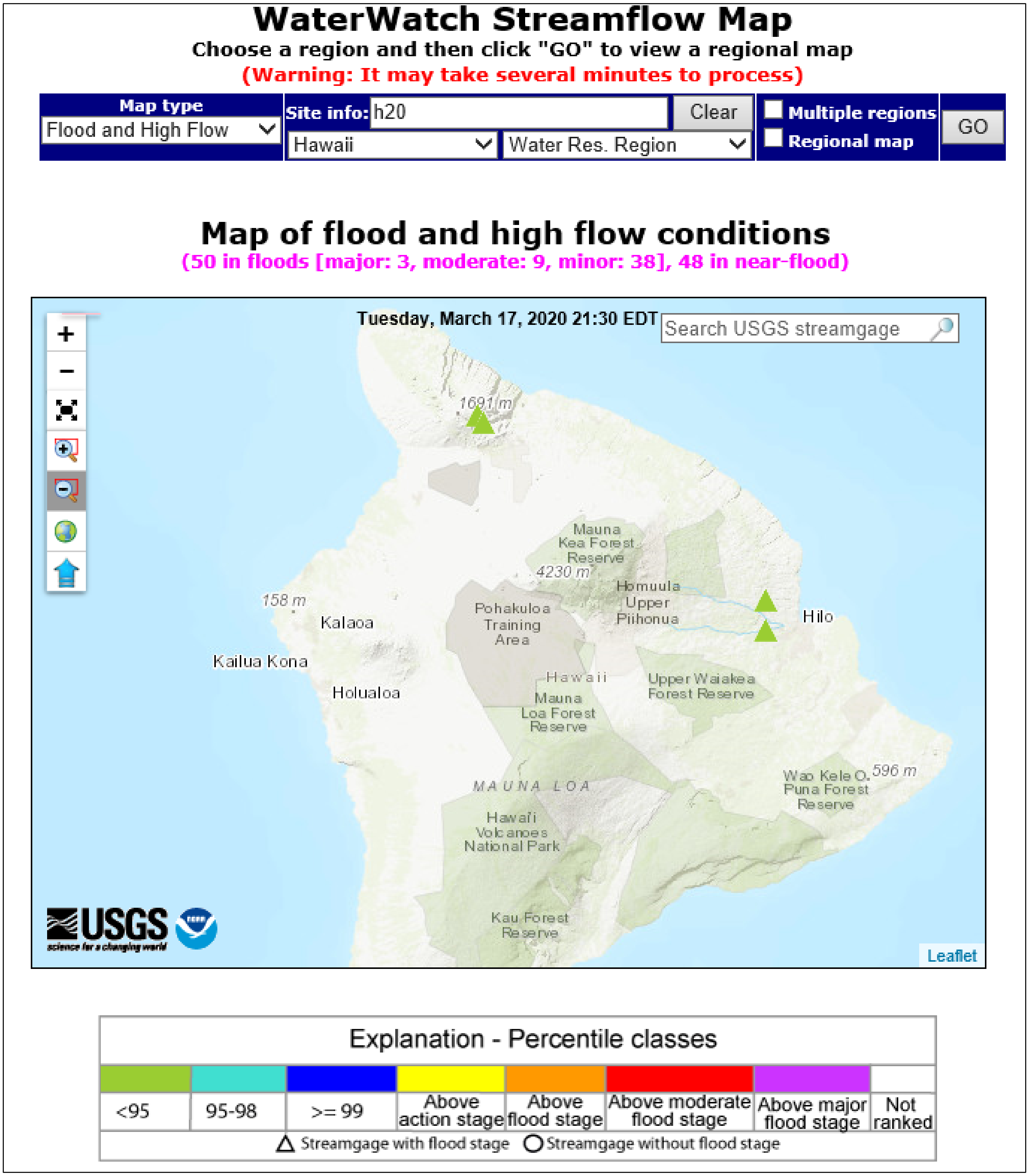


Figure 11-3. USGS WaterWatch Stream Flow Map

11.3 EXPOSURE

A quantitative assessment of exposure to the flood hazard was conducted using the flood mapping shown in Figure 11-1 and the asset inventory developed for this plan. Population exposure was estimated by calculating the number of buildings in the FEMA mapped floodplain as a percent of total planning area buildings, and then applying this percentage to the estimated planning area population. Detailed results by district are provided in Appendix F; results for the total planning area are presented below.

11.3.1 Population and Property

Table 11-6 summarizes the estimated population living in the mapped, 1 percent annual chance riverine flood zone and the estimated property exposure.

Table 11-6. Exposed Population and Property in Mapped 1% Annual Chance Riverine Flood Zone

Population	
Population Exposed	4,754
% of Total Planning Area Population	2.5%
Property	
Number of Buildings Exposed	2,225
Value of Exposed Structures	$5,647,191,438
Value of Exposed Contents	$5,394,891,374
Total Exposed Property Value	$11,042,082,811
Total Exposed Value as % of Planning Area Total	19%

11.3.2 Critical Facilities and Assets

Critical facilities exposed to the 1-percent-annual-chance flood hazard represent 4.6 percent (36 facilities) of the total critical facilities in the planning area. The breakdown of exposure by facility type is shown in Figure 11-4.

Toxic Release Inventory Reporting Facilities

Toxic Release Inventory facilities are known facilities that manufacture, process, store or other wise use certain chemicals above minimum thresholds. If damaged by a flood, these facilities may potentially release chemicals that cause cancer or other human health effects, significant adverse acute human health effects, significant adverse environmental effects (U.S. EPA, 2016). During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents. One Toxic Release Inventory facility has been identified as lying within the special flood hazard zone.

Utilities and Infrastructure

It is important to determine who may be at risk if flooding damages infrastructure. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

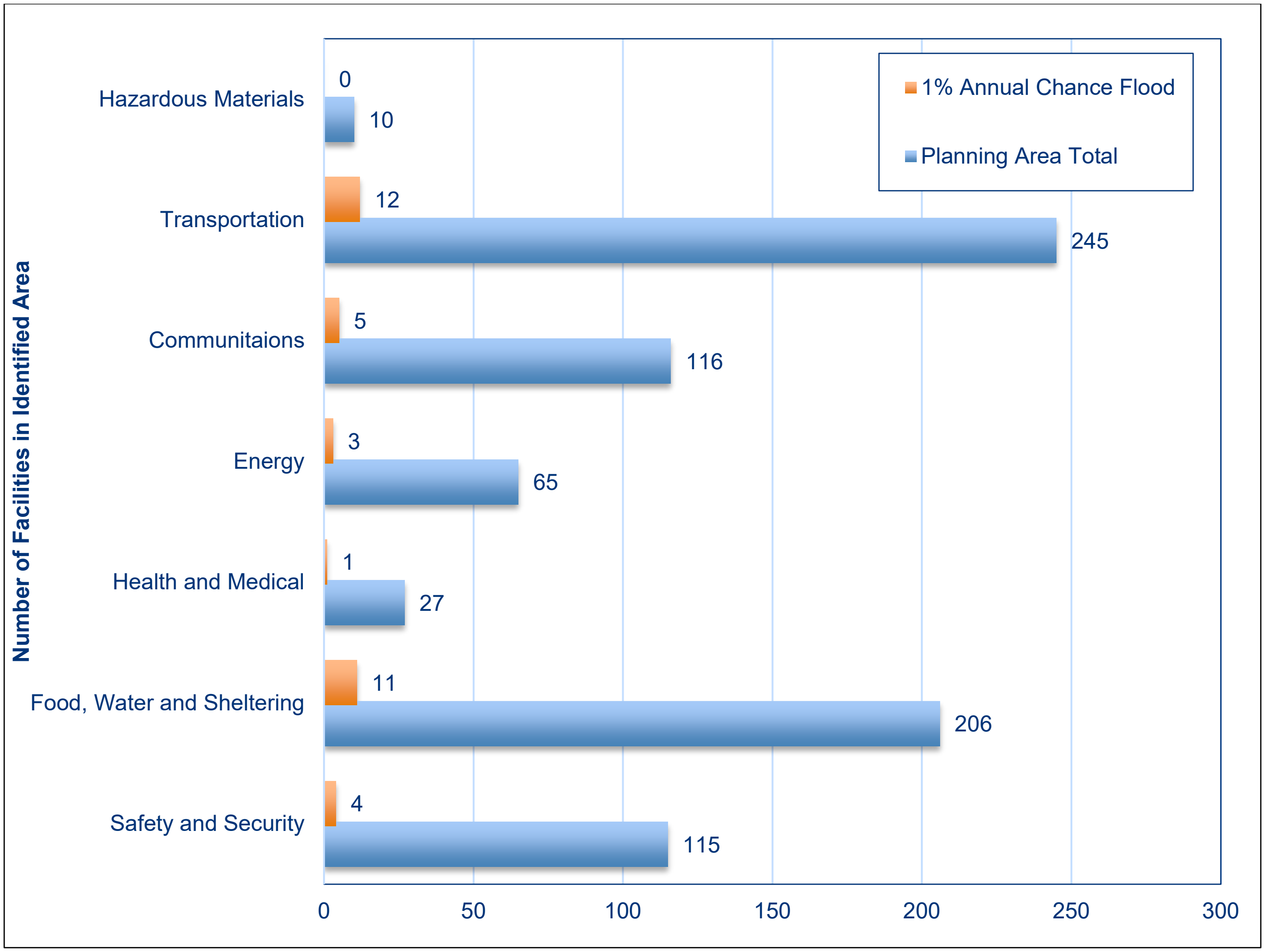


Figure 11-4. Critical Facilities in Mapped Flood Hazard Areas and Countywide

Roads

The following major roads in the planning area pass through the 1-percent-annual-chance flood zone and thus are exposed to flooding:

- Akoni Pule Highway
- Hawai'i Belt Rd (Māmalahoa Highway)
- Honoka'a-Waipio Road
- Kalaniana'ole Avenue
- Kalapana-Kapoho Beach Road
- Kamehameha Avenue
- Kanoelehua Avenue
- Kaūmana Drive
- Kawaihae Road
- Ke Ala O Keawe Road
- Kohala Mountain Road
- Kuakini Highway
- Lindsey Road
- Mamane Street
- Middle Ke'ei Road
- Nāpō'opo'o Road
- Palani Road
- Puuhonua Road
- Queen Kaahumanu Highway
- Waiānuenue Avenue

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Bridges

Flooding events can significantly impact road bridges. These are important because often they provide the only ingress and egress to some neighborhoods. An analysis showed that there are 12 bridges that are in or cross over the 1-percent-annual-chance flood zone (100-year floodplain).

Levees

Although identified levees in the County remain accredited, residual risk remains for properties behind levees from events that exceed the 1 percent annual flood hazard.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

11.3.3 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, with human development factored in, flooding can impact the environment in negative ways. Fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments and levees, and logjams from downed trees can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.

11.4 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment. Detailed results by district are provided in Appendix F; results for the total planning area are presented below.

11.4.1 Population

Vulnerable Populations

The following populations living in the floodplain are particularly vulnerable to the flood hazard:

- Economically Disadvantaged Population (defined as having household incomes of $20,000 or less)
- Population over 65 Years Old
- Population under 16 Years Old

Impacts on Persons and Households

The Hazus analysis of impacts on persons and households in the planning area estimated that 319 people could be displaced by the 1-percent-annual-chance event and that 9 people would need short-term sheltering following the 1-percent-annual-chance event.

Public Health and Safety

Floods and their aftermath present the following threats to public health and safety:

- **Unsafe food—**Floodwaters contain disease-causing bacteria, dirt, oil, human and animal waste, and farm and industrial chemicals. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat. Refrigerated and frozen foods are affected during power outages caused by flooding. Foods in cardboard, plastic bags, jars, bottles, and paper packaging may be unhygienic with mold contamination.
- **Contaminated drinking and washing water and poor sanitation—**Flooding impairs clean water sources with pollutants. The pollutants also saturate into the groundwater. Flooded wastewater treatment plants can be overloaded, resulting in backflows of raw sewage. Private wells can be contaminated by floodwaters. Private sewage disposal systems can become a cause of infection if they overflow.
- **Mosquitoes and animals—**Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools. The public should dispose of dead animals that can carry viruses and diseases only in accordance with guidelines issued by local animal control authorities. Leptospirosis—a bacterial disease associated predominantly with rats—often accompanies floods in developing countries, although the risk is low in industrialized regions unless cuts or wounds have direct contact with disease-contaminated floodwaters or animals.
- **Mold and mildew—**Excessive exposure to mold and mildew can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases, triggering cold-like symptoms. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets and bathrooms. Very small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning—**In the event of power outages following floods, some people use alternative fuels for heating or cooking in enclosed or partly enclosed spaces, such as small gasoline engines, stoves, generators, lanterns, gas ranges, charcoal or wood. Built-up carbon monoxide from these sources can poison people and animals.
- **Hazards when reentering and cleaning flooded homes and buildings—**Flooded buildings can pose significant health hazards to people entering them. Electrical power systems can become hazardous. Gas leaks can trigger fire and explosion. Flood debris—such as broken bottles, wood, stones and walls—may cause injuries to those cleaning damaged buildings. Containers of hazardous chemicals may be buried under flood debris. Hazardous dust and mold can circulate through a building and be inhaled by those engaged in cleanup and restoration.
- **Mental stress and fatigue—**People who live through a devastating flood can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected. Post-flood recovery can cause, anxiety, anger, depression, lethargy, hyperactivity, and sleeplessness. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with them in responding to flood events.

11.4.2 Property

Hazus calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with Hazus.

Table 11-7 summarizes Hazus estimates of flood damage in the planning area. The debris estimate includes only structural debris and building finishes; it does not include additional debris that may result from a flood event, such as from trees, sediment, building contents, bridges or utility lines.

Table 11-7. Estimated Impact of a 1 Percent-Annual-Chance Flood Event in the Planning Area

Structure Debris Generated (Tons)	775 (31 25-ton truckloads)
Buildings Impacted	631
Total Value (Structure + Contents) Damaged	$56.3 Million
Damage as % of Total Value	Less than 1%

11.4.3 Critical Facilities and Assets

Hazus was used to estimate the loss potential to critical facilities exposed to the flood risk, using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities. This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. Table 11-8 shows the results for the 1 percent-annual-chance flood event.

Table 11-8. Estimated Impact of a 1 Percent-Annual-Chance Flood Event on Critical Facilities

	Number of Facilities Affected	Average % of Total Value Damaged	
		Building	Contents
Safety and Security	2	20.62%	50.71%
Food, Water and Sheltering	1	0.18%	0.37%
Health and Medical	0	N/A	N/A
Energy	3	0.19%	N/A
Communications	4	6.42%	22.72%
Transportation	9	1.25%	N/A
Hazardous Materials	0	N/A	N/A
All Facilities	**19**	**5.73%**	**24.60%**

11.4.4 Environment

Loss estimation platforms such as Hazus are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

11.5 FUTURE TRENDS IN DEVELOPMENT

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land. Figure 11-5 shows the distribution of land use types in the flood zones. The dominant land uses are open areas and agricultural uses, which are considered to be lower-risk uses for the floodplain.

The planning area has experienced steady upward growth over the past 10 years. As of 2018, the County of Hawai'i had a population of 200,983 people. The island of Hawai'i's residential population is slated to grow to 296,322 by 2040, more than a 47 percent increase in 22 years. Hawai'i County is equipped to handle future growth within flood hazard areas and participates in the NFIP and has adopted a flood damage prevention ordinance in response to its requirements. Hawai'i County has committed to maintaining its good standing under the NFIP through initiatives identified in this plan. Hawai'i County has committed to linking its general policy and community plans to this hazard mitigation plan update. This will create an opportunity for wise land use decisions as future growth impacts flood hazard areas.

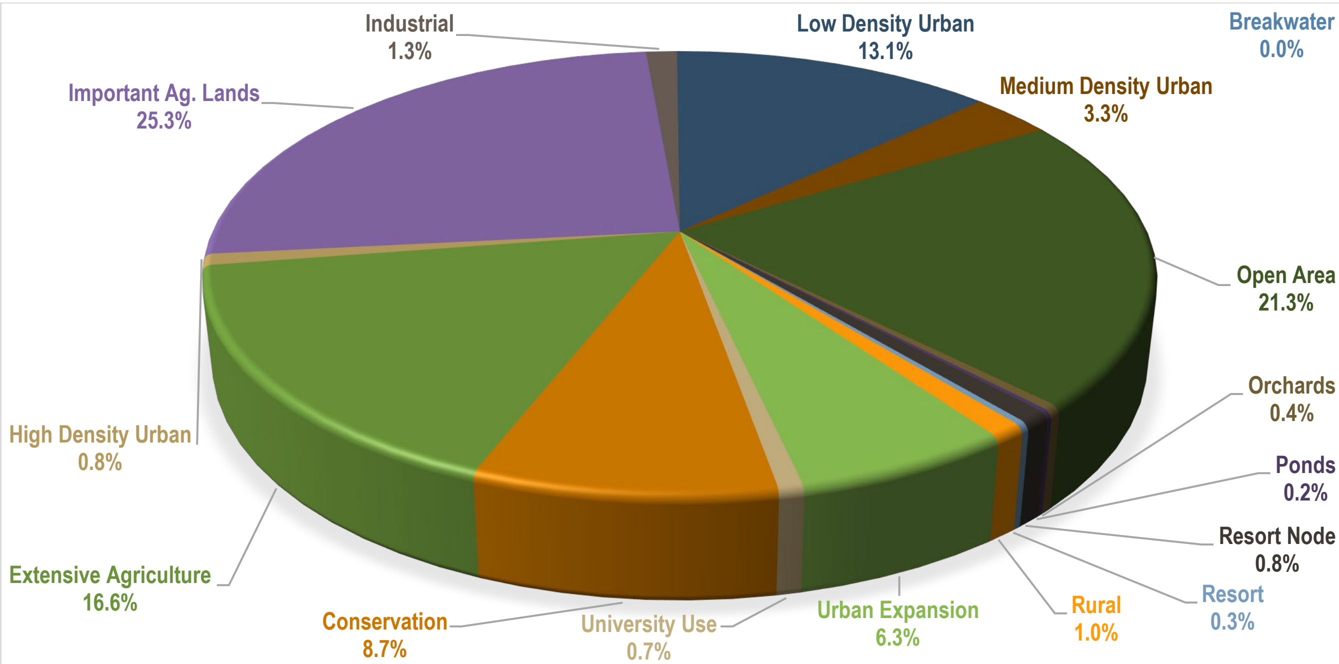


Figure 11-5. Land Use Distribution by Area in the 1-Percent-Annual-Chance Riverine Flood Hazard Area

11.6 SCENARIO

The worst-case scenario is a major, rain producing storm during the rainy season that occurs during high tide. This storm has the potential to flood numerous areas in a short time. This could overwhelm the response and floodplain management capability within the planning area, as the planning area would be subject immediately to flash flooding and coastal flooding with later influences on the County's streams. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, Hawai'i County would not be able to make repairs quickly enough to restore critical facilities and assets.

11.7 ISSUES

The planning team has identified the following flood-related issues relevant to the planning area:

- **Puna Area Flood Study**—The true flood risk reflected on the current FIRM for the Puna area does accurately reflect observed flood conditions and needs to be re-studied using better data and science.
- **Hiker Outreach for Flash Flooding**—Tourists hiking Hawai'i County's numerous trails are not always cognizant of issues associated with flash flooding. As such, the County could develop a tourism outreach program specifically designed to inform hikers about the danger and potential for flash flooding.
- **Climate Change Future Impacts**—Climate change has the potential to drastically alter the severity, location, and extent of flooding within Hawai'i County. The County must remain vigilant and be prepared to address anticipated and new issues as they occur as a direct result of climate change.
- **Levee Renovation**—Older levees are subject to failure or do not meet current building practices for flood protection. The County should discuss and investigate the resources needed to bring these levees up to date and reaccredited.
- **Multi-hazard Mitigation Techniques**—The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake and landslide. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

- **Risk Based Analysis**—Collect more information on flood risk to support the concept of risk-based analysis of capital projects.
- **Historical Data Collection**—There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- **Funding Identification**—Ongoing flood hazard mitigation will require funding from multiple sources.
- **Resident Education**—Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- **Residual Risk**—Residual risk associated with the flooding hazard is high due to the topography and nature of flooding in Hawai‘i County. The concept of residual risk should be considered in the design of future capital flood control projects and should be communicated with residents living in the floodplain.
- **Continue Emphasizing the Value of Flood Insurance**—As a flood-prone area, Hawai‘i County understands the importance and power of educated residents. The County should continue the promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events.
- **Upholding Land-Use Regulations**—Existing floodplain-compatible uses such as agricultural and open space need to be maintained. There is constant pressure to convert these existing uses to more intense uses within the planning area during times of moderate to high growth.
- **Proactive Floodplain Management**—The economy affects a jurisdiction’s ability to manage its floodplains. Budget cuts and personnel losses can strain resources needed to support floodplain management. The County should proactively manage current and future floodplains during affluent times to ensure self-sustainment of floodplains during budget cuts and personal losses.
- **Repetitive Loss Properties**—Several repetitive loss properties are located outside of FEMA mapped flood zones. Additional investigation and outreach should be conducted to determine likely sources of flood damage for these properties.

12. HIGH SURF, STORM SURGE, COASTAL FLOOD

12.1 HAZARD DESCRIPTION

The greatest number of deaths, injuries and rescues in the Hawaiian Islands are from high waves breaking at the shoreline. High surf, resulting from dangerous and damaging waves, is typically described as waves ranging in height from 10 feet to 20 feet or more. These waves result from storms passing across the higher latitudes of the Northern and Southern Hemispheres in addition to storms passing across the Central Pacific in proximity to the Islands. These high wave events threaten lives and coastal property and infrastructure.

The hazards associated with high surf include debris overwash, flooding, erosion, high wave energy and turbulence in the near shore zone, and strong currents. Waves that reach the shoreline are determined by the energy inherent in the approaching swell (a function of wave height and wave length—the distance between successive wave crests), shoreline aspect, slope, morphology, and geology, and offshore characteristics including seafloor depth, morphology, and barriers (islands, rocks, reefs, sandbars).

When deep-water ocean swells encounter the shallow island margins, they rise to great heights because their tops stack up on their slower moving bottoms due to friction along the shallower seafloor. Because the contact between deep water and the shallow margins around the Hawaiian Islands is abrupt, surface waves can grow very tall, very rapidly. Large waves tend to travel in sets, and after breaking they rush up onto the beach temporarily elevating the sea surface near the shoreline. Rip currents form as the water that is pushed up on the shore by successive large waves tries to flow back to the sea.

Large wind-generated waves can also cause storm surge (or overwash). A storm surge is a rise in the water level caused by wind forces driving water against the coast (wind set-up) or by wave forces (wave set-up). If the surge occurs at high tide, water height is even greater. The water rise enables the storm waves to reach further inland with the associated scouring and erosion caused by the wave forces.

High waves from tropical cyclones present a more complex hazard, as they may coincide with high tide, storm surge, and wind and wave setup, to produce a combined threat. High waves from tropical cyclones generally occur during hurricane season between the months of June and December. High waves from tropical cyclones most often hit the eastern shores of the Hawaiian Islands as storms approach the islands from the east and the south and west-facing shorelines as the storm passes to the south and west.

12.1.1 Measuring Coastal Flooding

The frequency and severity of flooding are measured using wave heights for coastal systems. Storm surge levels are determined by modeling water depth, wind speed, vegetative cover and other factors to determine the "wave run-up," how far inland waves will reach, and "wave setup" the height, speed, and slope of waves and how they differ from the still-water elevation (see Figure 12-1).

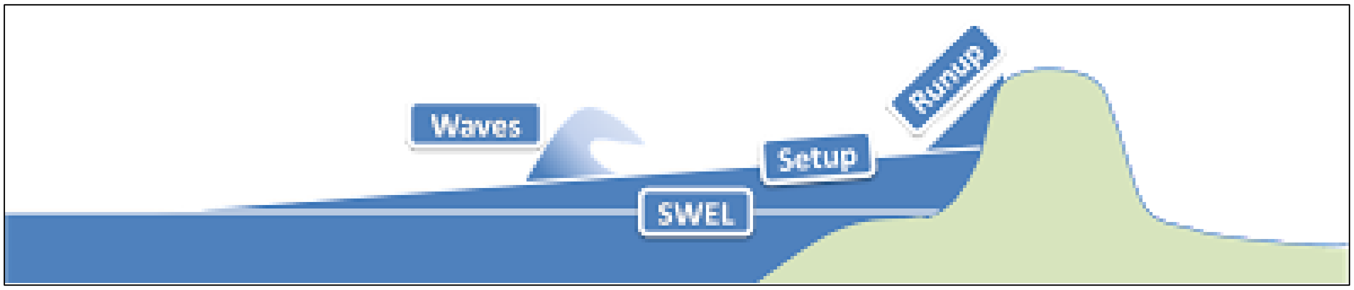


Figure 12-1. Storm Surge Stillwater Elevation and Added Effects of Wave Setup and Run-up

Coastal configuration in the form of estuaries or bays can cause a funneling or amplification effect on storm surge. Coincidence with high tide will also increase surge height. Although the maximum surge usually affects only a relatively short length of coastline, combined storm surge and wave action may have damaging effects over the entire coastline facing a major storm center. Wind-driven waves on top of the storm surge pose a number of added problems. In Hawai'i the wave run-up typically floods areas not reached by the surge itself. In Hawai'i, the high velocities of hurricane winds often produce wave heights higher than the maximum level of the prevailing high tide or of the surge itself.

12.1.2 FEMA Regulatory Coastal Flood Zones

Coastal SFHAs are of particular concern within the planning area along coastline areas that are at or slightly above sea level. In 2013, FEMA announced additional information regarding the flood hazard area associated with coastal zones. The NFIP depicts two coastal flood hazard zones on its DFIRMS:

- Zone VE, where the flood elevation includes wave heights equal to or greater than 3 feet.
- Zone AE, where flood elevation includes wave heights less than 3 feet.

Although the coastal flood zones were not developed exclusively to address the impacts of high surf, they do provide an approximate delineation of areas that may be at risk. The coastal zones in Hawai'i also include tsunami inundation risk in some areas, so these zones are likely to greatly overestimate the risk from high surf impacts alone.

Post-storm field visits and laboratory tests throughout coastal areas of the United States have consistently confirmed that wave heights as low as 1.5 feet can cause significant damage to structures that are constructed without considering coastal hazards. FIRMs recently published also include a line showing the Limit of Moderate Wave Action (LiMWA), which is the inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1-percent annual-chance flood event beyond the coastal VE zones and into the AE zone (Figure 12-2).

The addition of the LiMWA area to FIRMs allows communities and individuals to better understand the flood risks to their property. The LiMWA area alerts property owners on the coastal side of the line that although their property is in Zone AE, their property may be affected by 1.5-foot or higher breaking waves and may therefore be at significant risk during a 1-percent-annual-chance flood event. While not formally defined in the NFIP regulations or mapped as a flood zone, the area between Zone VE and the LiMWA is called the Coastal A Zone. This area is subject to flood hazards associated with floating debris and high-velocity flow that can erode and scour building foundations and, in extreme cases, cause foundation failure (FEMA, 2014a).

The current effective FIRM for the County of Hawai'i does not delineate LiMWA areas. Future map updates will include such information and should be used to develop additional coastal flooding mitigation items.

Source: FEMA, 2014a

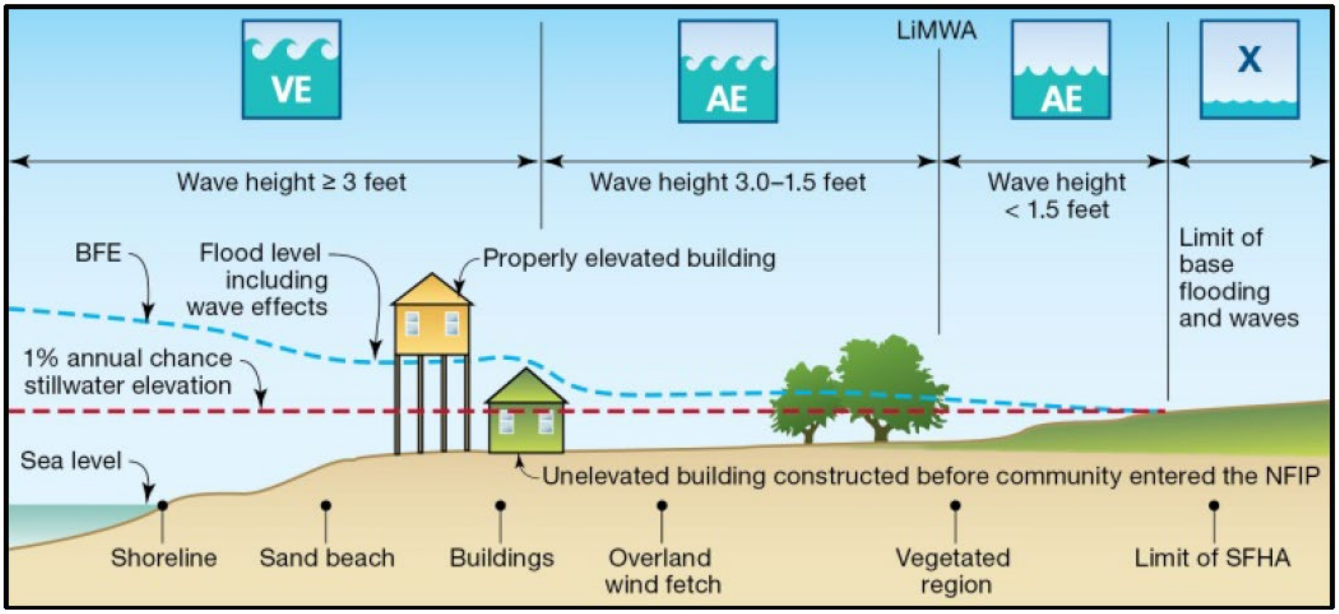


Figure 12-2. Limit of Moderate Wave Action

12.2 HAZARD PROFILE

Coastal floods are characterized by inundation of normally dry lands by ocean waters. This flooding is often caused by storm surge caused by severe storms, tsunamis, or extreme high tide events that result in shallow flooding of low-lying coastal areas. Storm surge floods typically result in coastal erosion, salinization of freshwater sources, and contamination of water supplies. These floods are also responsible for significant agricultural losses, loss of life and damage to public and private structures and infrastructure.

Coastal flooding is becoming increasingly exacerbated by sea level rise as a result of climate change or relative sea level rise caused by a local increase in the level of the ocean relative to land as a result of tectonic activity (NOAA, n.d.).

12.2.1 Past Events

Table 12-1 summarizes high surf events in the planning area since 1967.

Table 12-1. Past High Surf Events Impacting Planning Area

Start Date	End Date	Location	Description	Injuries[a]	Fatalities[a]
1/5/1967	1/6/1967	Hilo Coast	High Surf	0	0
2/15/1968	2/18/1968	Islands	Wind/ Rain/ Surf	0	0
2/26/1968	2/26/1968	Kailua Bay/ Kona/ Hawai‘i	Surf	0	0
3/3/1968	3/3/1968	Keauhou Bay	Swell	0	0
12/5/1968	12/6/1968	All Islands	Surf/ High Seas	0	0
12/1/1969	12/4/1969	Hawai‘i	Surf	4	4
12/25/1970	12/29/1970	All Islands	Wind/ Waves/ Icing	5	5
1/6/1971	1/6/1971	Keauhou/ Kona/ Island of Hawai‘i; and Pokai Bay/ O‘ahu	High Surf/ Waves	0	0
7/4/1972	7/4/1972	Hilo Bay	High Waves	0	1

Start Date	End Date	Location	Description	Injuries[a]	Fatalities[a]
7/6/1972	7/6/1972	ʻOpihikao	High Waves	1	1
1/6/1974	1/7/1974	Kona Coast Hawaiʻi	Rough Seas & Surf	0	0
3/23/1974	3/24/1974	Entire State	High Waves & Surf	0	0
1/27/1975	1/27/1975	Hilo Harbor/ Hawaiʻi	Heavy Surge	0	0
11/23/1975	11/27/1975	Entire State	High Seas/ High Winds/ Heavy Rain	5	5
2/5/1976	2/7/1976	Kauaʻi/ Oʻahu/ Kihei/ Maui And Puakō/ Hawaiʻi	High Wind/ High Surf/ Flood	3	0
10/9/1976	10/9/1976	Hilo Bay	High Wave	1	1
11/11/1976	11/13/1976	North And Western Shores of Islands	High Surf	0	0
12/10/1978	12/10/1978	Hawaiian Waters	Rough Seas	0	3
8/1/1982	8/1/1982	Hawaiʻi And Maui	Rain/Surf/Wind	0	0
8/9/1982	8/10/1982	Hawaiʻi County	Rain/ Wind/ Surf	0	0
8/14/1982	8/16/1982	Statewide	Rain/Surf/Wind	0	3
3/16/1983	3/17/1983	Hilo	High Surf	0	0
10/15/1983	10/20/1983	Hawaiʻi All Islands	Wind/ Surf	0	0
2/28/1984	2/29/1984	Island of Hawaiʻi	Surf	0	0
3/1/1985	3/11/1985	All Islands	Wind/Surf	0	0
7/1/1985	7/1/1985	All Islands	High Surf	1	0
7/25/1985	7/25/1985	Hawaiʻi	High Surf	0	0
12/9/1985	12/11/1985	All Islands	Surf	0	0
12/21/1985	12/21/1985	All Islands	Surf	0	0
2/23/1986	2/23/1986	Hiz004 Hawaiʻi	Surf	1	0
12/8/1986	12/9/1986	North And West Shores of All Islands	High Surf	0	0
1/9/1987	1/10/1987	All Islands	High Surf	0	0
8/4/1988	8/8/1988	Hawaiʻi And Kauaʻi	Flash Flooding/ High Surf	0	0
12/30/1988	12/31/1988	Statewide	Wind And Surf	0	0
1/8/1989	1/11/1989	Island of Hawaiʻi	Surf	0	0
3/1/1989	3/4/1989	All Islands	Wind/ Flash Flooding/ Surf	0	0
2/3/1993	2/4/1993	All Islands	High Surf	0	0
7/21/1994	7/22/1994	Hawaiʻi/ Maui/ Oʻahu	High Surf	0	0
6/12/1995	6/15/1995	All of Hawaiʻi	High Surf	4	0
11/23/1995	11/24/1995	All of Hawaiʻi	High Surf	2	0
12/21/1995	12/29/1995	All of Hawaiʻi	High Surf	0	0
3/16/1996	3/17/1996	Near Kailua-Kona	High Surf	0	2
11/23/2002	11/24/2002	Hāpuna Beach	Coastal	2	0
12/20/2004	12/20/2004	Kona	High Surf	0	1
12/15/2006	12/15/2006	Big Island North and East	High Surf	1	0
6/1/2015	6/1/2015	Kona	High Surf	0	1
1/21/2017	1/24/2017	Big Island North and East	High Surf	0	1
1/11/2019	1/11/2019	Kona	High Surf	0	1
Total				**30**	**29**

a. Counts of injuries and fatalities are for the entire event and are not specified by county; some of the counts shown may include injuries and fatalities in other counties.

Source: NCEI, 2020

12.2.2 Location

Damaging wind-generated waves occur from distant storms in the northern and southern hemisphere, tropical cyclones, and localized Kona storms (see Figure 12-3):

- North-facing shores receive annual North Pacific swells in winter ranging from 10 to 20 feet. Usually damage-causing events from north swells are over 20 feet. Waves from the north Pacific swells tend to be the highest on an annual basis and generally occur several days at a time, most frequently between October and March (Fletcher et al., 2002).
- Larger northeast trade waves are typically 2 to 4 feet; however, well-developed trade swells produce high waves of 6 to 8 feet that have caused damage. Trade wind swell-induced high waves, typically between 3 and 4 feet high, affect the eastern facing shores of the island.
- South-facing shores are exposed to Kona storms and southern swells, which have caused damage at heights of only 4 to 6 feet. Kona storms generate high waves that affect the south-facing coast of the island.

Source: State of Hawai'i, 2018

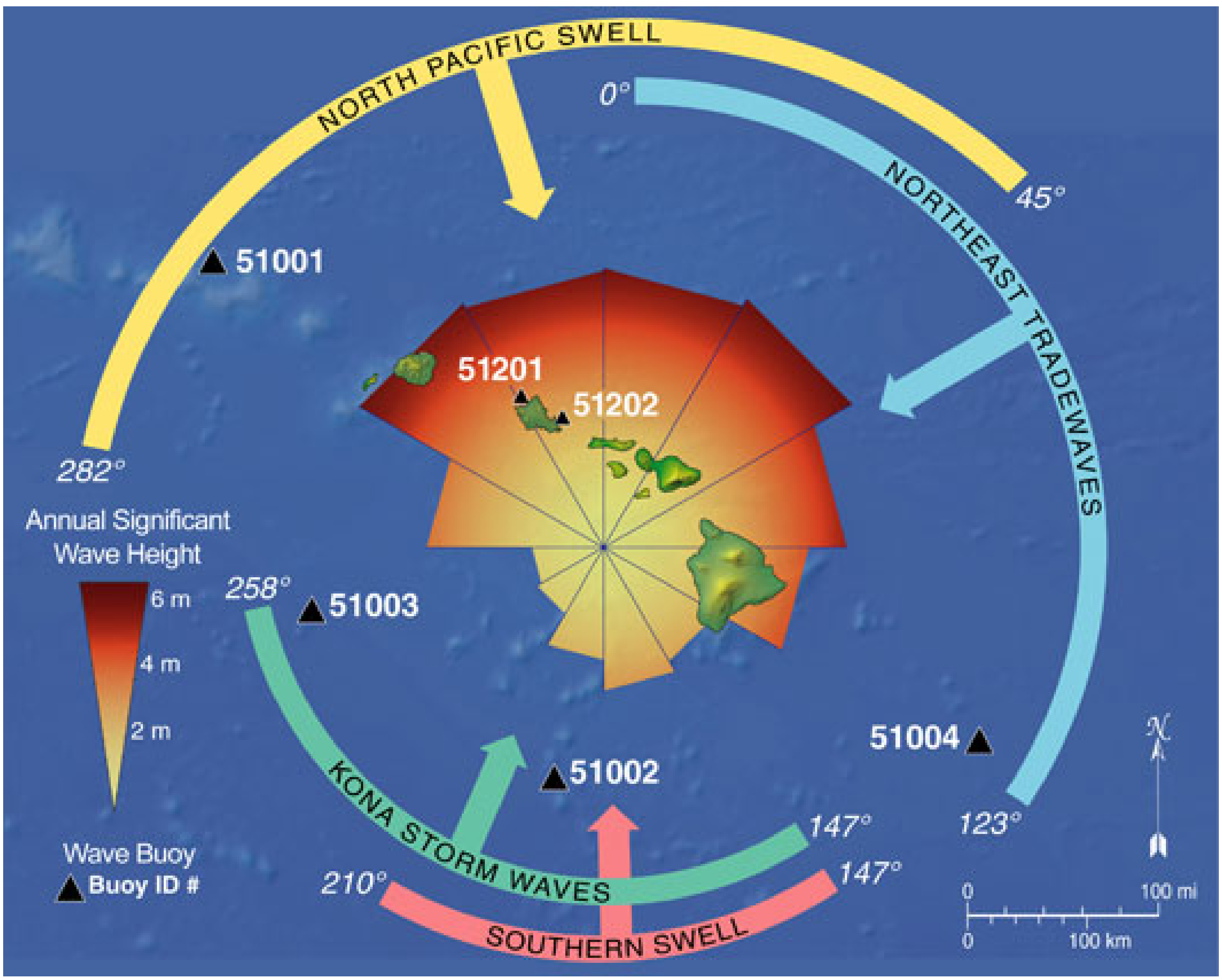


Figure 12-3. Dominant Swell Regimes in the State of Hawai'i

Even though deep ocean swells typically produce the highest waves affecting the Island, much of the high waves and surf on the island are attributable to passing tropical cyclones. Tropical cyclones can affect all shorelines, especially during summer and fall, with damaging high waves of 10 to 30 feet. Flooding from storm surge is a potential threat in heavily developed coastal areas near Kona, South Kohala and Hilo.

12.2.3 Frequency

High surf events occur quite frequently on all coasts of the County of Hawai‘i. Table 12-1 lists 48 events in 53 years.

12.2.4 Severity

The highest hazard occurs in most cases for north-facing shorelines where north Pacific swells arrive in the winter with regularity in heights exceeding 12 feet. Sets of these large waves are characterized by rapid onset so that within a few seconds they can double in size, often catching unaware swimmers, fishermen, and hikers walking along the shoreline. The water level on the coast increases with these large waves and rip currents are generated as this excess water surges seaward.

The wave zone of impact coincides to some extent with FEMA’s V and VE FIRM zones. These zones are subject to flooding and high velocity wave action (although some action identified is from tsunami events). The inland extent of the wave impact zone is expected to be much greater than the erosion zone. For residences displaced by the threat of high surf, shelters may be opened in or nearby the affected areas.

Table 12-2 summarizes the still-water elevations along the island of Hawai‘i coastline, representing the steady state water depth not accounting for breaking waves. These are the projected elevations of floodwaters in the absence of waves resulting from wind or seismic effects. In coastal areas, still-water elevations are determined when modeling coastal storm surge; the results of overland wave modeling are used in conjunction with the still-water elevations to develop the coastal base flood elevations.

Table 12-2. Summary of Still-Water Elevations

Flooding Source/Location	Still-Water Elevation (feet Local Mean Sea Level)			
	10-Year	50-Year	100-Year	500-Year
Station 28 ‘Anaeho‘omalu Bay	0.66	0.88	1.14	2.45
Station 65 Kailua-Kona	0.66	0.85	1.07	1.99
Station 148 Kehena	0.66	0.82	1.02	2.25

Source: FEMA Flood Insurance Study Number 155166V001B, Hawai‘i County, September 29, 2017

Flood severity from coastal flooding is determined by wave run-up and setup. Table 12-3 shows the storm surge water levels used for mapping the coastal floodplains in the planning area. Base flood elevations that include wave height range from 18 to 55 feet for a 1-percent-annual-chance event in the planning area.

The County of Hawai‘i may experience temporary economic impacts associated with disrupted transportation infrastructure along coastal areas. Long-term economic impacts are not expected as a result of this hazard.

Table 12-3. Regional Storm Surge Water Elevations

	Regional Storm Surge Water Elevations (feet, North American Vertical Datum)	
	Kailua Bay (Transect 51)	Kehena (Transect 5)
10-percent	0.7	0.7
2-percent	0.8	0.8
1-percent	1.1	1.0
0.2 percent	2.0	2.2

Source: FEMA Flood Insurance Study Number 155166V001B, Hawaiʻi County, September 29, 2017

12.2.5 Warning Time

The timing of individual waves cannot be predicted, however general forecasting can be made about surf conditions. Wave forecasting involves the prediction and evolution of wind-generated waves using numerical models. These mathematical simulations, often known as ocean surface wave models, consider atmospheric and oceanic conditions, wave interaction, and frictional dissipation. The models output typically consists of statistics regarding wave heights and periods that can be used by officials and managers in the shipping industry, emergency response personnel, news media, and the public.

The National Weather Service issues high surf warnings and advisories when general forecasting indicates high surf conditions. The definitions of the warning and advisory are as follows (NWS, 2020a):

- **High Surf Warning**—A high surf warning is issued when breaking wave action results in an especially heightened threat to life and property within the surf zone. High surf warnings may be issued up to 24 hours ahead of the arrival of the swell and may remain in effect for several days.
- **High Surf Advisory**—A high surf advisory is issued when breaking wave action poses a threat to life and property within the surf zone. High surf advisories may be issued up to 24 hours ahead of the arrival of the swell and may remain in effect for several days.

12.2.6 Secondary Hazards

Hazards associated with high waves include debris overwash, flooding, erosion, high wave energy and turbulence in the nearshore zone, and strong currents. The secondary hazard of coastal erosion has the potential to augment high surf or tsunami/run-up incidents along VE zones.

12.3 EXPOSURE

Although the coastal flood zones were not developed exclusively to address the impacts of high surf, they do provide an approximate delineation of areas that may be at risk. The coastal zones in Hawaiʻi also include tsunami inundation risk in some areas, so these zones are likely to greatly overestimate the risk from high surf impacts alone. FEMA mapped V and VE zones thus form the basis of the high surf hazard risk and vulnerability assessment. A quantitative assessment was made of exposure in these zones. Detailed results by district are provided in Appendix F; results for the total planning area are presented below.

12.3.1 Population and Property

Table 12-4 summarizes the estimated population living in the mapped coastal flood zone and the estimated property exposure.

Table 12-4. Exposed Population and Property in the 100-Year Coastal Flood Zone

Population	
Population Exposed	1,342
% of Total Planning Area Population	0.7%
Property	
Number of Buildings Exposed	588
Value of Exposed Structures	$276,366,246
Value of Exposed Contents	$186,595,362
Total Exposed Property Value	$462,961,608
Total Exposed Value as % of Planning Area Total	0.8%

The population at greatest risk for exposure to the high surf hazard is individuals along the affected beachfront areas. Surfers are potentially most at risk, as they will pursue their sporting activity during times when surf conditions are high.

12.3.2 Critical Facilities and Assets

Figure 12-4 summarizes the critical facilities and assets in the coastal flood zones of the planning area. Critical facilities and assets located just beyond the coastal flood zones may be exposed if previous high surf or storm events destroyed the beach buffer. In addition to facilities that may be exposed to high surf, coastal transportation routes may be exposed. These routes are often located in areas in which coastal erosion has gradually worn away the beach buffer, causing the potential for roadway inundation during high surf events.

12.3.3 Environment

All beaches are vulnerable to the effects of high surf events. In 2014, a study published in the Nature Communications journal indicated that coral reef plays an extremely large role in the dissipation of wave energy that affects high surf on beach areas. This study indicated that wave energy is reduced by an average of 97 percent, with reef crests alone dissipating most of the energy. This study further explores and asserts that natural reef formations can provide comparable wave attenuation benefits to those provided by artificial means, such as breakwaters (Ferrario et al., 2014).

12.4 VULNERABILITY

12.4.1 Population

The population most vulnerable to high surf events and strong currents are beach goers, swimmers, fisherman, and hikers along the shoreline. A particular population vulnerable to the high surf hazard is surfers. High surf indicates larger waves, which many amateur and professional surfers actively seek. As a result, warnings and advisories may cause an opposite effect for these populations. This requires beach patrols and first responders to remain on alert during days when surfers may ignore warnings and advisories in an effort to catch large waves.

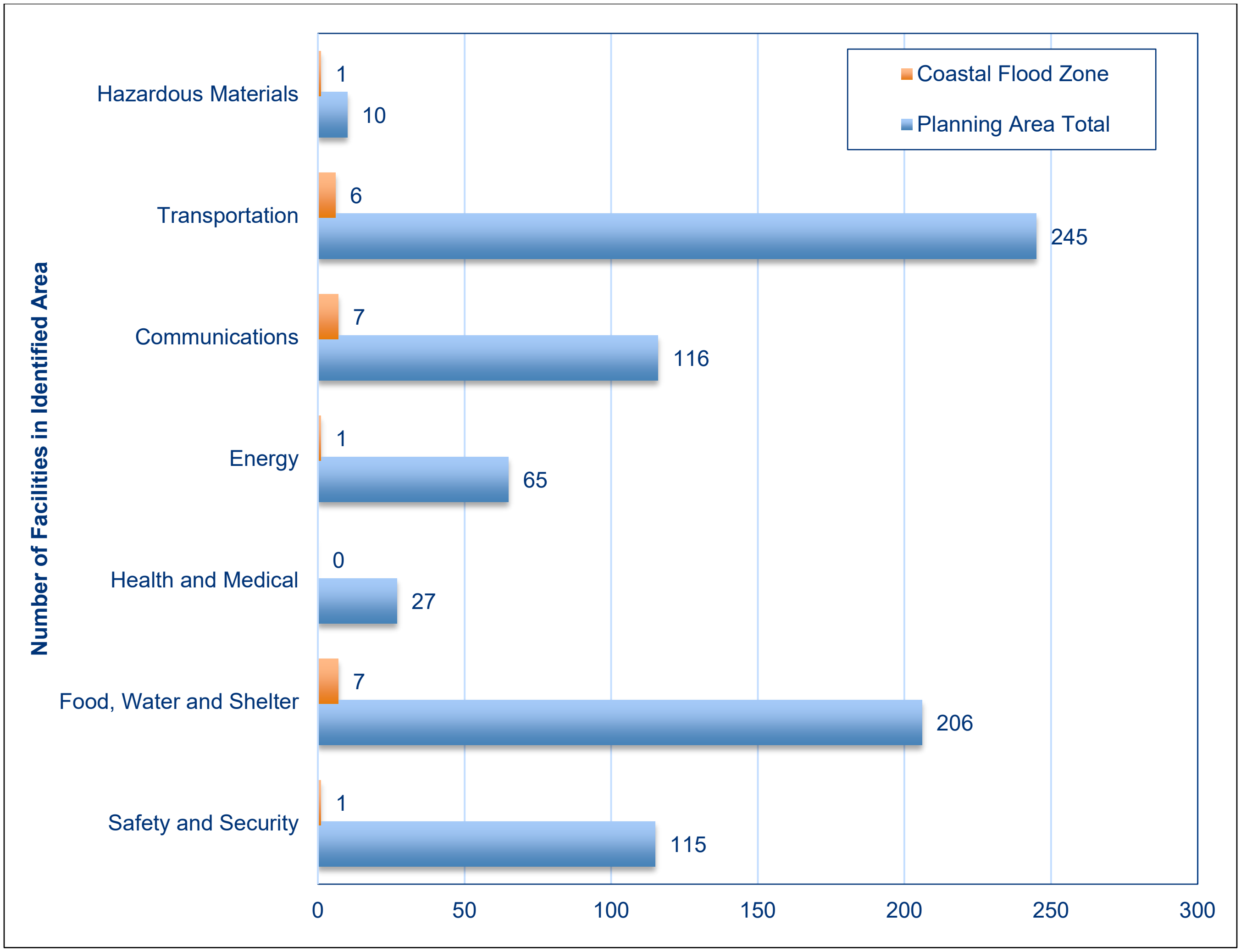


Figure 12-4. Critical Facilities in Mapped Coastal Flood Zone

12.4.2 Property

Loss estimations for the high surf hazard are not based on modeling utilizing damage functions, because the available modeling includes impacts from other hazards such as hurricanes and tsunami, not exclusively high surf. Instead, loss estimates were developed representing 1 percent, 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 12-5 shows the general building stock loss estimates in FEMA mapped coastal zones.

Table 12-5. Loss Potential for Coastal Flood Zones

Damage Type	1% Annual Chance Coastal Flood
Structure Debris (Tons)	1
Buildings Impacted	157
Total Value (Structure + Contents) Damaged	$36.2 million
Damage as % of Total Value	Less than 1%

12.4.3 Critical Facilities and Assets

Hazus was used to estimate the loss potential to critical facilities exposed to the coastal flood risk, using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities. This helps to gauge how long the planning area could have limited usage of facilities deemed critical to flood response and recovery. Table 12-6 shows the results for the 1 percent-annual-chance coastal flood event.

Table 12-6. Estimated Impact of a 1 Percent-Annual-Chance Coastal Flood Event on Critical Facilities

	Number of Facilities Affected	Average % of Total Value Damaged	
		Building	Contents
Safety and Security	2	20.62%	50.71%
Food, Water and Sheltering	1	0.18%	0.37%
Health and Medical	0	N/A	N/A
Energy	3	0.19%	N/A
Communications	4	6.42%	22.72%
Transportation	9	1.25%	N/A
Hazardous Materials	0	N/A	N/A
All Facilities	**19**	**5.73%**	**24.60%**

The areas important for tourism and commerce, lying between South Kona, South Kohala and Hilo bayfront, are situated on low coastal plains, and so experience periodic wave over-wash, which causes rapid erosion and temporarily disrupts transportation.

12.4.4 Environment

Secondary hazards associated with high surf events will likely have some of the most damaging effects on the environment. A combination of wave height and a long duration of swells impacting the shoreline can increase shore erosion, damage homes and infrastructure, as well as blocking coastal highways with sand, debris, and water (Meiers, 2014).

12.5 FUTURE TRENDS IN DEVELOPMENT

Development in Hawai‘i County is guided by Hawai‘i County code and the documents that make up the General Plan. This guidance includes requirements pertaining to development in coastal hazard areas, which would include areas that are susceptible to high surf.

Some land uses are more vulnerable to high surf, such as single-family homes, while others are less vulnerable, such as agricultural land or recreation areas. Figure 12-5 shows the distribution of land use by area in the FEMA coastal zones. Open area, agricultural lands and rural uses make up nearly three-quarters of these zones.

12.6 SCENARIO

The worst-case scenario would be high wave events from tropical cyclones coinciding with high tide, storm surge, wind and wave setup, producing a combined threat. During a scenario of this magnitude, individuals and properties alike are potentially impacted by high surf.

12.7 ISSUES

- **High Surf Public Information**—Those most prone to high surf are individuals that choose to be in areas that are impacted by high surf, whether for recreation or because they are unfamiliar with their surroundings. Develop pamphlets and other messaging about the dangers of high surf. Distribute in hotels, tourist venues, and high schools.

- **Future Development Impact Studies**—High surf events are particularly destructive when natural processes are unable to replenish beaches due to development, causing high surf to impact infrastructure. Ensure that future development does not contribute to coastal erosion, and subsequently, harmful high surf events.
- **Coastal AE Zone Building Standards**—Coastal AE zones have the potential to become affected by wave movement spilling over from the VE zones. Such flooding results in greater stressors for current and future development. Additional building standards should be investigated regarding the effect of the LiMWA on Coastal AE properties.
- **Potential Impacts from Sea Level Rise**—Rising sea levels are very likely to have significant impacts on the frequency and severity of high surf events. Areas not typically exposed to this type of event may become exposed, increasing vulnerability to this hazard of concern.

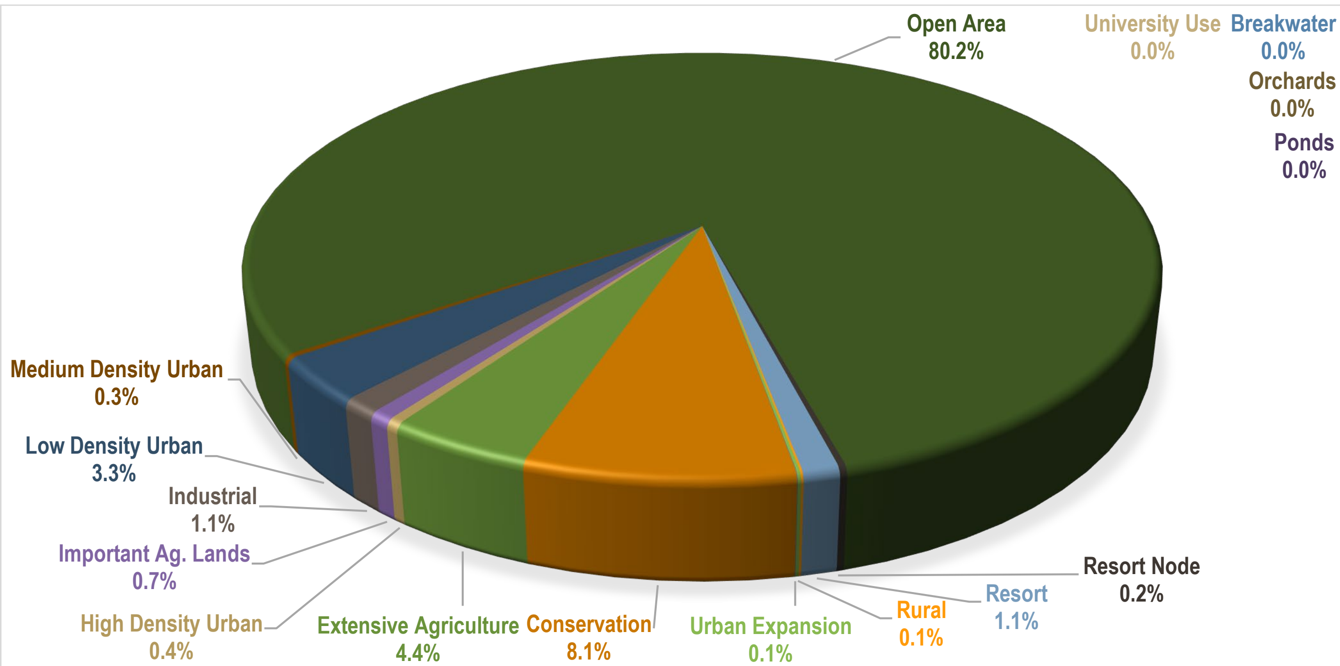


Figure 12-5. Land Use Distribution by Area in the 100-Year Coastal Flood Zone

13. HIGH WINDSTORM

13.1 HAZARD DESCRIPTION

13.1.1 Wind Pressure

Wind is one of the costliest hazards to insured property, causing more damage than earthquakes or other natural hazards. Wind pressure, not wind speed, causes damage. There are three types of wind pressure:

- **Positive wind pressure** is the direct pressure from the force of the wind pushing inward against walls, doors and windows.
- **Negative wind pressure** occurs on the sides and roof of buildings as wind blows past. Air moving parallel to a surface reduces the air pressure on the surface, resulting in a force pulling the surface outward toward the moving air. Negative pressure causes buildings to lose all or a portion of their roofs and side walls and pulls storm shutters off the leeward (side sheltered from wind) side of a building.
- **Interior pressure** increases dramatically when a building loses a door or window on its windward side. The roof is placed under tremendous internal pressures pushing up from inside of the building together with the negative wind pressure lifting the roof from the outside.

Besides the high wind pressures exerted on structures during windstorms, and especially during tropical cyclones, windborne debris can be a major factor in causing damage. Such debris includes flying objects, such as tree limbs, outdoor furniture, signs, roofs, gravel, and loose building components.

13.1.2 Types of Winds in Hawai‘i County

High trade winds, Kona winds, and tropical cyclone winds all affect the County of Hawai‘i. Trade and Kona winds are described below. Tropical cyclones are discussed in Chapter 15 of this hazard mitigation plan.

Trade Winds

Trade winds are the most common winds over Hawaiian waters. These persistent winds blow 70 percent of the time from the northeast or east-northeast and generally range from 10 to 25 miles per hour. Occasional extreme events reach 40 to 50 miles per hour when a sub-tropical high-pressure cell north of the islands intensifies. Trade winds occur up to 90 percent of the time in summer (June through August) and 50 percent of the time in winter (December through January). North Pacific high-pressure systems can cause gusty trade wind episodes over Hawaiian waters, which commonly persist for several days.

Kona Winds

Kona winds are rain-bearing winds that blow over the islands from the southwest or south-southwest. The western sides of the islands become windward during Kona winds, as the trade wind pattern is reversed. Kona winds occur as light and variable winds during winter when trade wind circulation diminishes, and as strong generally southerly winds when storm systems move across Hawaiian waters. Strong Kona winds are most likely when a system with an unusually low central pressure is located within 500 miles northwest of the islands. Kona storms move erratically with a slow tendency toward the west.

Damaging Kona winds have reached velocities of 50 miles per hour for several days. Though most strong Kona wind episodes last no more than a day, some last up to two weeks. During this time, considerable damage can be inflicted to boats caught in the open ocean or anchored in southwest-exposed anchorages.

The effects of Kona winds on land can also be severe. Winds can accelerate down the slopes of mountains, hills, and escarpments to over 100 miles per hour. Winds with these speeds can be very destructive when they reach heavily populated low-lying areas. It is common for trees to be uprooted, for signs and utility poles to be overturned, and for residential roofs to be blown off.

13.1.3 Wind Speed

Wind speeds vary with height above ground—the higher the elevation, the stronger the wind. Figure 13-1 shows the average wind speed for the County of Hawai'i at 50 meters (164 feet) above ground level. Since wind forces increase proportionally to the wind speed squared, any amplification of the basic wind speed may significantly increase its effects.

Source: Hawaiian Electric Company, 2020

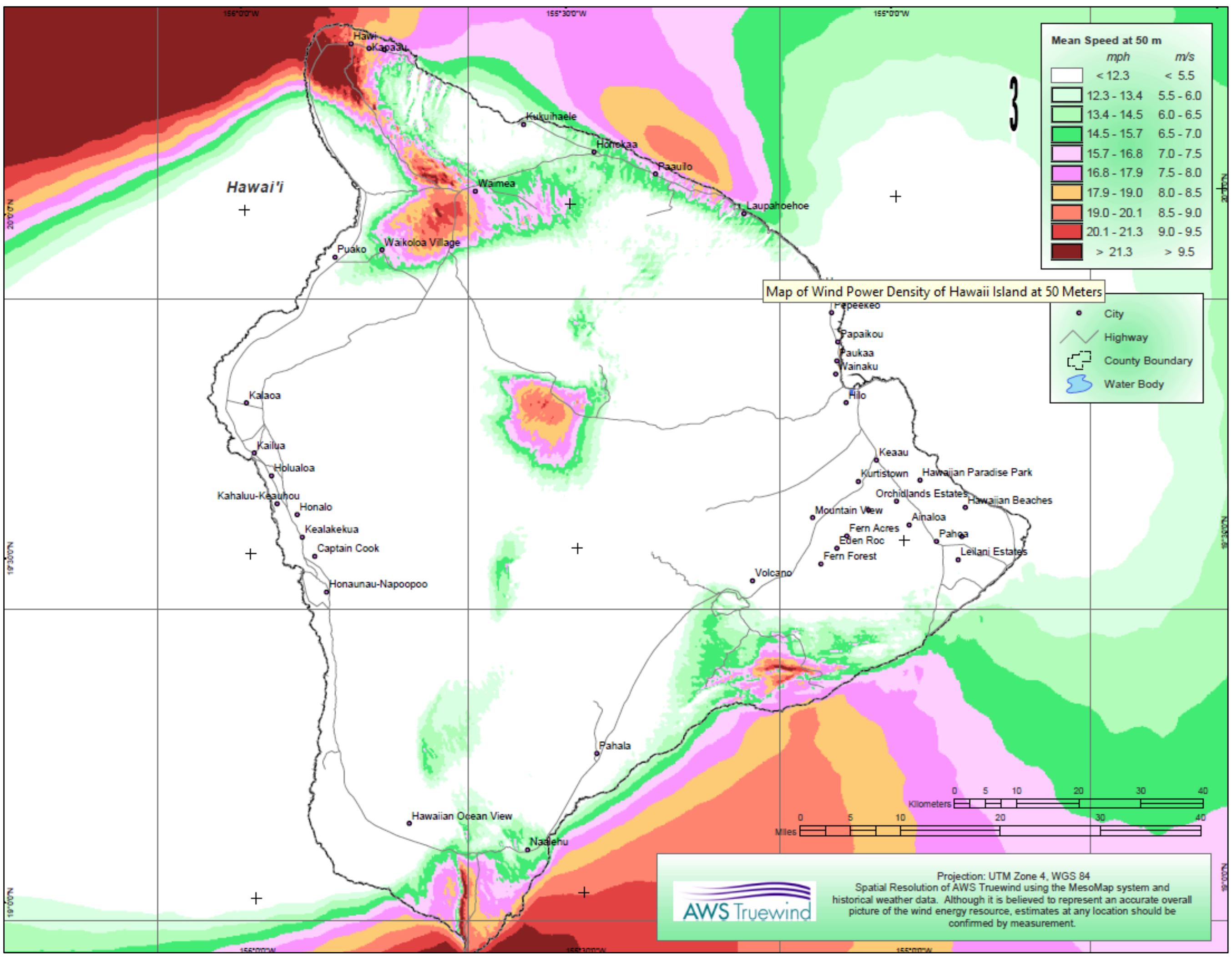


Figure 13-1. Average Wind Speed at 50 Meters Above Ground Level

There are many ways to measure wind speed:

- **The fastest-mile wind speed** is the highest recorded speed during a time interval in which one mile of wind passes a fixed measuring point. The measurement is taken at an elevation of 33 feet in open terrain. The fastest-mile wind speed measurement has been historically used in many building codes and design standards such as the Uniform Building Code.
- **Sustained Wind** is the wind speed averaged over 1 minute.
- **Peak Gusts** are the maximum wind gust speeds averaged over a period of 2 to 5 seconds.

13.2 HAZARD PROFILE

13.2.1 Past Events

Table 13-1 summarizes high wind events in the planning area since December 2004, as recorded by the National Oceanic and Atmospheric Administration (NOAA). According to this data, there have been no recorded fatalities or severe injuries attributable to high wind events in Hawai‘i County in that timeframe. Many of the events caused power outages, downed trees, and some property damage, but the costs of property damage are not available.

Table 13-1. Past High Wind Events Impacting Planning Area

Start Date	End Date	Property Damage	Injuries	Fatalities	Start Date	End Date	Property Damage	Injuries	Fatalities
12/02/2004	12/04/2004	$0	0	0	12/23/2014	12/26/2014	$0	0	0
12/06/2004	12/06/2004	$0	0	0	12/26/2014	12/28/2014	N/A	0	0
01/09/2005	01/14/2005	$0	0	0	12/30/2014	12/31/2014	N/A	0	0
01/13/2005	01/13/2005	N/A	0	0	01/02/2015	01/02/2015	N/A	0	0
01/21/2005	01/22/2005	$0	0	0	01/09/2016	01/09/2016	$0	0	0
01/28/2005	01/29/2005	$0	0	0	02/06/2016	02/07/2016	$0	0	0
03/12/2005	03/16/2005	$0	0	0	03/08/2016	03/09/2016	N/A	0	0
03/19/2005	03/21/2005	$0	0	0	03/28/2016	03/30/2016	N/A	0	0
03/25/2005	03/27/2005	$0	0	0	08/31/2016	08/31/2016	$0	0	0
12/18/2005	12/19/2005	$0	0	0	12/11/2016	12/13/2016	N/A	0	0
05/01/2006	05/02/2006	$0	0	0	12/15/2016	12/17/2016	N/A	0	0
11/02/2006	11/02/2006	$0	0	0	01/05/2017	01/07/2017	N/A	0	0
01/28/2007	01/29/2007	N/A	0	0	01/16/2017	01/16/2017	N/A	0	0
02/02/2007	02/02/2007	$0	0	0	01/21/2017	01/21/2017	N/A	0	0
02/08/2007	02/09/2007	$0	0	0	01/22/2017	01/22/2017	N/A	0	0
04/01/2007	04/02/2007	$0	0	0	02/05/2017	02/11/2017	N/A	0	0
12/04/2007	12/05/2007	N/A	0	0	03/07/2017	03/09/2017	N/A	0	0
04/04/2008	04/05/2008	$0	0	0	04/29/2017	04/30/2017	$0	0	0
01/14/2009	01/18/2009	N/A	0	0	10/24/2017	10/24/2017	N/A	0	0
03/15/2009	03/19/2009	$0	0	0	11/17/2017	11/20/2017	$0	0	0
04/20/2009	04/21/2009	$0	0	0	12/06/2017	12/06/2017	$0	0	0
01/07/2011	01/13/2011	$0	0	0	12/16/2017	12/17/2017	$0	0	0
02/07/2012	02/07/2012	N/A	0	0	12/21/2017	12/21/2017	$0	0	0
05/21/2012	05/26/2012	$0	0	0	12/26/2017	12/28/2017	$0	0	0
06/04/2012	06/04/2012	$0	0	0	01/30/2018	01/31/2018	$0	0	0
06/17/2012	06/18/2012	$0	0	0	02/01/2018	02/02/2018	$0	0	0

Start Date	End Date	Property Damage	Injuries	Fatalities	Start Date	End Date	Property Damage	Injuries	Fatalities
12/03/2012	12/03/2012	$0	0	0	02/05/2018	02/06/2018	$0	0	0
01/05/2013	01/05/13	N/A	0	0	02/08/2018	02/10/2018	$0	0	0
01/06/2013	01/06/2013	N/A	0	0	02/15/2018	02/16/2018	$0	0	0
02/18/2013	02/18/2013	N/A	0	0	02/19/2018	02/21/2018	$0	0	0
02/26/2013	02/28/2013	$0	0	0	03/07/2018	03/08/2018	$0	0	0
03/12/2013	03/17/2013	$0	0	0	03/12/2018	03/13/2018	$0	0	0
03/31/2013	03/31/2013	$0	0	0	03/20/2018	03/20/2018	$0	0	0
04/01/2013	04/02/2013	$0	0	0	03/23/2018	03/27/2018	$0	0	0
04/02/2013	04/03/2013	$0	0	0	04/02/2018	04/04/2018	$0	0	0
04/13/2013	04/14/2013	$0	0	0	04/27/2018	04/28/2018	$0	0	0
04/22/2013	04/23/2013	$0	0	0	04/29/2018	04/30/2018	$0	0	0
04/23/2013	04/23/2013	$0	0	0	05/01/2018	05/01/2018	$0	0	0
05/21/2013	05/21/2013	$0	0	0	01/27/2019	01/27/2019	$0	0	0
05/23/2013	05/23/2013	$0	0	0	02/07/2019	02/10/2019	N/A	0	0
11/11/2013	11/14/2013	$0	0	0	02/20/2019	02/22/2019	$0	0	0
01/21/2014	01/25/2014	N/A	0	0	02/27/2019	02/28/2019	$0	0	0
01/25/2014	01/26/2014	$0	0	0	03/16/2019	03/16/2019	$0	0	0
01/26/2014	01/27/2014	$0	0	0	05/03/2019	05/06/2019	$0	0	0
02/28/2014	02/28/2014	$0	0	0	12/25/2019	12/26/2019	N/A	0	0
03/01/2014	03/03/2014	$0	0	0	12/30/2019	12/30/2019	$0	0	0
03/16/2014	03/16/2014	N/A	0	0					
					Total		**N/A**	**0**	**0**

Source: NCEI, 2020

Notes: N/A in property damage represents damage costs not available. Zero dollars represents no significant property damage. Injuries or fatalities may have been occurred that were not recorded in available datasets.

The most notable documented winter storm high wind event in Hawai'i County was that of January 1980, which caused damage of $42 million statewide, including $11.7 million on the island of Hawai'i (Disaster Declaration DR-613-HI). Agriculture had the major losses (County of Hawai'i, 2015). Other winter storms have caused less damage, but more localized effects, with flooding and power disruption constituting the main problems. In 2014, power outages impacting tens of thousands of residents for days occurred due to downed power transmission and distribution lines during winter storms with high winds. A winter windstorm on February 14, 2015, knocked out power for more than 5,000 residents in the area for four days. Within the 12 months prior to March 2015, residents in the Puna District were without power for at least 12 days. This also affected the internet and communications network service.

13.2.2 Location

High windstorms have the potential to happen anywhere in the planning area, but topography plays a significant role in where the impacts of such events are most severe. For example, strong Kona storms bring wind and rain and can cause extensive damage to south- and west-facing shores. In general, wind speeds vary with height above ground—the higher the elevation, the stronger the wind. As a result, the mountainous areas of Hawai'i County generally experience the highest wind speeds (State of Hawai'i, 2018).

Wind speed increases over hills, ridges and escarpments (steep slopes or long cliffs). This is known as wind speed-up. Because wind speed is related to wind pressure, structures in wind speed-up areas experience more severe damage than those on flat, open terrain if building codes do not take the local topographic factor into consideration. In the past, the magnitude of wind speed-up caused by topography in Hawai‘i County has not been well understood and it was not historically considered in any building code used in the state (State of Hawai‘i, 2018).

13.2.3 Frequency

Monthly counts of high wind events impacting the populated lower slopes and elevations of Hawai‘i County over a 10-year period indicate that winter months are the most active (County of Hawai‘i, 2015). The overall average island wide is a little over 0.2 such events per month, but the average is 0.4 per month for December through April.

13.2.4 Severity

Windstorms can be a frequent problem in the planning area and have been known to cause damage to utilities. Hawai‘i County is located in FEMA’s Wind Zone II, with speeds up to 160 miles per hour (FEMA, 2014). Economic impact is largely associated with disrupted services as a result of downed debris blocking transportation infrastructure and potential disruption of energy resources. Outside of a catastrophic high wind event, the economic disruption caused by this hazard is expected to remain short-term.

13.2.5 Warning Time

Meteorologists can often predict the likelihood of a severe storm. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher. The National Weather Service Forecast Office in Honolulu issues the following watches, warnings, and advisories when high wind threatens the state:

- **High Wind Watch**—A high wind watch is issued when sustained winds exceeding 40 miles per hour (mph) and/or frequent gusts over 60 mph are likely to develop in the next 24 to 48 hours. For summit areas, high wind watches are issued for predicted sustained winds exceeding 56 mph and/or frequent gusts over 66 mph.
- **High Wind Warning**—A high wind warning is issued when sustained winds exceeding 40 mph and/or frequent gusts over 60 mph are occurring or imminent. For summit areas, warnings are issued for winds exceeding 56 mph and/or frequent gusts over 66 mph. Wind warnings may be issued up to 24 hours ahead of the onset of high winds.
- **Wind Advisory**—A wind advisory is issued when sustained winds of 30 to 39 mph and/or frequent gusts to 50 mph or greater are occurring or imminent. For summit areas the range is 45 to 55 mph for sustained wind and/or 55 to 65 mph for frequent gusts. Wind advisories may be in effect for 6 to 12 hours.
- **Small Craft Advisory**—A small craft advisory is issued for coastal waters when winds of 25 to 33 knots and seas 10 feet or higher are occurring or forecast.
- **Gale Warning**—A gale warning is issued for coastal, offshore, and high seas areas when winds of 34 to 47 knots not associated with a tropical cyclone are occurring or forecast.

13.2.6 Secondary Hazards

High winds can contribute to strong surf, which in turn results in coastal erosion.

13.3 EXPOSURE

The entire planning area is exposed to some extent to high windstorms. Certain areas are more exposed due to geographic location and local weather patterns.

13.4 VULNERABILITY

13.4.1 Population

Populations living in areas with large stands of trees or power lines, especially at higher elevations, may be more susceptible to wind damage and black out. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance. Vulnerable populations are the elderly, low income or linguistically isolated populations, and people with life-threatening illnesses. These populations face isolation and exposure during high windstorms and could suffer more secondary effects of the hazard. Power outages can be life threatening to those dependent on electricity for life support.

13.4.2 Property

All property is vulnerable during high windstorms, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Structures that were built before the building code incorporated provisions for wind load are particularly vulnerable Those in higher elevations and on ridges may be more prone to wind damage. Buildings under or near overhead lines or near large trees may be vulnerable to falling lines or trees.

13.4.3 Critical Facilities and Assets

The most common problems associated with high windstorms are loss of utilities. Downed power lines can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. High winds can block roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly.

High wind events pose a problem for facilities that house hazardous materials. Such facilities often depend on electricity and other utilities to maintain safe operations. During a severe high wind event, downed trees may cut off power. While most of these facilities have a back-up power source to ensure continued operations, backup power can only be used for a finite time; prolonged utility disruption could have dire consequences.

13.4.4 Environment

Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction including downed debris, uprooted trees, and debris-blocked rivers and streams.

13.5 FUTURE TRENDS IN DEVELOPMENT

All future development in the County will be affected by high windstorms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. Hawai‘i County has adopted the International Building Code and has developed county-specific wind load requirements. These codes are equipped to deal with the impacts of high windstorms. Land use policies identified in general plans within the planning area also address many of the secondary impacts of high windstorms. With these tools, Hawai‘i County is well-equipped to deal with future growth and the associated impacts of high windstorms.

13.6 SCENARIO

A worst-case event would involve prolonged high winds. Initially, schools and roads would be closed due to power outages caused by high winds and downed debris. Some isolated communities throughout the planning area could experience limited or no ingress and egress. Additionally, temporary structures and structures unable to resist sustained wind speeds may collapse, posing an immediate threat to those within or around the structure. Long-term effects may include the removal of collapsed buildings and removal of debris from waterways.

13.7 ISSUES

Important issues associated with high windstorms in the planning area include the following:

- **Review of Building Stock**—Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to windstorms. The County could conduct a study within the planning area to identify at-risk buildings and investigate options for bringing them up to code.
- **Alternate Power Supply**—Redundancy of power supply must be evaluated to ensure continuity of power at critical facilities throughout the planning area.
- **Public Outreach for Isolated Population Centers**—Depending on the severity of the storm, isolated population centers could potentially become stranded from the rest of the island. As such, the County should take steps to inform such isolated population centers about what to do if they become stranded. This could include public information on sheltering in place, tips on developing a personal go-kit, and instructions on developing a personal emergency plan.

14. LANDSLIDE

14.1 HAZARD DESCRIPTION

A landslide is a mass of rock, earth or debris moving down a slope, caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. They can be initiated by storms, earthquakes, fires, or volcanic eruptions. These natural conditions may be affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it.

Rivers of rock, earth, organic matter and other soil materials saturated with water can develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. The material can travel miles from its source, growing as it descends, picking up trees, boulders, cars and anything else in its path. These slides may pack many times the hydraulic force of water due to the mass of material included in them. They can be some of the most destructive events in nature.

Landslides are caused by one or more of the following factors: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation on slopes. In general, landslide hazard areas are where the land has characteristics that contribute to the risk of the downhill movement of material, such as the following:

- A slope greater than 33 percent
- A history of landslide activity or movement during the last 10,000 years
- Stream or wave activity, which has caused erosion, undercut a bank or cut into a bank to cause the surrounding land to be unstable
- The presence of an alluvial fan, indicating vulnerability to the flow of debris or sediments
- The presence of impermeable soils, such as silt or clay, mixed with granular soils such as sand and gravel.

Landslides or mudflows also can result from the following volcanic activities:

- Intrusion of magma into a volcano
- Explosive eruptions
- Large earthquake directly beneath a volcano or nearby

Landslides may be minor or very large and can move at slow to very high speeds. They are commonly categorized by the form of initial ground failure. Figure 14-1 through Figure 14-4 show common types of slides. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

Slides can pose serious hazard to property in hillside terrain. When they move—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures.

Source: Washington State Department of Ecology, 2014

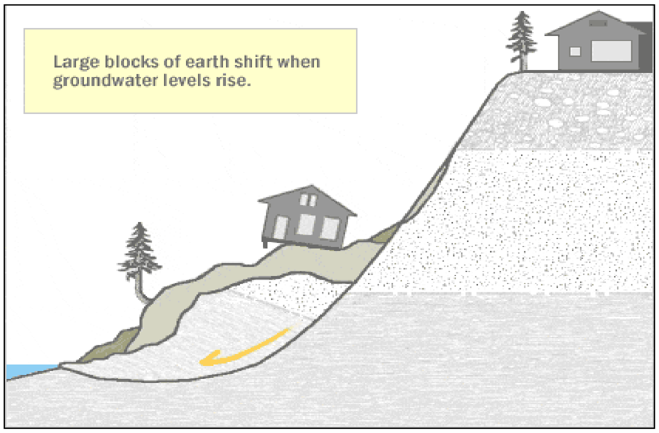


Figure 14-1. Deep Seated Slide

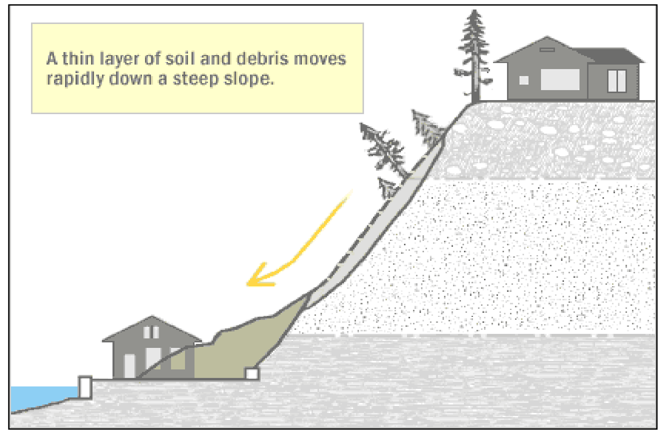


Figure 14-2. Shallow Colluvial Slide

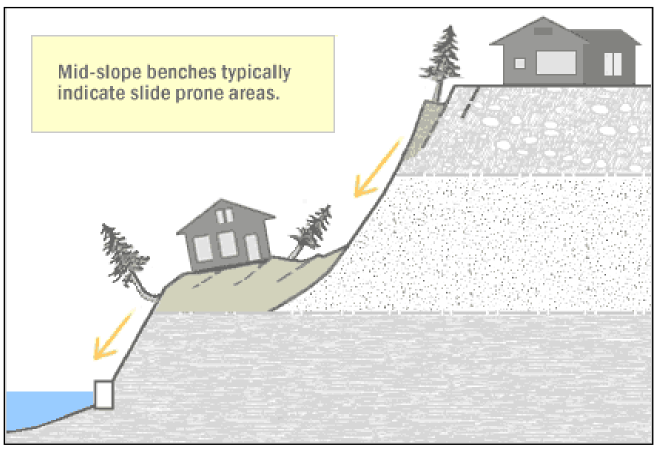


Figure 14-3. Bench Slide

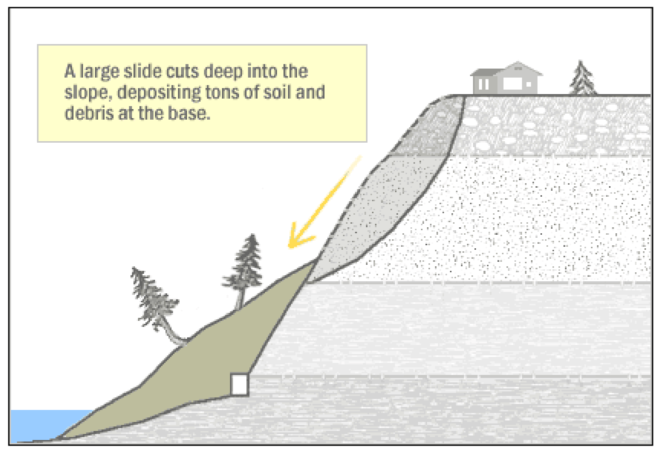


Figure 14-4. Large Slide

14.2 HAZARD PROFILE

14.2.1 Past Events

Giant catastrophic slides occurred around the major Hawaiian Islands thousands of years ago. At least 15 giant landslides have been identified by the U.S. Geological Survey (USGS), with the most recent occurring approximately 100,000 years ago off the Kona coast. Each of these slides resulted in huge land losses to the islands and resulted in large waves that have carried rocks and sediments as high as 1,000 feet above sea level. Although these giant landslides have the potential for enormous loss of life, property and resources, they are infrequent in human terms, occurring perhaps once every few tens of thousands of years, and were associated with an earlier geologic setting of island building. The USGS suggests that hazard mitigation should not focus on giant landslides because they are so infrequent.

A significant landslide mentioned in historical times is a mudflow triggered by the largest earthquake in recorded history in April 1868. The mudflow killed 31 people in Wood Valley in the Ka'ū district. No other landslide event has been mentioned as resulting in any loss of life.

14.2.2 Location

Roadcuts and other altered or excavated areas of slopes are particularly susceptible to landslides. Several areas along the Hāmākua Coast are chronic problem areas particularly during periods of heavy rainfall. Three major gulches—Maulua, Laupāhoehoe and Ka‘awali‘i—which are known for the “horseshoe” turns on State Highway 19, present rock fall problems. The rock fall problems arise during times of heavy rain as well as strong winds that sway the trees along the walls of the gulch, loosening the dirt and rocks that they grow in.

Homes along the edge of the Hāmākua coast cliffs are susceptible to abrupt collapse, particularly during times of heavy rainfall. These sea cliffs along the northeast coast of Mauna Kea range in height from 50 to 350 feet. They are eroded through a continuous process of wave action at the base of the cliff, which cuts a notch and undermines the higher section of the cliff, which eventually collapses and drops off.

The best available predictor of where landslides might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small portion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant landslide sites is important in identifying areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding. Examples of historical landslides associated with the volcanoes on the island of Hawai‘i include Punalu‘u slide, Hilina slump, and South Kona landslide complex.

The landslide risk mapping for this assessment was provided by the Pacific Disaster Center (PDC). Landslide susceptibility is measured on a scale of I to X, with I being the least susceptible. The hazard areas based on these criteria are shown in Figure 14-5.

14.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. The County of Hawai‘i is susceptible to all of these factors that trigger landslides. Earthquakes may occur at any time of the year. Tropical cyclone events are more likely during the Pacific Cyclone season. Heavy rain may result from cyclonic storms or seasonally rainy weather. During storm-related landslide events, the ground must be saturated prior to the onset of a major storm for significant landslides to occur.

14.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. Economic impact is largely associated with the disruption of transportation infrastructure. Communities that are isolated as a result of the landslide hazard may suffer from economic issues resulting from a lack of resource movement in and out of the area. This issue could last for a significant amount of time based on the extent of the event.

14.2.5 Warning Time

The velocity of a landslide may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods.

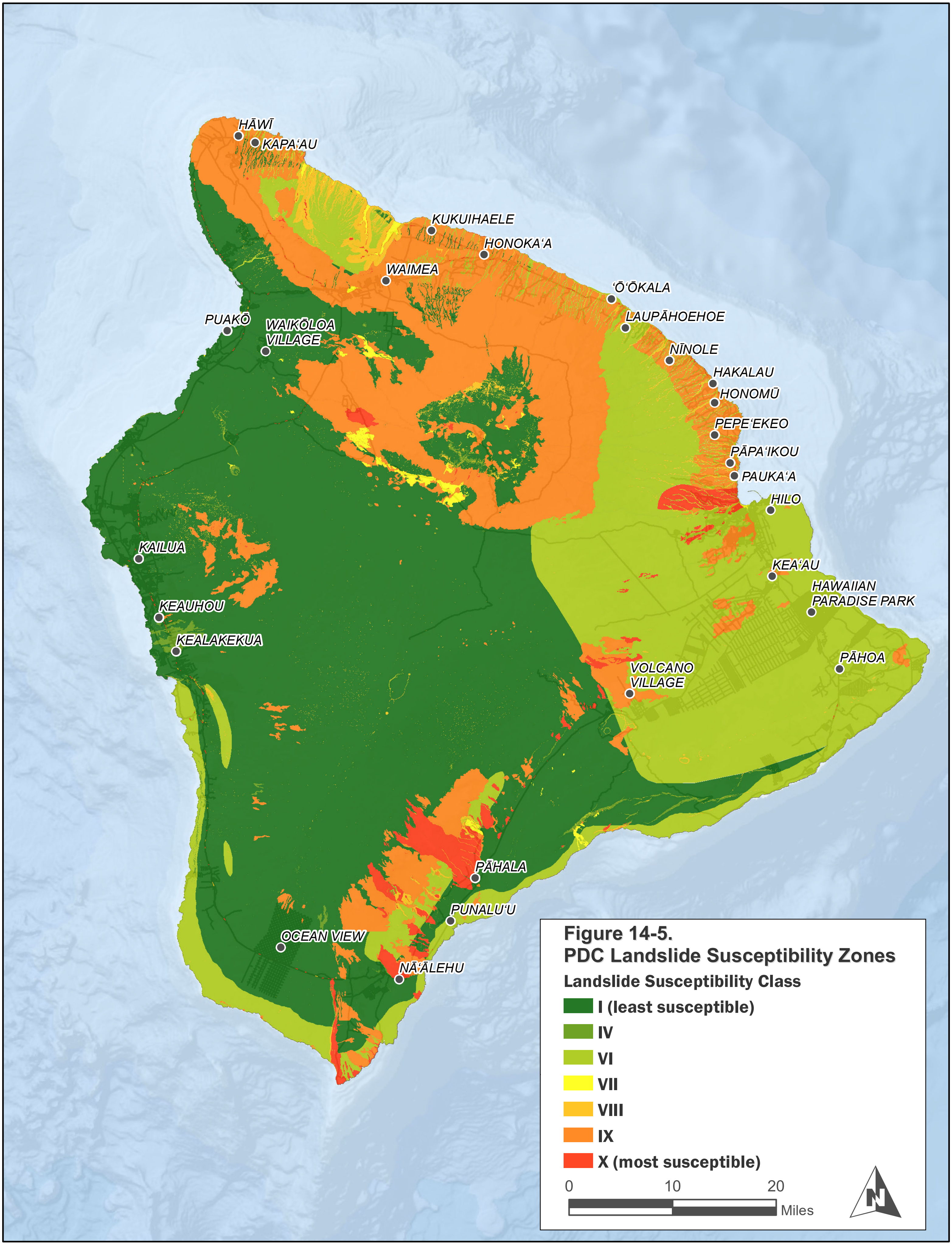


Figure 14-5.
PDC Landslide Susceptibility Zones

Assessing the geology, vegetation and amount of predicted precipitation for an area can help in predicting landslides. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis and respond after the event has occurred. Generally accepted warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

14.2.6 Secondary Hazards

Landslides can cause secondary effects such as blocking access to roads, which can isolate residents and businesses and delay commercial, public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents.

14.3 EXPOSURE

14.3.1 Population and Property

A quantitative assessment of exposure to the landslide hazard was conducted using the landslide hazard mapping and the asset inventory developed for this plan, with an emphasis on the zones with the highest degree of susceptibility (Zones VIII, IX and X). Population exposure was estimated by calculating the number of buildings in each hazard area as a percent of total planning area buildings, and then applying this percentage to the estimated planning area population. Table 14-1 summarizes the estimated population living in the mapped landslide risk areas and the estimated property exposure. Detailed results by district are provided in Appendix F.

14.3.2 Critical Facilities and Assets

Figure 14-6 summarizes the critical facilities exposed to the landslide hazard (Zones IX and X). A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Access to major roads is crucial after a disaster event for response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.

Table 14-1. Exposed Population and Property in Mapped Landslide Hazard Zones

	Landslide Susceptibility Zone X	Landslide Susceptibility Zone IX	Landslide Susceptibility Zone VIII
Population			
Population Exposed	5,718	39,600	986
% of Total Planning Area Population	3.0%	20.7%	0.5%
Property			
Number of Buildings Exposed	2,495	16,262	364
Value of Exposed Structures	$1,840,607,743	$4,435,166,948	$96,931,778
Value of Exposed Contents	$2,008,653,234	$2,798,532,339	$48,596,742
Total Exposed Property Value	$3,849,260,978	$7,233,699,287	$145,528,520
Total Exposed Value as % of Planning Area Total	6.6%	12.4%	0.3%

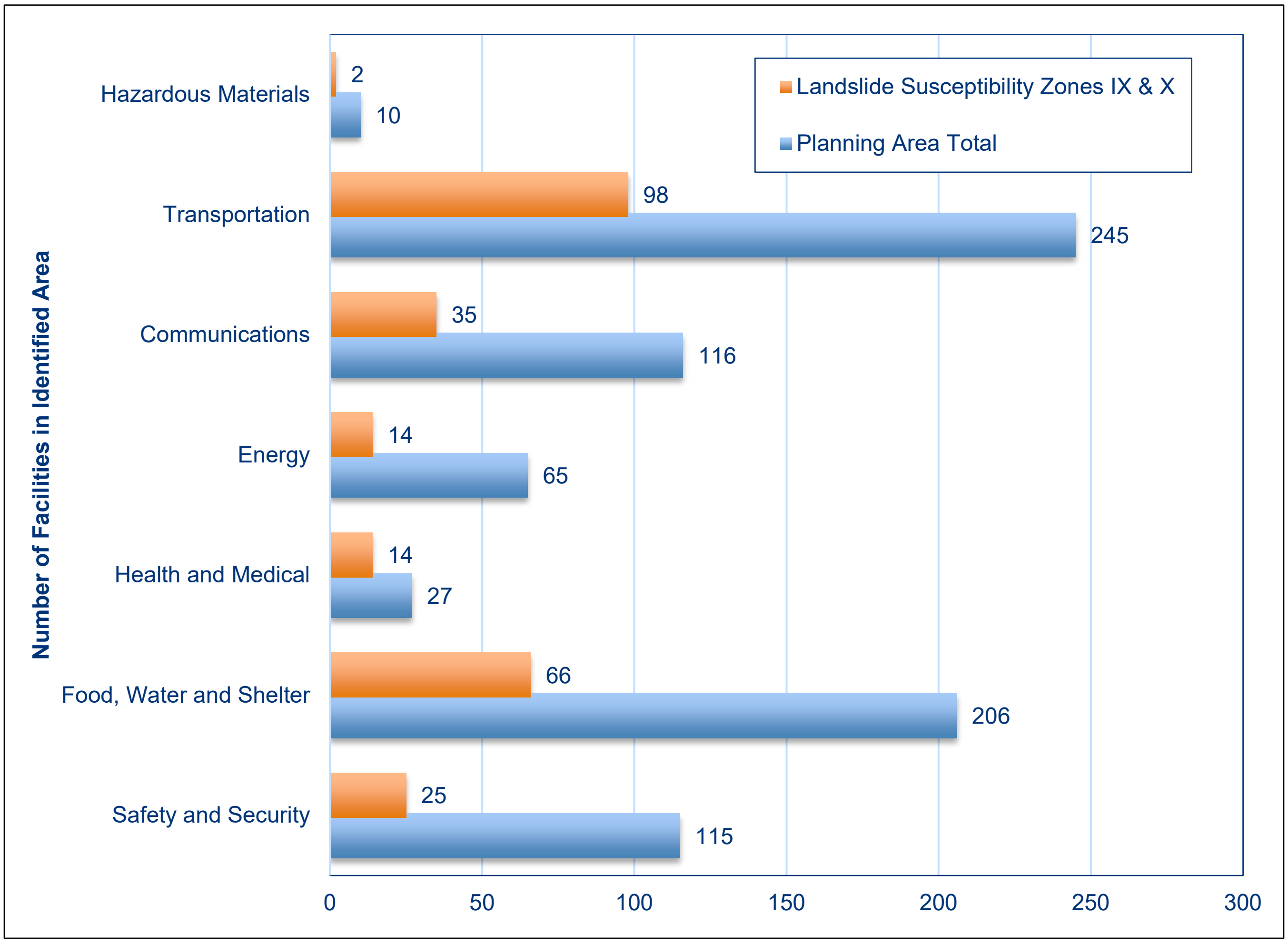


Figure 14-6. Critical Facilities in Mapped Landslide Susceptibility Zones IX and X

- **Power Lines**—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

14.3.3 Environment

All natural areas within the high susceptibility zones for landslide are considered to be exposed to the hazard.

14.4 VULNERABILITY

14.4.1 Population

Due to the preliminary nature of the analysis used to determine exposure, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all the persons exposed to higher risk landslide areas are considered to be vulnerable.

14.4.2 Property

Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 14-2 shows potential losses in the areas with the highest degree of landslide susceptibility (Zones IX and X).

Table 14-2. Loss Estimation for Landslide (Susceptibility Zones IX and X)

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Loss = 1% of Exposed Value	$11.1 Billion	$110.8 Million	Less than 1%
Loss = 10% of Exposed Value		$1.1 Billion	1.9%
Loss = 30% of Exposed Value		$3.3 Billion	5.71%
Loss = 50% of Exposed Value		$5.5 Billion	9.52%

14.4.3 Critical Facilities and Assets

No loss estimation of critical facilities was performed due to the lack of established damage functions for the landslide hazard. An in-depth analysis should be done of mitigation measures to prevent damage taken by critical facilities exposed to the landslide hazard, in order to determine if they could withstand a landslide event.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the planning area include mountain and coastal roads and transportation infrastructure. Many roads in the planning area are single lane highways that if blocked would cause a significant impact to the areas they serve. If impacted from a landslide, blocked highways could possibly isolate communities for a significant amount of time. At this time, all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

14.4.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolonged periods of time due to landslides.

Landslides that occur along coastal areas pose a particular threat to Hawaiʻi County's coastal coral reefs. As massive amounts of land falls into surrounding ocean waters, tides and waves may draw the earthen sediment to the reef area, choking the natural habitat. Natural cyclical processes normally remove earthen sediment and clean the coral reef area; however a large landslide may produce too much sediment to be removed by the natural processes (Piniak, 2004).

14.5 FUTURE TRENDS IN DEVELOPMENT

Land use in the planning area will be directed by plans adopted by the Hawai'i County Council. These plans include the General Plan and community development plans. The protective and preventive elements of these plans, from building height to transportation and environmental aspects, establish standards and plans for the protection of the community from hazards. The distribution of general land use types in the landslide hazard areas is shown in Figure 14-7. Agricultural and conservation land make up the greatest extent of exposed areas.

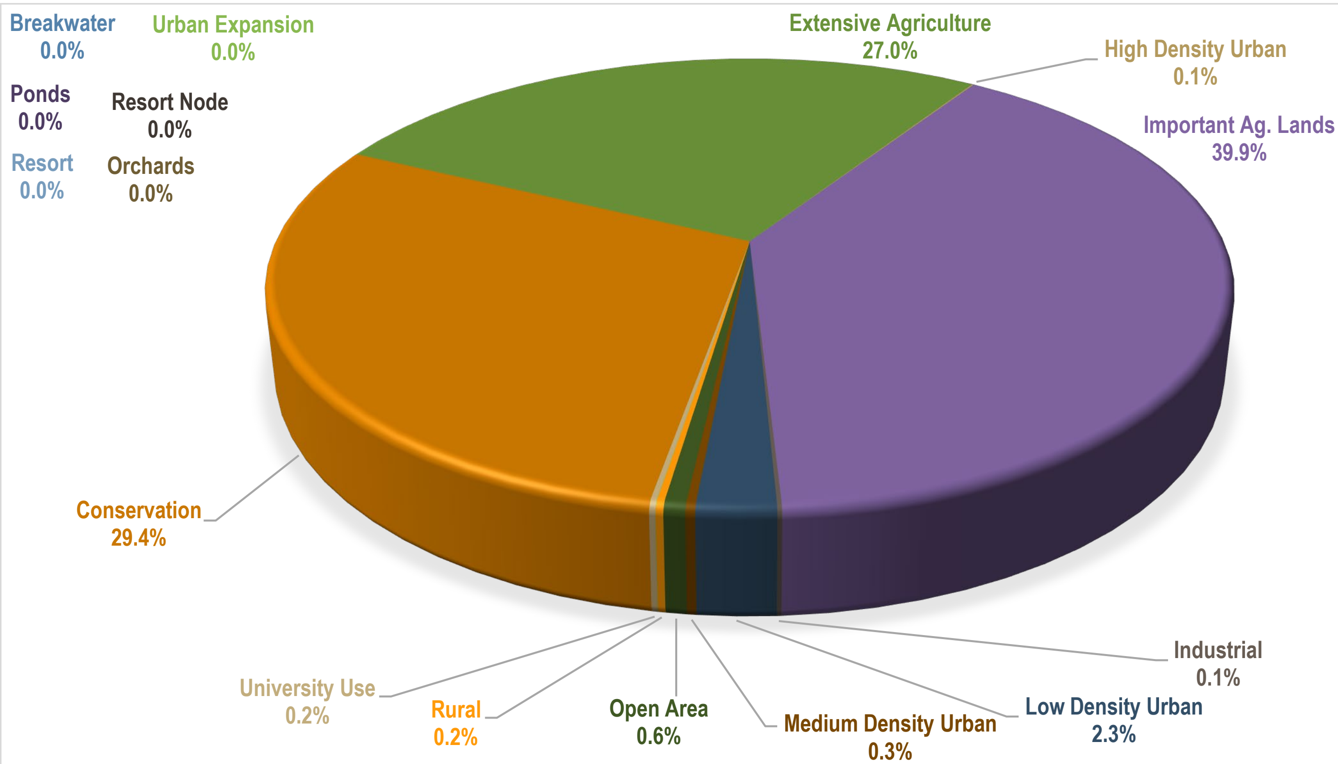


Figure 14-7. Land Use Distribution by Area in Landslide Susceptibility Zones IX and X

14.6 SCENARIO

Major landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater, or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding and an unrelated seismic event associated with volcanic activity in Hawai'i County. After heavy rains, soils become saturated with water. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table, poor soil, and ground shaking exacerbate hazardous conditions.

Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, would be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the planning area. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

Continued heavy rains and flooding would complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over the planning area.

14.7 ISSUES

Important issues associated with landslides in the planning area include the following:

- **Collection of Detailed Information**—Existing homes and transportation corridors are situated in landslide risk areas throughout the planning area. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- **Monitoring of Future Development**—Future development could lead to more homes in landslide risk or potentially isolated areas. By continuing to monitor land use and development, Hawaiʻi County could play an integral part in minimizing development in known landslide risk areas or areas prone to isolation due to blocked transportation corridors by landslides.
- **Reevaluation of Current Data**—Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- **Water Quality Degradation**—Landslides may cause negative environmental consequences, including water quality degradation. The County must continue to monitor water quality during potentially impactful landslide events.
- **Multi-Hazard Mitigation Measures**—The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- **State Transportation Projects**—The State Department of Transportation tries to address landslide and rock fall problems through its maintenance budget. The more chronic problem areas require capital improvement project funding that has not been provided to date, although data is available regarding the frequency and severity of landslide events.
- **Private Property Protection —**Individual homeowners are attempting to address the problem of the collapse of the Hāmākua Coast sea cliffs by reinforcing the cliff sides and anchoring their structures. Additional information is needed to assess these efforts and to determine adequate setbacks for future construction.

15. TROPICAL CYCLONE

15.1 HAZARD DESCRIPTION

Tropical cyclones are among the most dramatic, damaging, and potentially deadly events that occur in the Hawaiian Islands. Hawai‘i lies in the Central Pacific, which, on average, experiences four to five tropical cyclones every year. Almost all tropical cyclones in the Pacific basin form between June 1 and November 30. This timeframe is known as hurricane season. August and September are peak months for hurricane development (County of Maui, 2015).

15.1.1 Impacts of Tropical Cyclones

The threats caused by an approaching hurricane can be divided into three main categories:

- **Storm Surge**—Water that is pushed toward the shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level 15 feet or more. Storm surge is responsible for nearly 90 percent of all hurricane-related deaths and injuries.
- **Wind Damage**—The force of wind can quickly decimate the tree population, down power lines and utility poles, knock over signs, and damage/destroy homes and buildings. Flying debris can also harm both structures and people. When hurricanes first make landfall, it is common for tornadoes to form, which can cause severe localized wind damage.
- **Rainfall/Flooding**—The torrential rains that normally accompany a hurricane can cause serious flooding. Whereas the storm surge and high winds are concentrated around the “eye,” the rain may extend for hundreds of miles and may last for several days, affecting areas well after the hurricane has diminished.

Waves and storm surges normally hit coasts ahead of high winds, as waves move faster than a hurricane advances. Locally intense rainfall may occur as the hurricane makes landfall. History has shown that the islands do not have to take a direct landfall from a cyclone to sustain a high level of damage. Wind strength, storm radius of maximum winds, timing, and proximity, are important factors that control storm impact. The winds can affect all parts of an island and can be intensified by mountain ranges (orographic or topographic amplification). Hurricane winds, blowing from variable directions, will experience topographic amplification, so a minimal hurricane or tropical storm can have significant wind effects on land.

15.1.2 Severity Ratings

In the United States, forecast centers classify tropical cyclones in the following categories according to their maximum sustained winds:

- **Tropical Depression**—A weak tropical cyclone with a surface circulation including one or more closed isobars (lines or curves of constant pressure) and highest sustained winds (measured over one minute or more) of less than 38 miles per hour. Tropical depressions are assigned a number denoting their chronological order of formation in a given year.
- **Tropical Storm**—A tropical cyclone with highest sustained winds between 39 and 73 miles per hour.

- **Hurricane**—A tropical cyclone with highest sustained winds greater than 74 miles per hour. Intensity is quantified by the Saffir-Simpson Hurricane Scale, based on a hurricane's sustained wind speed. Table 15-1 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventive measures.

Table 15-1. The Saffir-Simpson Hurricane Scale

Category	Wind Speed	Expected Damage
1	74-95 mph	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NWS, 2013

15.2 HAZARD PROFILE

15.2.1 Past Events

Little was recorded of hurricanes striking Hawaiʻi before the last half of the 20th century. Until 1950, tropical storms hitting the Hawaiian Islands were not classified as hurricanes. It was not until the advent of weather satellites that the storms in this part of the world were understood to be hurricanes. The only documented hurricane before 1950 was the "Kohala Cyclone" of 1871, which was believed to be a minimal hurricane that affected Maui and Hawaiʻi.

Since 1950, when adequate records began, eight hurricanes have affected the Hawaiian Islands and 14 others have posed a threat by their passage. Figure 15-1 depicts storm tracks in the vicinity of Hawaiʻi from 1950 to 2014.

Tropical Storm Iselle made landfall in Hawaiʻi County in August 2014 with maximum sustained winds of 60 mph. This storm caused severe disruption of power and roadways due to treefall during high winds. The storm resulted in a federally declared major disaster on September 12, 2014 (DR-4194-HI). A combination of southwesterly wind shear, drier air and cooler waters weakened Iselle considerably as it approached the Hawaiian Islands. In Puna, downed power lines and road and highway closures due to treefall, and reports of damage to light-framed homes from fallen trees and strong winds were the major damaging impacts of Tropical Storm Iselle.

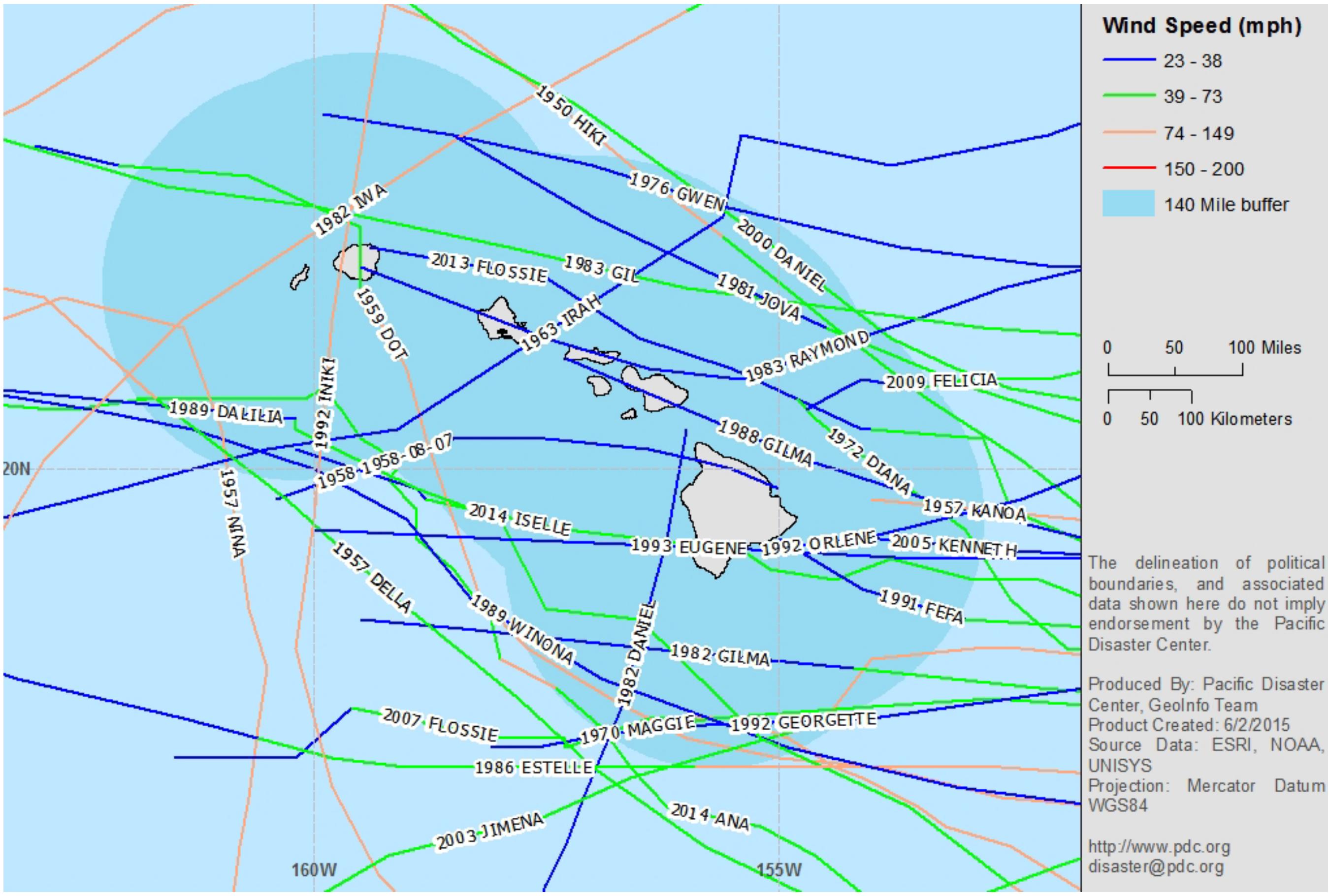


Figure 15-1. Historical Tropical Cyclones Within 140 Miles of Hawai'i, 1950 to 2014

All of the main Hawaiian Islands are at approximately the same risk of a direct hit by a hurricane. The following other hurricanes or tropical storms have caused serious damage in the state of Hawai'i:

- Hurricane Nina in 1957 produced record winds in Honolulu on the Island of O'ahu.
- Hurricane Dot was responsible for extensive damage on the Island of Kaua'i in 1959.
- Hurricane Iwa resulted in widespread damage on the islands of Kaua'i and O'ahu in 1982.
- Hurricane Estelle caused high surf on the islands of Hawai'i and Maui and floods on O'ahu in 1986.
- Hurricane Iniki produced widespread severe damage on the Island of Kaua'i and on the leeward coast of the Island of O'ahu in 1992.

In addition to all these destructive hurricanes, seven tropical storms or hurricanes since 1950 could have caused serious damage to the islands had they come much closer to the islands than they did. Among these hurricanes that missed the islands are Hurricane Fernanda in 1993, Hurricane Emilia in 1994, and Hurricane Ana in 2014.

15.2.2 Location

Historically, most tropical cyclones have passed the Hawaiian Islands to the south. Because they spin counter-clockwise in the northern hemisphere, east-facing coastlines in Hawai'i receive the brunt of strong onshore winds as storms approach the islands, while the south and west coastlines feel onshore winds as the storms pass to the west. Coastlines facing the passing storms usually are adversely impacted by both wind and storm surge damage. The highest wind speeds, however, may occur on the side opposite the storm approach, as downdrafts accelerate downslope as they descend over the mountainous terrain.

15.2.3 Frequency

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event (equal to the inverse of the annual frequency of exceedance). The following maximum 3-second gust wind speeds have been identified for the Hazus model:

- For the 50-year MRP, 39 to 95 mph, characteristic of a Category 1 hurricane.
- For the 100-year MRP, 74 to 110 mph, characteristic of a Category 2 hurricane.
- For the 500-year MRP, 111 to more than 157 mph, characteristic of a Category 5 hurricane.

15.2.4 Severity

It is estimated that Tropical Storm Iselle delivered 60 mph winds in the Puna District and about 50 mph winds in Hilo. These windspeeds would be in the middle range of the tropical storm category. A full Category 1 hurricane would generate wind forces approximately three times greater than Tropical Storm Iselle. Hurricane-induced storm surge and waves also pose a flooding threat to the island. Review of hurricane storm-tracks from 1949 to 2008 indicate that 14 storms of Category 1 or higher have come within a 200 nautical mile radius of the Hawaiian Islands.

For this risk assessment, Hawai‘i County determined that a Category 4 event with a storm track west by northeast was the scenario likely to have the greatest impact on the planning area. Using Hazus, two types of impacts were modeled for the Category 4 storm scenario event: wind and storm surge. Figure 15-2 and Figure 15-3 show the extent and location for these two parameters for the scenario event in the planning area; detailed area maps for storm surge are provided in Appendix B. The maximum wind gusts for the Category 4 scenario event modeled for this assessment range from 130 to 147 mph. This would correlate to an MRP of approximately 180 years, using interpolation from the above referenced Hazus MRP values.

15.2.5 Warning Time

Tropical cyclones can be closely monitored and tracked. As a result, accurate warnings up to days in advance of the event are possible, with the modeling offering possible storm movement up to a week prior. Track forecasts have improved due in part to the increased numbers of satellites, outfitted with more sophisticated weather-monitoring devices. At the same time, supercomputing power has increased exponentially, and computer models used to forecast a cyclone’s direction keep improving (Main, 2014). The National Oceanic and Atmospheric Administration (NOAA) offers multiple watch, warning, and resource tools through the National Hurricane Center including, but not limited to those described in the sections below.

Tropical Cyclone Public Advisory

The tropical cyclone public advisory contains a list of all current watches and warnings on a tropical or subtropical cyclone. It gives the cyclone position in terms of latitude and longitude and distance from a selected land point, as well as the current motion. The advisory includes the maximum sustained wind speed and the estimated or measured minimum central pressure. The advisory may also include information on potential storm tides, rainfall or tornadoes associated with the cyclone, as well as any pertinent weather observations.

Public advisories are issued for all Atlantic, eastern Pacific and central Pacific tropical or subtropical cyclones. Public advisories for eastern Pacific and central Pacific tropical cyclones are normally issued every 6 hours. Intermediate public advisories may be issued every 3 hours when coastal watches or warnings are in effect, and every 2 hours when coastal watches or warnings are in effect and land-based radars have identified a reliable storm center. Special public advisories may be issued at any time due to significant changes conditions.

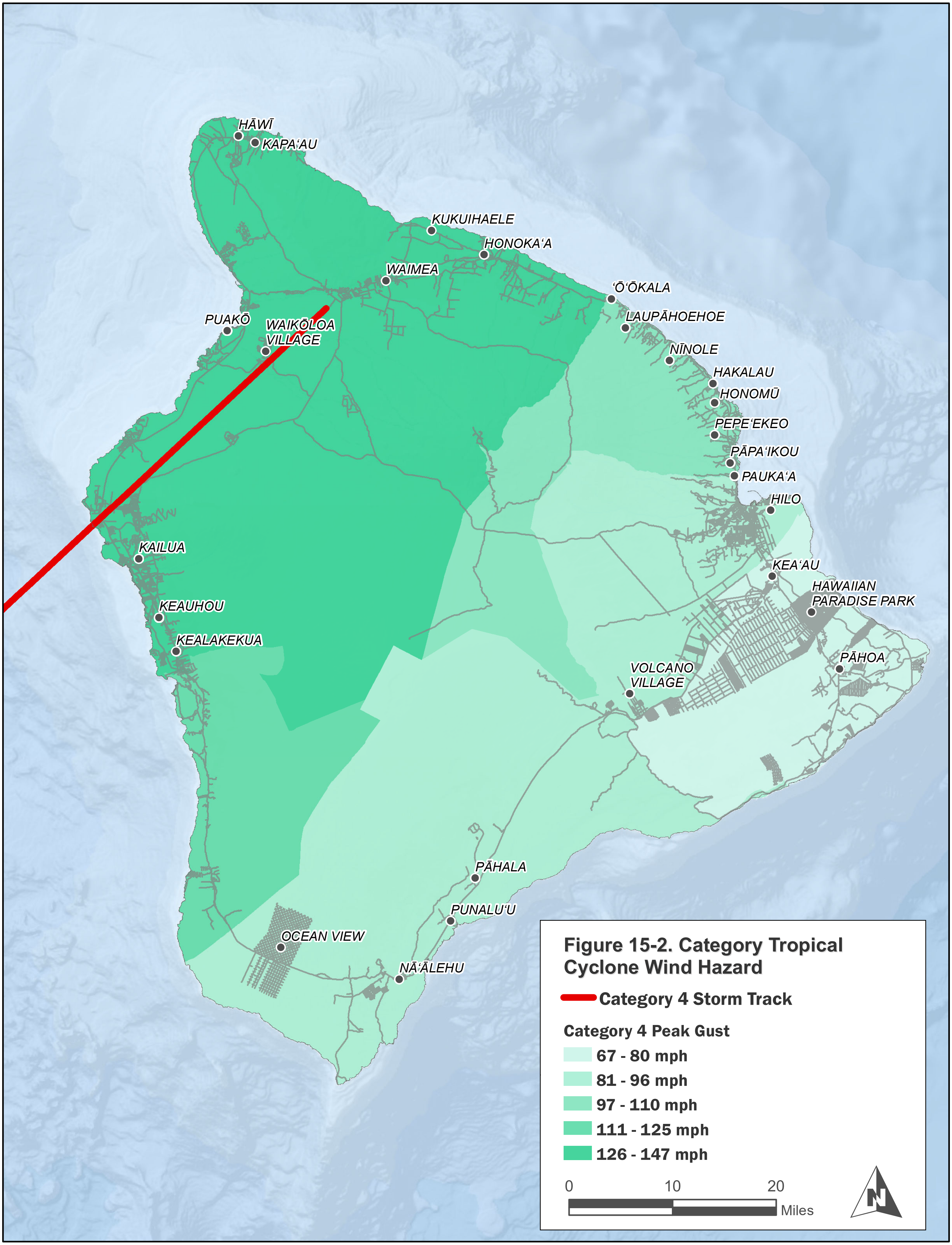


Figure 15-2. Category Tropical Cyclone Wind Hazard

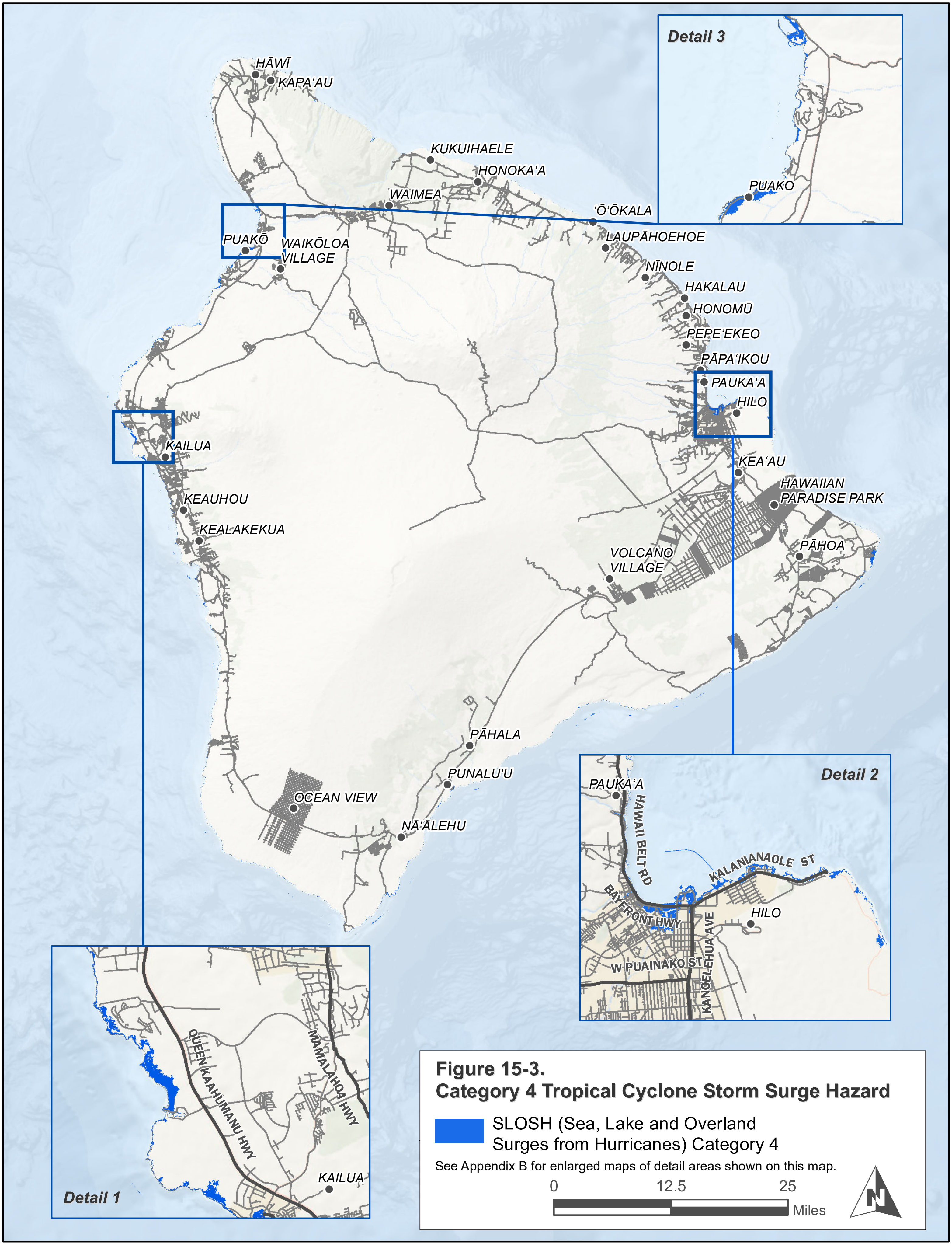


Figure 15-3.
Category 4 Tropical Cyclone Storm Surge Hazard

Tropical Cyclone Forecast/Advisory

The tropical cyclone forecast/advisory contains a list of all current watches and warnings on a tropical or subtropical cyclone, as well as the current latitude and longitude, intensity, and system motion. The advisory contains forecasts of the cyclone positions, intensities, and wind fields. It may also include information on any pertinent storm tides associated with the cyclone. Forecast/advisories are issued on all eastern Pacific tropical and subtropical cyclones every 6 hours.

Tropical Cyclone Discussion

The tropical cyclone discussion explains the reasoning for the analysis and forecast of a tropical or subtropical cyclone. It includes a table of the forecast track and intensity. Tropical cyclone discussions for eastern and central Pacific tropical cyclones are normally issued every 6 hours. Special tropical cyclone discussions may be issued at any time due to significant changes in warnings or in the cyclone.

15.2.6 Secondary Hazards

The main secondary effects of tropical cyclones are storm surge and high winds. Other secondary hazards include landslides, flooding, coastal erosion, storms, and high surf.

15.3 EXPOSURE

It is assumed that the entire County’s population, property, critical facilities and environment are exposed to the wind impacts of tropical cyclones to some degree. Storm surge impacts were assessed using storm surge inundation mapping for a Category 4 tropical cyclone, as determined using the NOAA National Hurricane Center’s SLOSH (Sea, Lake and Overland Surges from Hurricanes) methodology.

15.3.1 People and Property

Table 15-2 summarizes the estimated population living in the mapped storm surge inundation area and the estimated property exposure.

Table 15-2. Exposed Population and Property in Category 4 Storm Surge Inundation Area

Population	
Population Exposed	1,081
% of Total Planning Area Population	Less than 1%
Property	
Number of Buildings Exposed	654
Value of Exposed Structures	$749,971,054
Value of Exposed Contents	606,241,521
Total Exposed Property Value	1,356,212,574
Total Exposed Value as % of Planning Area Total	2.33

15.3.2 Critical Facilities and Assets

Figure 15-4 summarizes the critical facilities and assets in the Category 4 storm surge inundation zones of the planning area. Critical facilities and assets located just beyond the storm surge zones may be exposed if previous high surf or storm events destroyed the beach buffer. Coastal transportation routes also may be exposed. These routes are often located in areas where coastal erosion has gradually worn away the beach buffer, causing the potential for roadway inundation during high surf events.

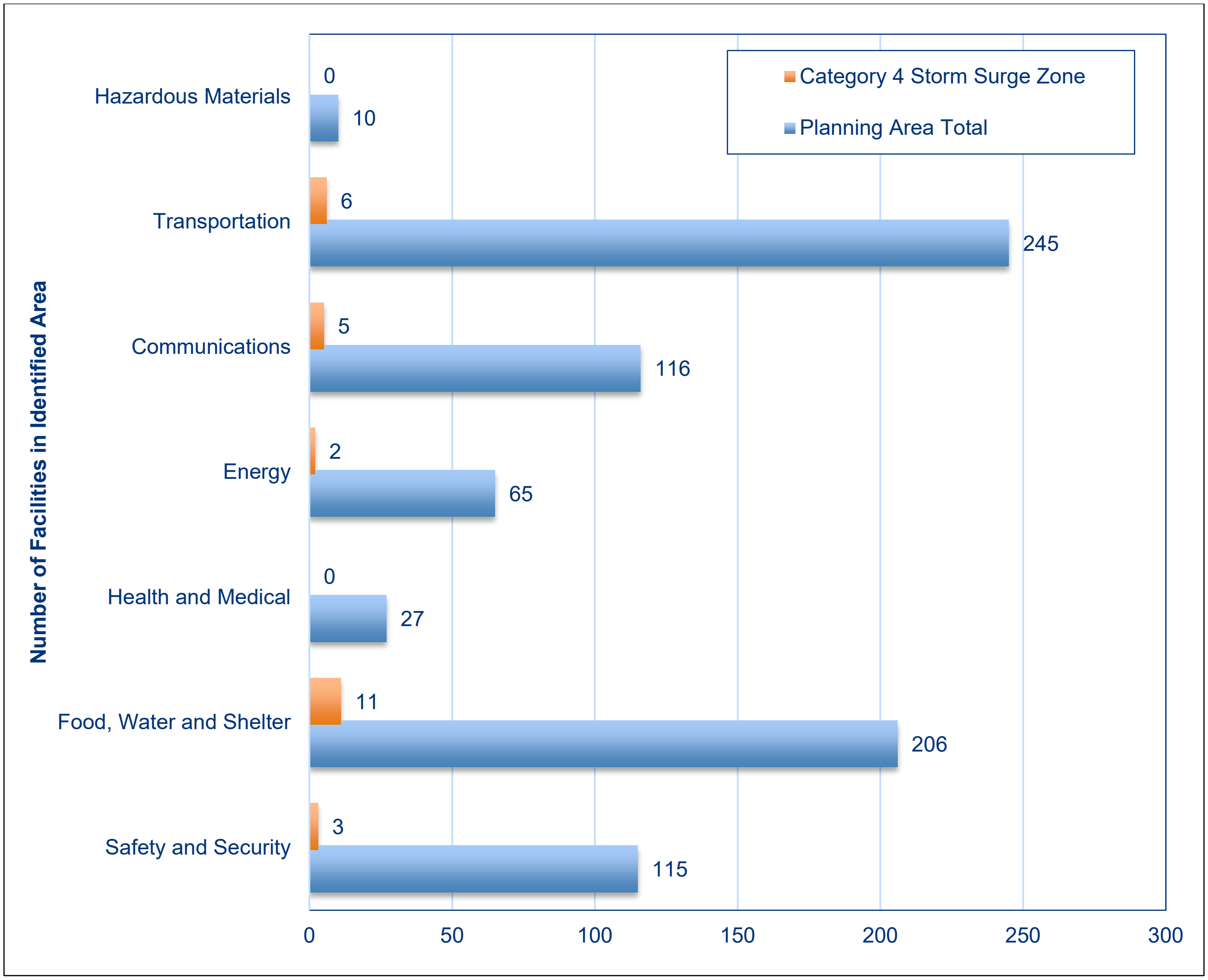


Figure 15-4. Critical Facilities in the Category 4 Storm Surge Inundation Zones

15.3.3 Environment

All beaches are vulnerable to the effects of storm surge. A 2014 study indicated that coral reef plays a large role in the dissipation of wave energy that affects beach areas. This study indicated that wave energy is reduced by an average of 97 percent, with reef crests alone dissipating most of the energy. This study further explores and asserts that natural reef formations can provide comparable wave attenuation benefits to those provided by artificial means, such as breakwaters (Ferrario et al., 2014).

15.4 VULNERABILITY

15.4.1 Population

The planning area is densely populated along its coastal shores and thus vulnerable to storm surge. Downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Residents may be displaced or require temporary sheltering. Impacts in the planning area were estimated for the Category 4 tropical cyclone for both wind and storm surge through the Level 2 Hazus analysis. Table 15-3 summarizes the results.

Table 15-3. Estimated Tropical Cyclone Impact on Persons and Households

Tropical Cyclo0ne Event	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
Category 4 Cyclone-Wind	19,985	12,032
Category 4 Cyclone-Storm Surge	181	17
Total	**20,166**	**12,049**

Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Economically disadvantaged populations are vulnerable because they may not have funds to evacuate. The population over the age of 65 is also more vulnerable because they may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available due to isolation during a storm event.

15.4.2 Property

Property losses were estimated through the Level 2 Hazus analysis for the Category 4 cyclone event for both wind and storm surge impacts. Table 15-4 shows the overall planning-area results. The Hazus analysis also estimated the amount of damage-caused debris in the planning area for the Category 4 event, as summarized in Table 15-5. Detailed results for all districts are provided in Appendix F.

Table 15-4. Loss Estimates for Tropical Cyclone

	Estimated Loss Associated with Tropical Cyclone		
	Structure	Contents	Total
Category 4 Cyclone-Wind	$7,440,752,904	$3,764,241,595	$11,204,994,498
Category 4 Cyclone-Storm Surge	$18,568,483	$17,675,024	$36,243,508
Total	**$7,459,321,387.00**	**$3,781,916,619.00**	**$11,241,238,006.00**

Table 15-5. Damage Caused Debris, Category 4 Cyclone

	Structure Debris to Be Removed	
	Tons	Truckloads
Category 4 Cyclone-Wind	1,025,962.00	41,038
Category 4 Cyclone-Storm Surge	10	1
Total	1,025,972	41,039

15.4.3 Critical Facilities and Assets

Hazus estimates the probability that critical facilities and assets may sustain damage as a result of Category 4 cyclone winds. Table 15-6 summarizes the results.

Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to storm surge and cascading effects such as flooding, falling debris etc. Impacts on transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs.

Utility structures could suffer damage associated with falling tree limbs or other debris. Such impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts).

Table 15-6. Damage to Critical Facilities from a Category 4 Hurricane Winds

Category	Number of Facilities Affected	Number of Facilities with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Safety and Security	115	62	9	25	19	0
Food, Water and Sheltering	178	87	9	35	47	0
Health and Medical	27	16	0	4	7	0
Energy	65	27	4	7	27	0
Communications	116	57	6	19	34	0
Transportation	12	8	0	4	0	0
Hazardous Materials	10	5	2	0	3	0
Total	**523**	**262**	**30**	**94**	**137**	**0**

15.4.4 Environment

In general, the environmental vulnerabilities include direct and secondary hazard effects from the tropical cyclone hazard. Direct effects include those caused by a tropical cyclone’s associated winds. High wind causes storm surge on Hawai‘i County’s coastline, exacerbating the rate at which the coast erodes. While natural processes replenish and revitalize the damaged coastline, a series of tropical cyclones have the potential to permanently change the topography of Hawai‘i County’s beaches.

High winds also affect natural vegetation within the planning area. Effects include downed trees and blocked waterways. Severity of the effect of downed debris depends on the location and magnitude of material. Tropical cyclones can also significantly add to acidification problems currently being suffered by coral reefs as the carbon dioxide content of the oceans continues to increase. The change in salinity and pH levels of the ocean is not short-lived after a tropical cyclone and not only affects living coral reefs but can dissolve the existing coral structure, which are the skeletons of past coral generations (Tripp, 2013).

Indirect effects of tropical cyclones on the environment mainly deal with flooding, which has the potential to upset the natural balance of the County’s ecosystems. This is of particular concern when dealing with the compounding effects of multiple events in a single season.

15.5 FUTURE TRENDS IN DEVELOPMENT

The distribution of general land use types in the Category 4 storm surge inundation areas is shown in Figure 15-5. Open areas and conservation land make up the greatest extent of exposed areas.

There is no single reference documenting the historical criteria used for wind design of structures in each county of Hawai‘i; however, Hawai‘i design wind pressures have changed over the years through different editions of the Uniform Building Code (UBC) and more recently the International Building Code (IBC). In the case of the IBC, design wind pressures have changed through different editions of the referenced American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures (ASCE 7). The design vintage can be used as an indicator of a building’s susceptibility to wind damage. Design wind pressures, typical construction type (single or double wall), and use of hurricane uplift resistance can all be determined by the year built based on the corresponding version of the UBC or IBC in effect at the time.

The current Hawai‘i County building code includes specific provisions for future development regarding hurricane-resistant construction.

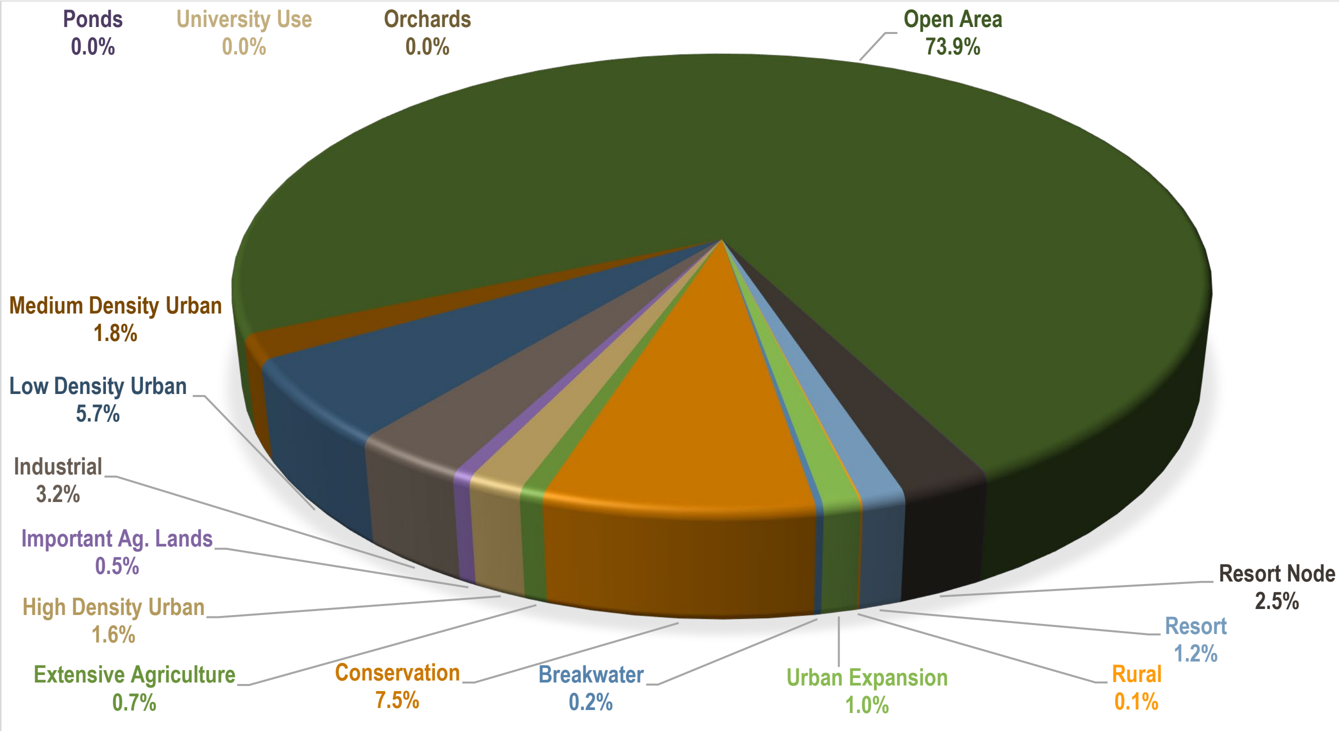


Figure 15-5. Land Use Distribution by Area in Category 4 Storm Surge Inundation Zone

15.6 SCENARIO

A worst-case scenario would be a direct hit to Hawai'i County by a Category 3 or stronger hurricane. An event of such magnitude would result in widespread damage to private and public property, including critical facilities and assets. Long-term power outages would be expected, which may result in loss of utilities such as potable water and wastewater systems. Loss of transportation facilities such as the harbor and airport would exasperate the magnitude of the event by taxing already limited resources and further isolating the islands from response and recovery resources. Many facilities and structures would require months or years to return to pre-event functionality. Long-terms impacts on tourism, supporting industries and the local tax base would be expected.

15.7 ISSUES

Important issues associated with the tropical cyclone hazard include but are not limited to the following:

- **Emergency Shelter Wind Speed Capability Assessment**—Because of the secondary hazards associated with tropical cyclones, emergency shelters are often needed to house residents displaced by collapsing houses or rising flood waters. The County should begin making efforts to test its emergency shelters to ensure that they can withstand sustained wind speeds comparable to a Category 2 hurricane.
- **Vulnerable Trees**—There is a significant tree exposure to hurricane wind forces within the planning area. The vulnerability of these trees to wind forces should be monitored by the County to pre-identify potential problem areas prior to pending storms.
- **Debris Management**— The scenario event modeled for this assessment estimated a significant amount of post-event debris accumulation. The ability to manage this amount of debris should be considered by the County prior to a pending event.
- **Power Interruption**— Long-term loss of power is likely to be a major impact from the scenario event modeled for this assessment. Energy assuredness planning should be considered for the planning area.

16. TSUNAMI

16.1 HAZARD DESCRIPTION

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs. The waves arrive at shorelines over an extended period. According to the National Tsunami Hazard Mitigation Program's *National Tsunami Hazard Assessment*, Hawai‘i as a whole is classified as a "high hazard" area for tsunamis. The state has experienced the highest number of tsunami-associated deaths in the country (Dunbar and Weaver, 2008).

16.1.1 Tsunami Characteristics

Tsunamis are typically classified as local or distant. Locally generated tsunamis have minimal warning times, leaving little time for response. They may be accompanied by damage resulting from the triggering earthquake through ground shaking, surface faulting, liquefaction or landslides. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement more detailed evacuation plans.

In the open ocean, a tsunami may be only a few inches or feet high, but it can travel with speeds approaching 500 miles per hour. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. The first wave usually is not the largest. Several larger and more destructive waves often follow the first one. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in the water level that advances rapidly (up to 60 miles per hour).

The tsunami's size and speed, as well as the coastal area's form and depth, affect the impact of a tsunami; wave heights of 50 feet are not uncommon. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

16.1.2 Damage from Tsunami

The first visible indication of a tsunami may be a rise in water level. The advancing tsunami can resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and often does not break as a normal wave. Additionally, this surge of water does not stop at the shoreline and pushes above normal sea level tidal reach. This phenomenon is called "run-up" (Figure 16-1). Even if the run-up appears to be small—3 to 6 feet for example—the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes. Floating debris carried by a tsunami can endanger human lives and batter inland structures. Breakwaters and piers can collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves.

Source: UNESCO, n.d.

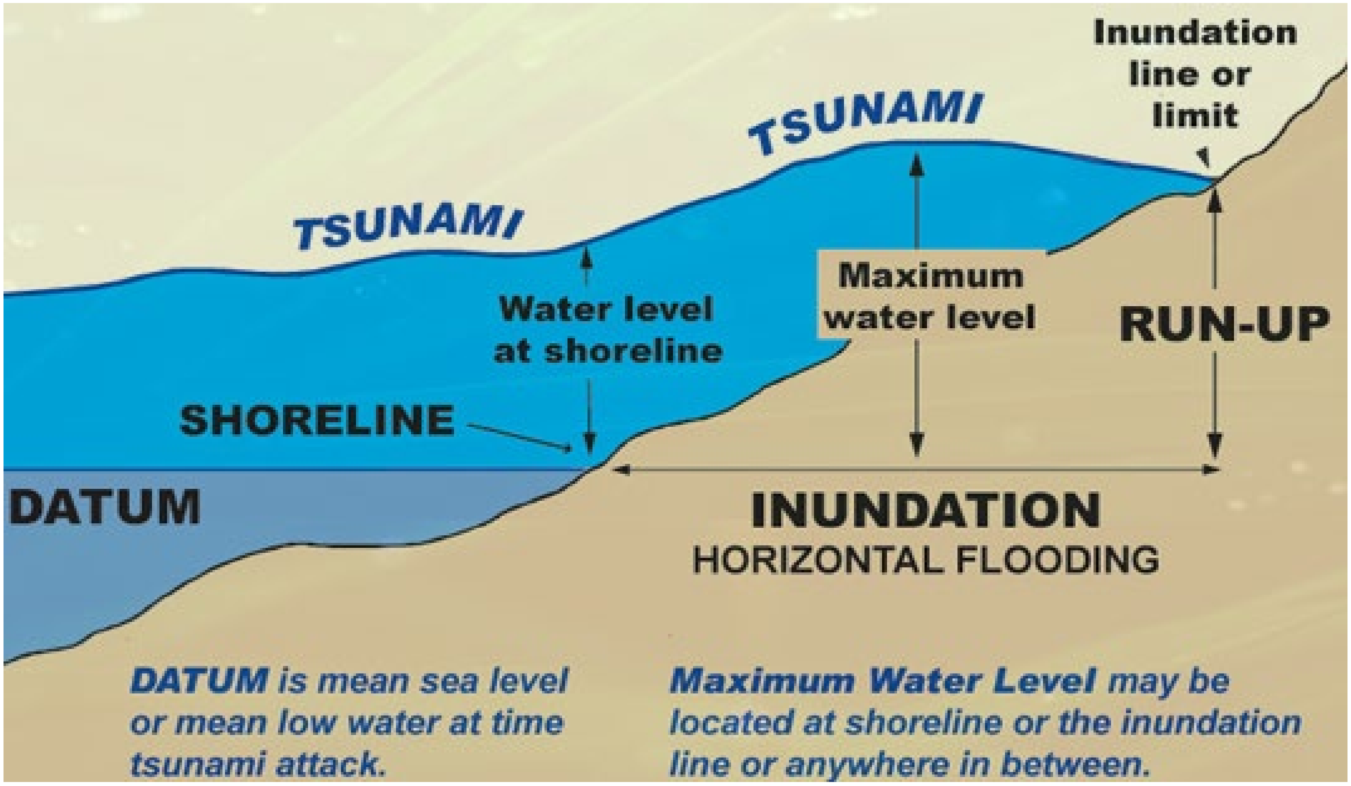


Figure 16-1. Run-up Distance and Height in Relation to the Datum and Shoreline

Conversely, the first indication of an approaching tsunami may be recession of water (draw down) caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels, undermining roads, buildings, bulkheads, and other structures and severely damaging coastal structures due to erosive scour around piers and pilings. As the water's surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom. The outflow action also can carry enormous amounts of highly damaging debris with it, resulting in further destruction.

At some locations, the advancing turbulent front will be the most destructive part of the tsunami. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests.

16.1.3 Sources of Tsunamis

A tsunami can be generated by any disturbance that displaces a large water mass from its equilibrium position. The most common causes of tsunamis are earthquakes, landslides, and submarine volcanic explosions (see Figure 16-2). The three tsunami sources are described in the following sections.

Tsunamis Induced by Earthquakes

Earthquakes that cause tsunamis are referred to as "tsunamigenic earthquakes." Earthquakes generate tsunamis when the sea floor abruptly deforms and displaces the overlying water from its equilibrium position. Waves are formed as the displaced water mass, which acts under the influence of gravity, attempts to regain its equilibrium. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami.

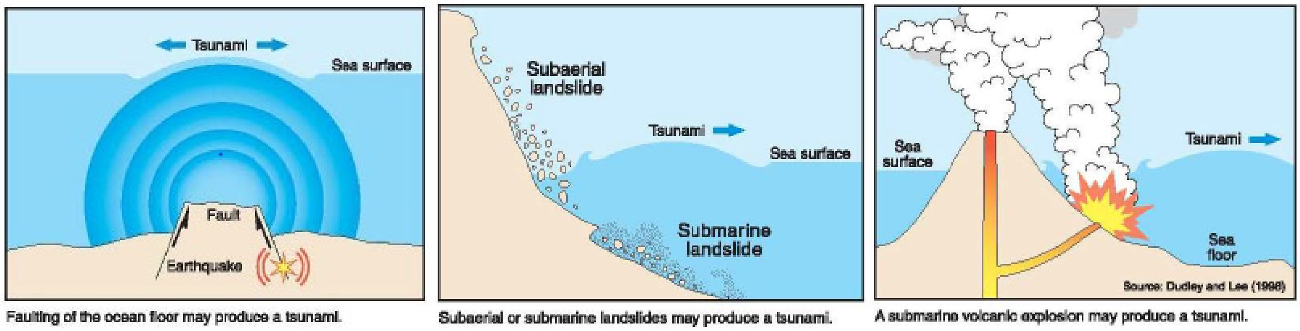


Figure 16-2. Common Sources of Tsunamis

The main factor that determines the initial size of a tsunami is the amount of vertical sea floor deformation. The earthquake's magnitude, depth, fault characteristics, and coincident slumping of sediments or secondary faulting control the size of the tsunami. Other features that influence the size of a tsunami along the coast are the shoreline and bathymetric configuration, the velocity of the sea floor deformation, the water depth near the earthquake source, and the efficiency at which energy is transferred from the earth's crust to the water column.

Most tsunamis induced by earthquakes originate in the Pacific Ocean, where resulting tsunami waves can travel at up to 500 miles per hour, striking distant coastal areas in a matter of hours (see Figure 16-3). Tsunamis affecting Hawai‘i County may be induced by earthquakes at a considerable distance, such as in Alaska or South America.

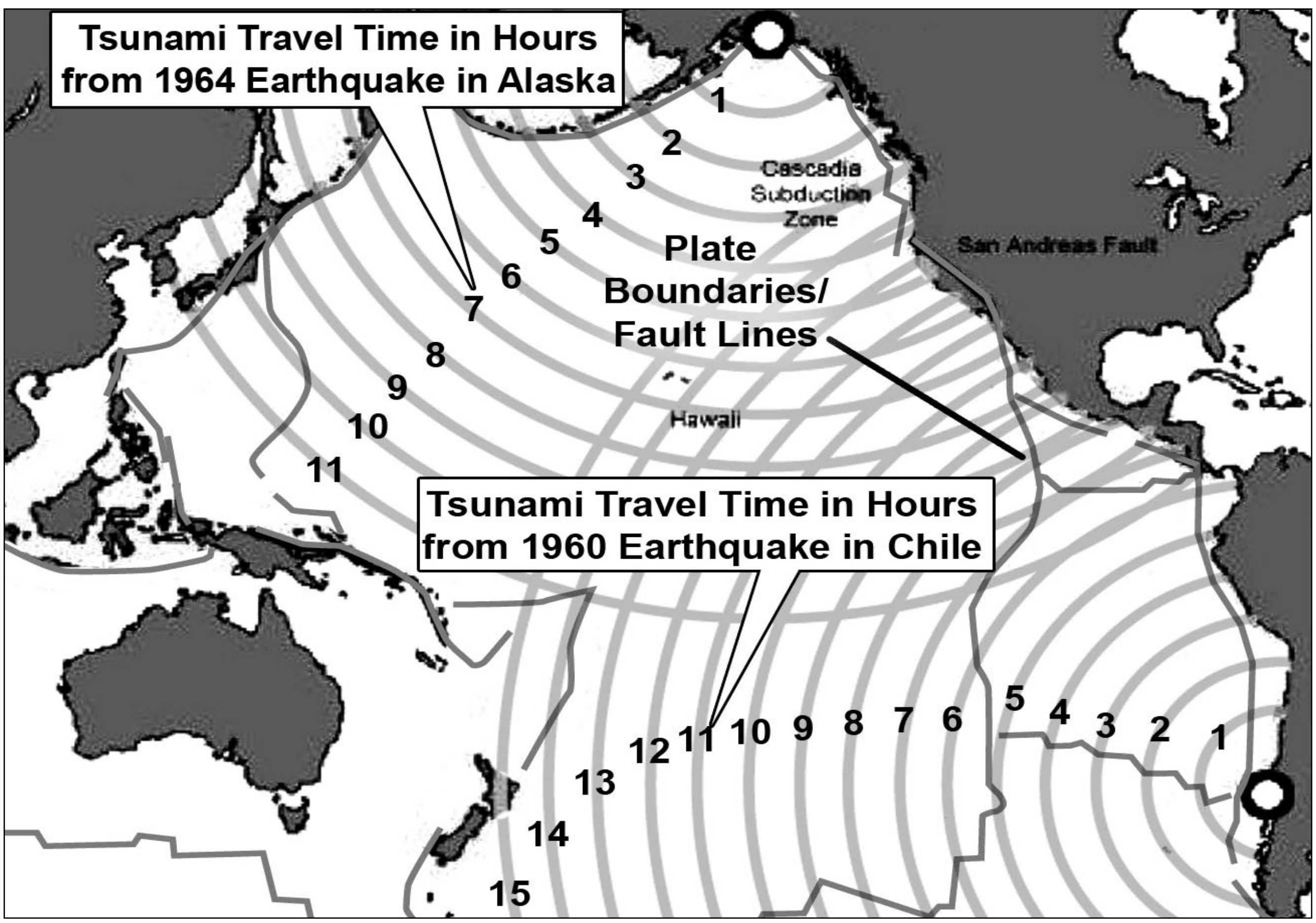


Figure 16-3. Potential Tsunami Travel Times in the Pacific Ocean

Tsunamis Induced by Landslides

The second most common cause of tsunamis is landslides. A tsunami may be generated by a landslide originating above sea level but plunging into the sea, by a landslide occurring mainly beneath the sea level, or by a landslide occurring entirely beneath sea level.

Submarine landslides often occur during a large earthquake. During a submarine landslide, the equilibrium sea level is altered by sediment moving along the sea floor. Hydraulic forces then propagate the tsunami, given the initial perturbation of the sea level. The Hawaiian island chain is flanked by at least 20 large submarine landslides. Sedimentary evidence of landslide-induced tsunamis in Hawaiʻi is believed to have been found 200 feet above sea level on the flanks of the Kohala volcano in the northern tip of the island of Hawaiʻi.

Above-water landslides disturb the water from above the surface. Like submarine landslides, they typically occur during large earthquakes. A tsunami also can be generated by the collapse of the flanks of volcanic islands.

Tsunamis Induced by Submarine Volcanic Explosions

Three island volcanoes are the subject of studies pertaining to their potential to generate destructive tsunamis: Cumbre Vieja volcano on the Island of La Palma in the Canary Islands, and Mauna Loa and Kīlauea volcanoes on the island of Hawaiʻi. Review of submarine geology around Mauna Loa shows evidence of past landslides along the volcano's southwestern flank.

16.2 HAZARD PROFILE

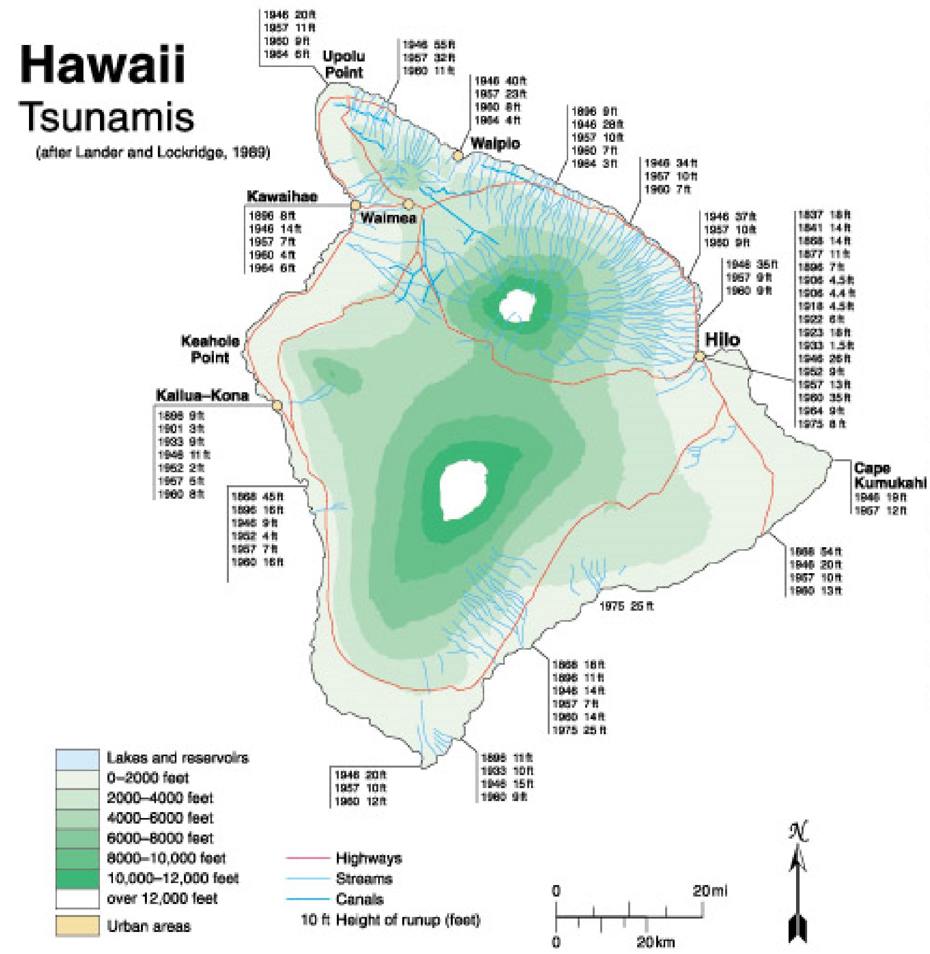
16.2.1 Past Events

The recorded history of tsunamis in Hawaiʻi encompasses several phases according to the availability of recorded data. During the 19th century, numerous tsunamis were reported in newspapers, weeklies, and books written by residents at the time. The cause of tsunamis was not generally known, nor was the origin in terms of whether the tsunami was the result of a distant seismic event or a local submarine landslide. Toward the end of the 19th century, seismological stations became available to record and locate earthquakes. Through the instruments in these stations, it became easier to associate distant earthquakes with tsunamis in Hawaiʻi. The establishment of the Hawaiian Volcano Observatory in 1912 brought the expertise needed to accurately determine the origin and causes of local earthquakes and tsunamis in the islands. After a 1946 tsunami, the Tsunami Warning System was established and a group of experts was constituted to track and document origin, wave heights, and other data pertinent to tsunamis.

Since 1812, 25 tsunamis have adversely impacted the Big Island. Of these, 22 were generated by distant triggers and three were generated by local events (see Figure 16-4 for historical events and run-up heights). Table 16-1 summarizes tsunamis experienced in Hawaiʻi County since 1819.

The most devastating tsunamis to hit the island of Hawaiʻi in this century occurred in 1946 and 1960. In both cases, the worst damage was inflicted on the northeastern coast of the island. The tsunami of 1946 originated in the Aleutian Islands, struck Hawaiʻi without warning, and killed over 170 people, mainly at Laupāhoehoe and Hilo, where the wave heights averaged 30 feet. The maximum wave height was 55 feet at Pololū Valley on the northern tip of the island.

The 1960 tsunami originated in Chile and advanced upon the island from the southeast. Its effects were greatest at Hilo. The arrival time of this tsunami was correctly predicted, but many people failed to heed the warnings, and authorities evacuated an insufficient area of Hilo. As a result, 61 lives were lost as waves up to 35 feet high crashed through homes. Whole city blocks were swept clean of all buildings, and 580 acres were flooded. Reported damage totaled $23 million.



Large tsunamis* (>1m, 3.3 ft) with reported damage in the Hawaiian Islands

Year	Date	Area of origin Magnitude**
1819	Apr 12	N Central Chile M= 2.0
1835	Feb 20	Southern Chile M = 4.0
1837	Nov 7	Southern Chile M = 3.0
1841	May 17	Kamchatka M = 2.0
1868	Apr 3	SE Hawai'i M = 4.1
1868	Aug 13	Northern Chile M = 4.3
1868	Oct 2	South Pacific
1869	Jul 24	South Pacific
1877	May 10	Northern Chile M = 4.0
1878	Jan 20	Aleutian Is (?)
1896	Jun 15	Japan M = 4.0
1901	Aug 9	Tonga
1906	Jan 31	Colombia/Ecuador M = 1.0
1906	Aug 17	Central Chile M = 2.0
1918	Sep 7	Kurils M = 3.6
1919	Oct 2	Hawaii (H = 14 ft)
1922	Nov 11	N Central Chile M = 3.0
1923	Feb 3	Kamchatka M = 3.0
1933	Mar 2	Japan M = 3.0
1946	Apr 1	Eastern Aleutian Is M = 5.0
1952	Mar 17	Hawaii (H = 10 ft)
1952	Nov 4	Kamchatka M = 4.0
1957	Mar 9	Central Aleutian Is M = 3.5
1960	May 22	Chile M = 4.5
1964	Mar 28	Gulf of Alaska M = 4.5
1975	Nov 29	Big Island/Hawai'i (H = 47 ft)

*Reliability of ≥ 3 (of 4)(Lander and Lockridge, 1989), run-up > 1m (3.3 ft), and reported damage.

** Tsunami magnitude is defined by $M = \log_2 H$ as revised by Lida et al. (1967), where H is the maximum run-up height or amplitude on a coastline near the generating area.

Other tsunamis have occurred, such as that of Oct 1994, however, because of their low (<1 m) run-up, insignificant damage, and/or uncertainty surrounding their timing and magnitude as noted in Lander and Lockridge (1989), they were not included here.

Figure 16-4. Tsunamis on the Island of Hawai‘i, 1819 – 1975

Table 16-1. Tsunamis Affecting Hawai‘i County, 1819 to Present

Date	Place of Observation	Source	Meters	Fatalities	Damage
04/12/1819	West Hawai‘i	Chile	2.5	0	Houses destroyed
11/07/1837	Hilo	Chile	2.0	16	100 houses destroyed
05/17/1841	Hilo	Kamchatka	4.6	0	Unknown
04/02/1868	Keauhou Landing	Ka‘ū	13.7	47	Severe in Puna and Ka‘ū
08/13/1868	Hilo	Chile	4.6	0	Houses, bridges destroyed
08/24/1869	SE Puna	South Pacific	8.2	0	Houses destroyed; roads washed out
05/10/1877	Hilo	Chile	4.8	5	Severe in Hilo
06/15/1896	Keauhou	Japan	5.5	0	Houses, wharfs, stores destroyed
10/02/1919	Ho‘ōpūloa	South Kona	4.3	0	Wharf damaged, car swept away
11/11/1922	Hilo	Chile	2.1	0	Fishing boats swept away
02/03/1923	Hilo	Kamchatka	6.1	1	$1,500,000
03/02/1933	Keauhou	Japan	3.2	0	Boathouses, walls destroyed in Kona
04/01/1946	Hilo	Eastern Aleutian Is.	10.7	159	Hilo waterfront was destroyed. $26 million in damage (1946 $)

Date	Place of Observation	Source	Meters	Fatalities	Damage
05/22/1960	Hilo	Chile	10.5	61	$23,000,000
11/29/1975	Keauhou Landing	South Puna	14.3	2	$1,500,000
03/11/2011	Kona	Japan		0	$14,200,000
10/28/2012	Kawaihae, Honokōhau, Honu‘apo, Kapoho, and Hilo	British Columbia	0.09 to 0.56	0	None Reported
11/7/2012	Hilo	Guatemala	0.6	0	None Reported
2/6/2013	Kawaihae, Honokōhau	Santa Cruz Islands	0.07 to 0.09	0	None reported
4/1/2014	Kawaihae, Honokōhau, Honu‘apo, Kapoho, and Hilo	Northern Chile	0.04 to 0.57	0	None reported
9/16/2015	Kawaihae, Hilo	Central Chile	0.27 to 0.01	0	None Reported
11/21/2016	Hawai‘i	Japan	0.09	0	None reported
9/8/2017	Hilo	Mexico	0.17	0	None reported

The tsunamis of 1868 and 1975 were locally generated by earthquakes beneath the southern coast of the island. The 1868 waves destroyed several coastal villages in the Ka’ū and Puna districts, most of which were never rebuilt. The 1975 tsunami claimed two lives and caused widespread damage along the Kalapana coast.

In March 2011, tsunami waves from the Great East Japan Earthquake flooded portions of west Hawai‘i, leading to about $30 million in damage (major disaster declaration issued on April 8, 2011):

- Seven homes suffered extensive damage on Manini Beach Road near Kealakekua Bay. Power lines also were downed in the area.
- One two-story home at Kealakekua Bay was reported completely washed away, and a number of vehicles in the area were damaged.
- King Kamehameha’s Kona Beach Hotel on Ali’i Drive suffered extensive water damage to its ground floor, and observers reported possible damage to the Ahu’ena Heiau on the hotel grounds. Shops across Ali’i Drive from the hotel also suffered extensive damage.
- Large amounts of asphalt, concrete and other debris were thrown onto Ali’i Drive near the hotel and near the breakwall at the edge of Ali’i Drive. Large amounts of debris were also deposited on Kailua Pier, and two vehicles left parked on the pier were damaged when the tsunami pushed them across the pier.
- The county Department of Environmental Management reported water damage to a sewer pump station near King Kamehameha’s Kona Beach Hotel.
- Extensive damage was reported to businesses on both sides of Ali’i Drive, including the Bubba Gump Shrimp Company, the ground floor of the Kona Reef Hotel, and the Kona Inn Restaurant.
- In Kailua-Kona, crews reported one single-family home was destroyed, and one suffered major damage. Six Kailua apartments or condominiums suffered major damage, and 19 had minor damage.
- The Kona Village Resort had 20 guest units damaged when they were lifted off their foundations. Two restaurants at the resort were flooded.
- The Four Seasons Resort Hualālai reported water damage to utility buildings, pools and damage to a restaurant at the resort.

16.2.2 Location

Detailed FEMA flood studies were conducted on the entire coastline of Hawai‘i to determine tsunami inundation limits. Figure 16-5 shows the tsunami inundation mapping for the planning area; detailed area maps are provided in Appendix B.

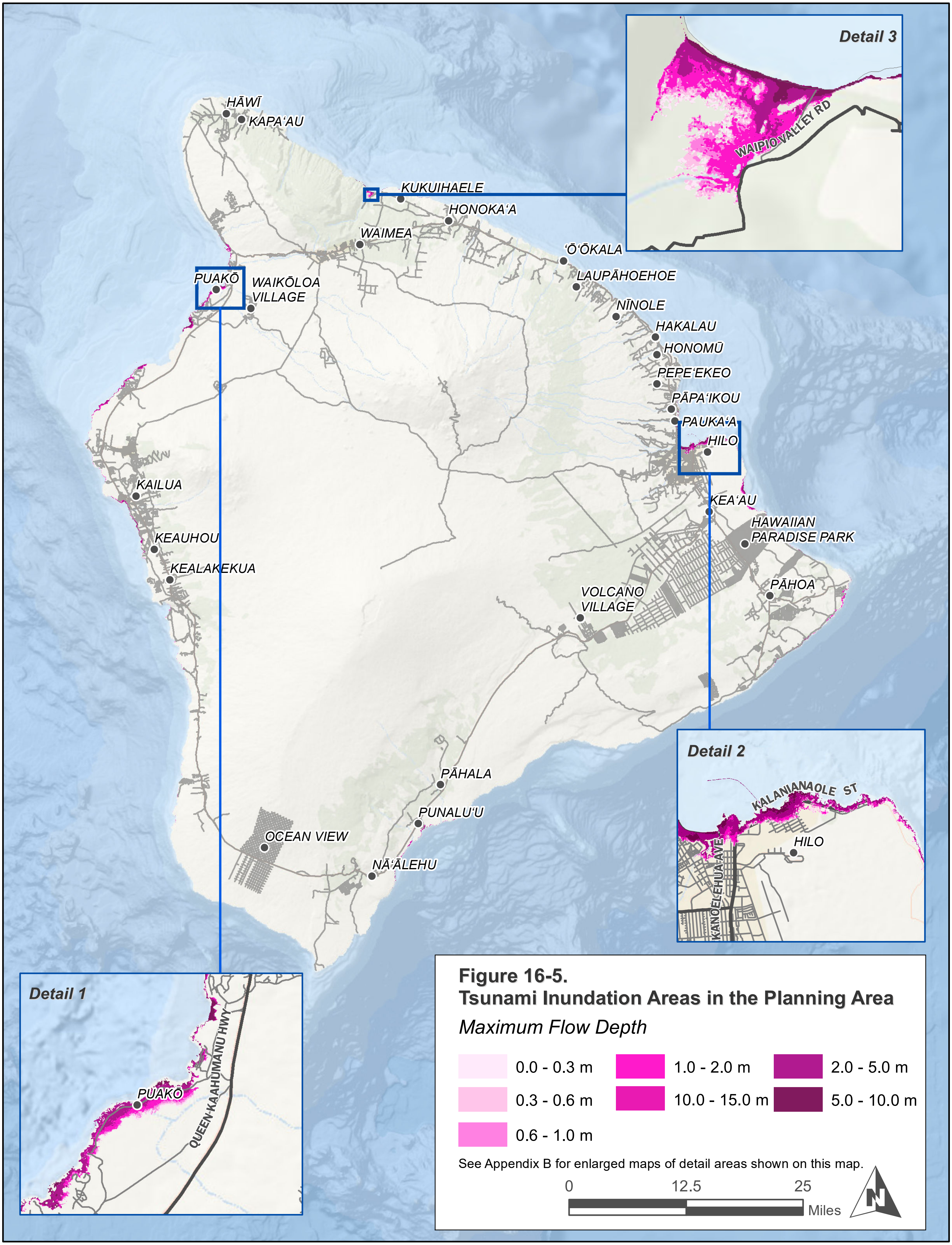


Figure 16-5.
Tsunami Inundation Areas in the Planning Area

Maximum Flow Depth

0.0 - 0.3 m
0.3 - 0.6 m
0.6 - 1.0 m
1.0 - 2.0 m
10.0 - 15.0 m
2.0 - 5.0 m
5.0 - 10.0 m

See Appendix B for enlarged maps of detail areas shown on this map.

16.2.3 Frequency

Distant tsunamis have an annual probability of affecting Hawaiʻi of roughly 10 percent. Local tsunami events occur with a roughly 2 percent probability in a year.

16.2.4 Severity

According to the National Tsunami Hazard Mitigation Program, tsunami events with run-ups of more than 1 meter (about 3 feet) are the most likely to be dangerous to people and property.

16.2.5 Warning Time

Typical signs of a tsunami hazard are earthquakes and/or sudden and unexpected rise or fall in coastal water. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean because waves are often less than 3 feet high.

The Pacific Tsunami Warning System evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service operates two regional information distribution centers: one located in Ewa Beach, Hawaiʻi; and the other in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the Pacific warning system.

The warning system only begins to function when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.
- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to agencies that relay it to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

This system is not considered to be effective for communities located close to the tsunami-generating source because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

In addition, NOAA as part of the U.S. National Tsunami Hazard Mitigation Program, implemented the Deep-Ocean Assessment and Reporting of Tsunami (DART) project to ensure detection of tsunamis and to acquire data critical to real-time forecasts. DART systems consist of an anchored seafloor bottom pressure recorder and a moored surface buoy for real-time communications. An acoustic link transmits data from the recorder on the seafloor to the surface buoy. The surface buoy transmits data to the National Weather Service Telecommunications Gateway, which then distributes it in real-time to the Tsunami Warning Centers. Figure 16-6 depicts the operation of the DART System (County of Maui, 2015).

16.2.6 Secondary Hazards

Port facilities, naval facilities, fishing fleets and public utilities are often the backbone of the economy of the affected areas, and these are the resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

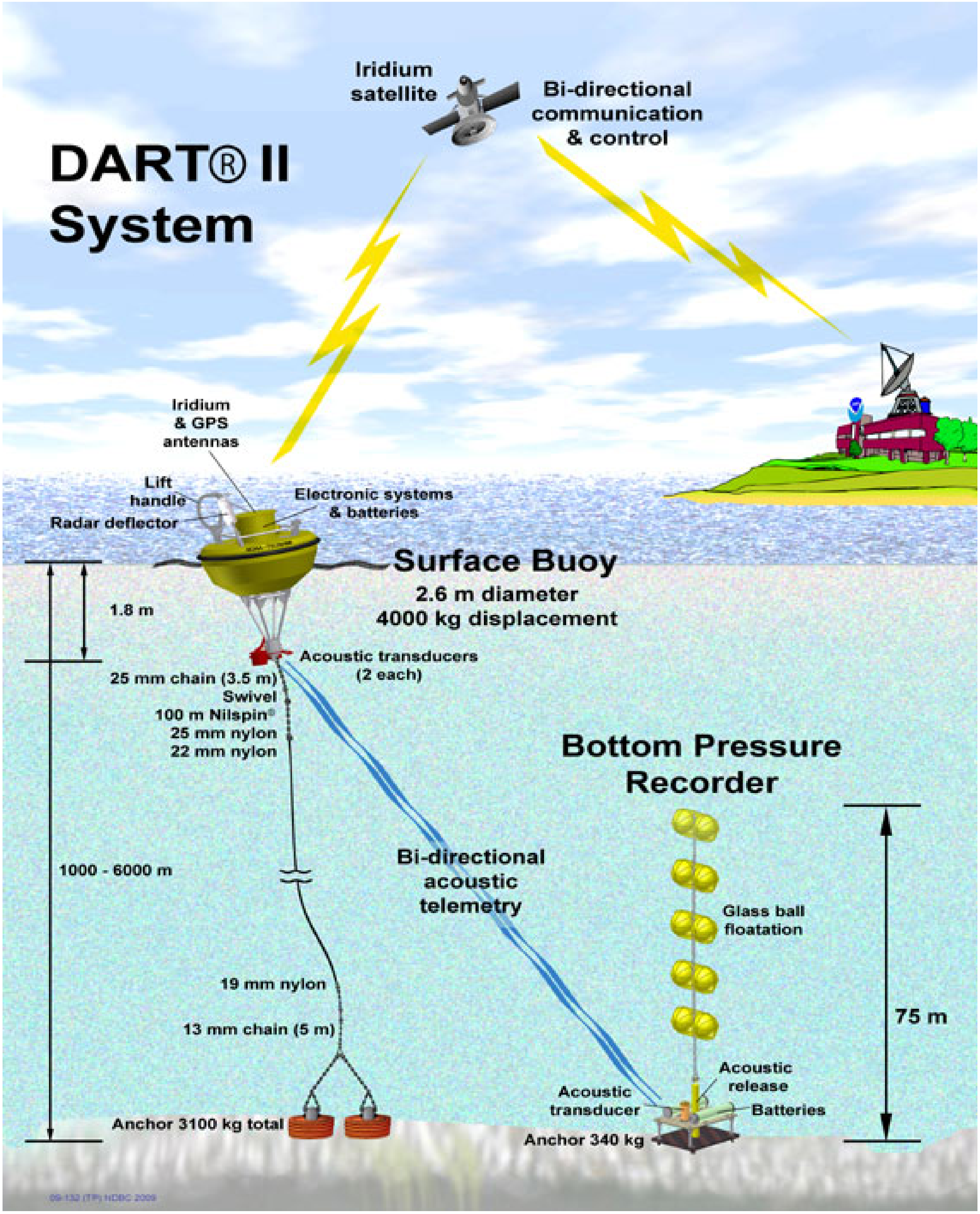


Figure 16-6. DART II System

16.3 EXPOSURE

Exposure and vulnerability estimates are based on tsunami inundation maps. The value of exposed buildings in the tsunami inundation zone within the planning area was generated by overlaying the inundation areas on the general building stock. The population living in tsunami hazard zones was estimated using the percent of buildings within the tsunami inundation areas and applying this percent to the estimated planning area population. Detailed results by district are provided in Appendix F; results for the total planning area are presented below.

16.3.1 Population and Property

Table 16-2 summarizes the estimated population living in the evaluated tsunami inundation areas and the estimated property exposure. The populations that would be most exposed to this type of hazard are those along beaches, low-lying coastal areas, tidal flats and stream deltas that empty into ocean-going waters. People recreating in these areas would also be exposed.

Table 16-2. Exposed Population and Property in the Tsunami Inundation Zone

Population	
Population Exposed	5,190
% of Total Planning Area Population	2.71%
Property	
Number of Buildings Exposed	2,562
Value of Exposed Structures	1,765,245,684
Value of Exposed Contents	1,311,145,649
Total Exposed Property Value	3,076,391,333
Total Exposed Value as % of Planning Area Total	5.29%

16.3.2 Critical Facilities and Assets

Figure 16-7 provides an estimate of the number and types of critical facilities exposed to the tsunami hazard.

Roads

Roads are the primary resource for evacuation to higher ground before and during a tsunami event. Roads that are blocked or damaged can isolate residents and prevent access for emergency service providers. Roads often act as flood control facilities in low depth, low velocity flood events by acting as levees or berms and diverting or containing flood flows. Hazus indicated that the following major roads may be impacted by tsunami events:

- Akoni Pule Highway
- Hawai‘i Belt Road
- Kalaniana‘ole Avenue
- Kalapana-Kapoho Beach Road
- Kamehameha Avenue
- Kanoelehua Avenue
- Palani Road
- Puuhonua Road
- Waiānuenue Avenue

This list of roads should not be misinterpreted as possible evacuation routes for tsunami events. Evacuation routes are identified in emergency response plans.

Bridges

Bridges washed out or blocked by tsunami inundation or debris also cause isolation. Bridges can be extremely vulnerable due to forces transmitted by wave run-up and by the impact of debris carried by waves. Hazus identified 12 bridges that would be exposed to the tsunami scenario event.

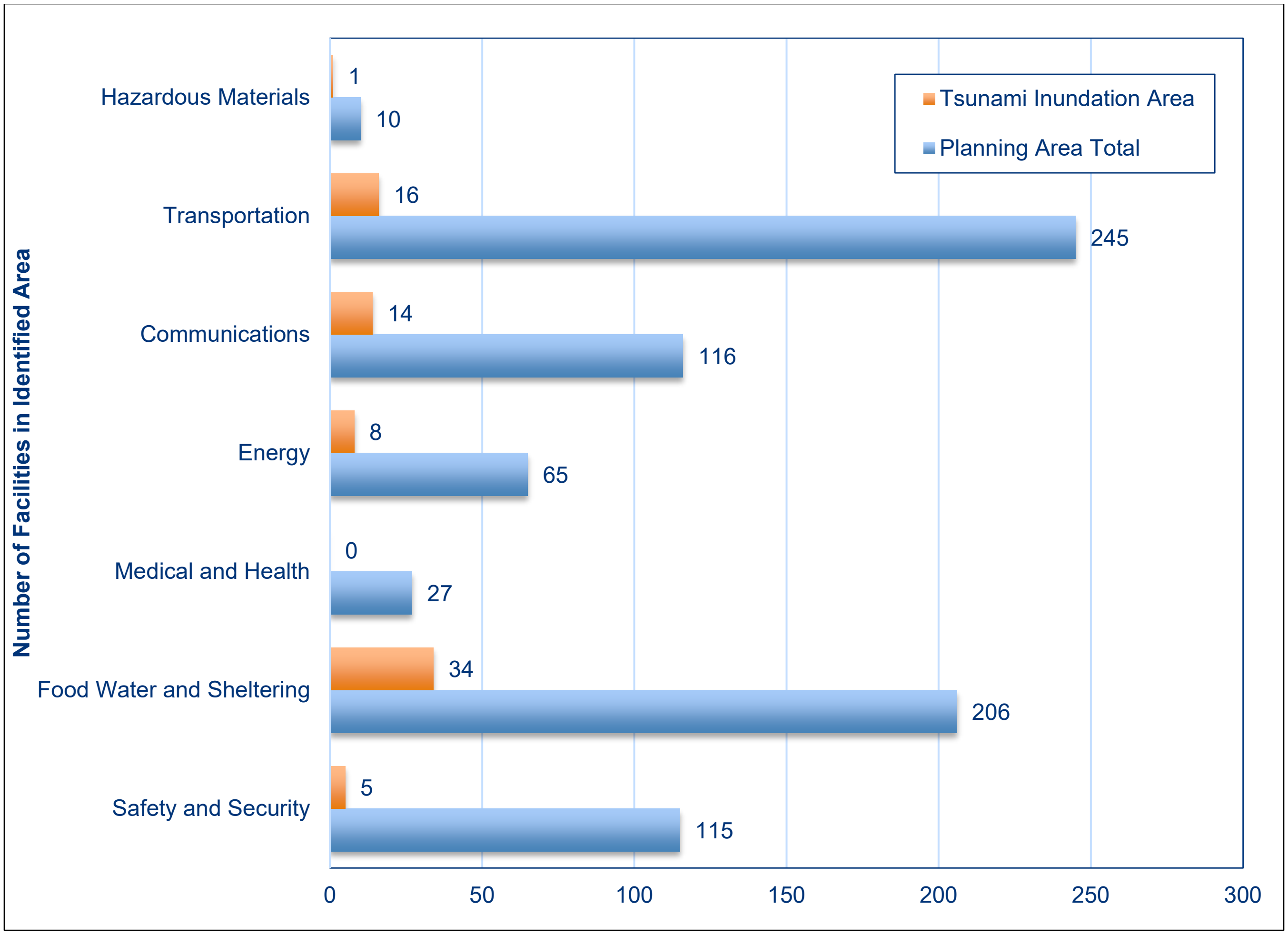


Figure 16-7. Critical Facilities in Tsunami Inundation Areas

Ports / Fuel Farms

In general, due to their locations, all ports and fuel farms within Hawai'i County are vulnerable to inundation by a tsunami. Depending on the strength and location of the tsunami, ports and fuel farms could sustain damage from water and debris that would render them out of commission for months, exacerbating the disaster.

Water/Sewer/Utilities

Water and sewer systems can be flooded or backed up, causing further health problems. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by flood debris, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams. The forces of tsunami waves can impact above-ground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the impact of the wave action and the inundation of floodwaters. Underground utilities can also be damaged during flood events.

Toxic Release Inventory Reporting Facilities

Toxic Release Inventory facilities are known facilities that manufacture, process, store or other wise use certain chemicals above minimum thresholds. If damaged by a tsunami, these facilities could release chemicals that cause cancer or other significant adverse human health effects, as well as significant adverse environmental effects

(U.S. EPA, 2016). During a tsunami event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment and people. Three facilities in the tsunami inundation area are Toxic Release Inventory reporting facilities.

16.3.3 Environment

All waterways would be exposed to the effects of a tsunami; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area also is exposed. Depending on the size and associated force of a tsunami event, Hawaiʻi County's coral reefs may be exposed to increased pressure caused by an incoming tsunami. Additionally, based on how far inland the tsunami reaches, hazardous waste and other materials may be pulled into the ocean by retreating waters, disturbing the natural habitat of the coral reef.

16.4 VULNERABILITY

16.4.1 Population

The populations most vulnerable to the tsunami hazard are the elderly, disabled and very young who reside or recreate near beaches, low-lying coastal areas, tidal flats and stream or river deltas that empty into ocean-going waters. Visitors recreating in or around inundation areas would also be vulnerable as they may not be as familiar with residents on appropriate responses to a tsunami or ways to reach higher ground. In the event of a local tsunami generated in or near the planning area, there would be little warning time, so more of the population would be vulnerable. The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Will the people evacuate when warned?

For this assessment, the population vulnerable to possible tsunami inundation is considered to be the same as the exposed population.

16.4.2 Property

All structures along beaches, low-lying coastal areas, tidal flats and stream or river deltas would be vulnerable to a tsunami, especially in an event with little or no warning time. The impact of the waves and the scouring associated with debris that may be carried in the water could be damaging to structures in the tsunami's path. Those that would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound.

No model was available for a quantitative vulnerability analysis of the tsunami hazard. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 16-3 shows the general building stock loss estimates in the tsunami inundation areas.

Table 16-3. Loss Potential for Tsunami

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Loss = 1% of Exposed Value	$3.1 Billion	$30.8 Million	Less than 1%
Loss = 10% of Exposed Value		$307.6 Million	Less than 1%
Loss = 30% of Exposed Value		$922.2 Million	1.59%
Loss = 50% of Exposed Value		$1.5 Billion	5.29%

16.4.3 Critical Facilities and Assets

A more in-depth analysis of the mitigation measures taken by critical facilities in the tsunami inundation area to prevent damage from tsunami events should be done to determine if they could withstand impacts of a tsunami.

16.4.4 Environment

The vulnerability of aquatic habit and associated ecosystems would be highest in low-lying areas close to the coastline. Areas near gas stations, industrial areas and hazardous material containing facilities would be vulnerable due to potential contamination from hazardous materials.

Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment, including onshore and offshore reef habitat. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami. There are currently no tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the tsunami hazard.

16.5 FUTURE TRENDS IN DEVELOPMENT

Figure 16-8 shows the land use distribution by area within the tsunami inundation areas. About 70 percent of the land in these areas is agricultural or open area. Residential parcels (apartment and residential) make up 10.9 percent of the total acreage.

The County does not currently have regulatory provisions for identified tsunami hazard areas. There is some overlap between the County's regulated floodplains and the tsunami impact areas assessed by this plan. However, with historical run-up levels reaching up to 14.3 meters on the island of Hawaiʻi, standard floodplain development regulation may not provide adequate risk protection for new development. Once deterministic data and science can be applied to official mapping with assigned probabilities of occurrence, Hawaiʻi County may want to consider higher regulatory provisions for new development in high risk tsunami inundation areas.

16.6 SCENARIO

A tsunami in Hawaiʻi can be generated by a landslide or by a nearby or distant earthquake. Several scenarios could create large tsunami events and greatly impact Hawaiʻi County. One scenario includes a local tsunami event triggered by a collapse of a flank of Mauna Loa or Kīlauea in Hawaiʻi County. Review of submarine geology indicates historical landslides along these flanks have occurred, another flank collapse is possible. This would probably be very damaging, giving little or no warning time. This could result in great loss of life and property and cause severe environmental impacts (Oskin, 2012).

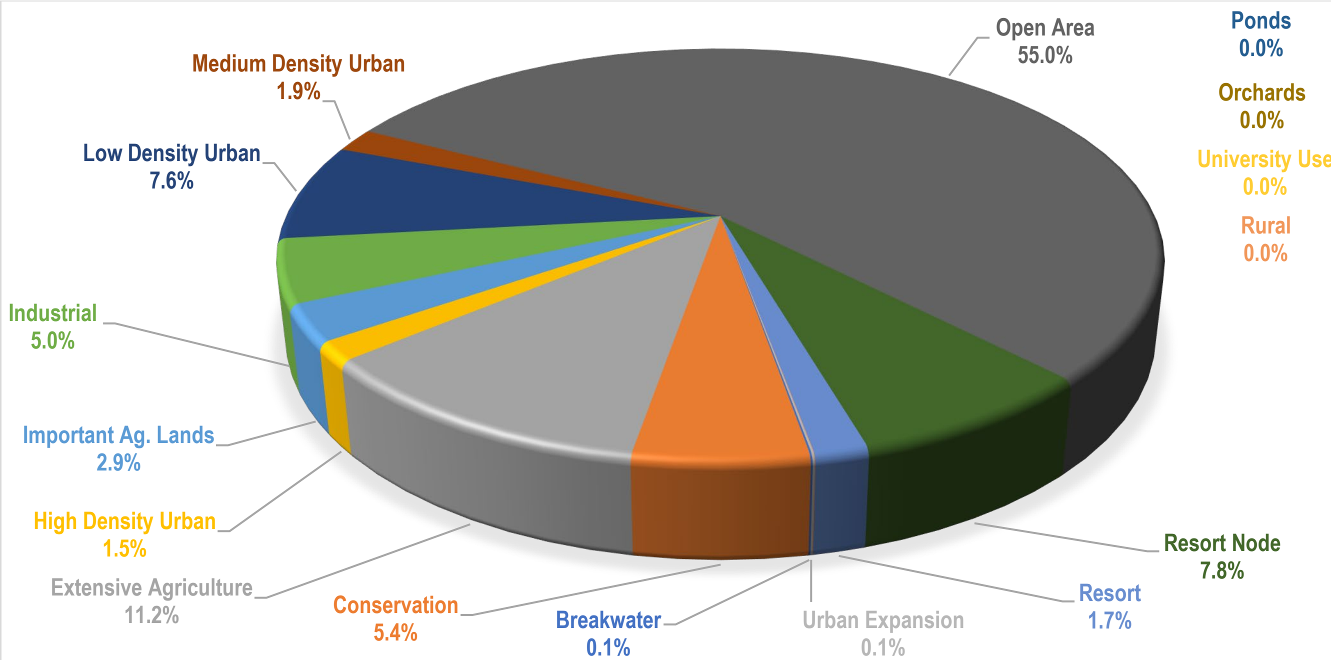


Figure 16-8. Land Use Distribution by Area in the Tsunami Inundation Area

16.7 ISSUES

The following are issues related to the tsunami hazard for the planning area:

- **Hazard Identification**—To truly measure and evaluate the probable impacts of tsunamis on planning, new hazard mapping based on probabilistic scenarios likely to occur needs to be created. The science and technology in this field are emerging. For tsunami hazard mitigation programs to be effective, probabilistic tsunami mapping will need to be a key component.
- **Building Code Revisions**—Present building codes and guidelines do not adequately address the impacts of tsunamis on structures, and current tsunami hazard mapping is not appropriate for code enforcement.
- **Enhancement of Current Capabilities**—As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning.
- **Vulnerable Populations Planning**—Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education and outreach. This may be especially true for visitors to Hawai‘i County.
- **Debris Accumulation**— Significant debris would be produced as a result of a major tsunami impacting the planning area and could be exacerbated by damage caused by the earthquake that preceded it.
- **Climate Change Impacts**—With the future impacts from climate change, the issue of sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.

17. VOLCANIC ERUPTION

17.1 HAZARD DESCRIPTION

17.1.1 Volcano Formation and Activity

The Hawaiian Islands are geophysically young land masses caused by tectonic and volcanic activity within the Pacific Ocean. The islands were created by a hotspot beneath the Earth's crust over which Hawai'i County is currently located. Scientists theorize that the hotspot is stationary and that, over millions of years, the Pacific tectonic plate has drifted in a northwesterly direction over the plume at about 9 centimeters a year, resulting in the chain of Hawaiian Islands. The island of Kaua'i is the oldest of the main islands at about 5 million years old, and the island of Hawai'i is about 700,000 years old (USGS, 1999; Wayman, 2011).

The volcanoes formed by this hot spot are shield volcanoes, which are the largest volcanoes on earth. Lava from shield volcanoes consists almost entirely of basalt, which is very fluid, so the lava flows for long distances, resulting in the volcanoes' gentle slopes (Figure 17-1).

Source: USGS, 2019j

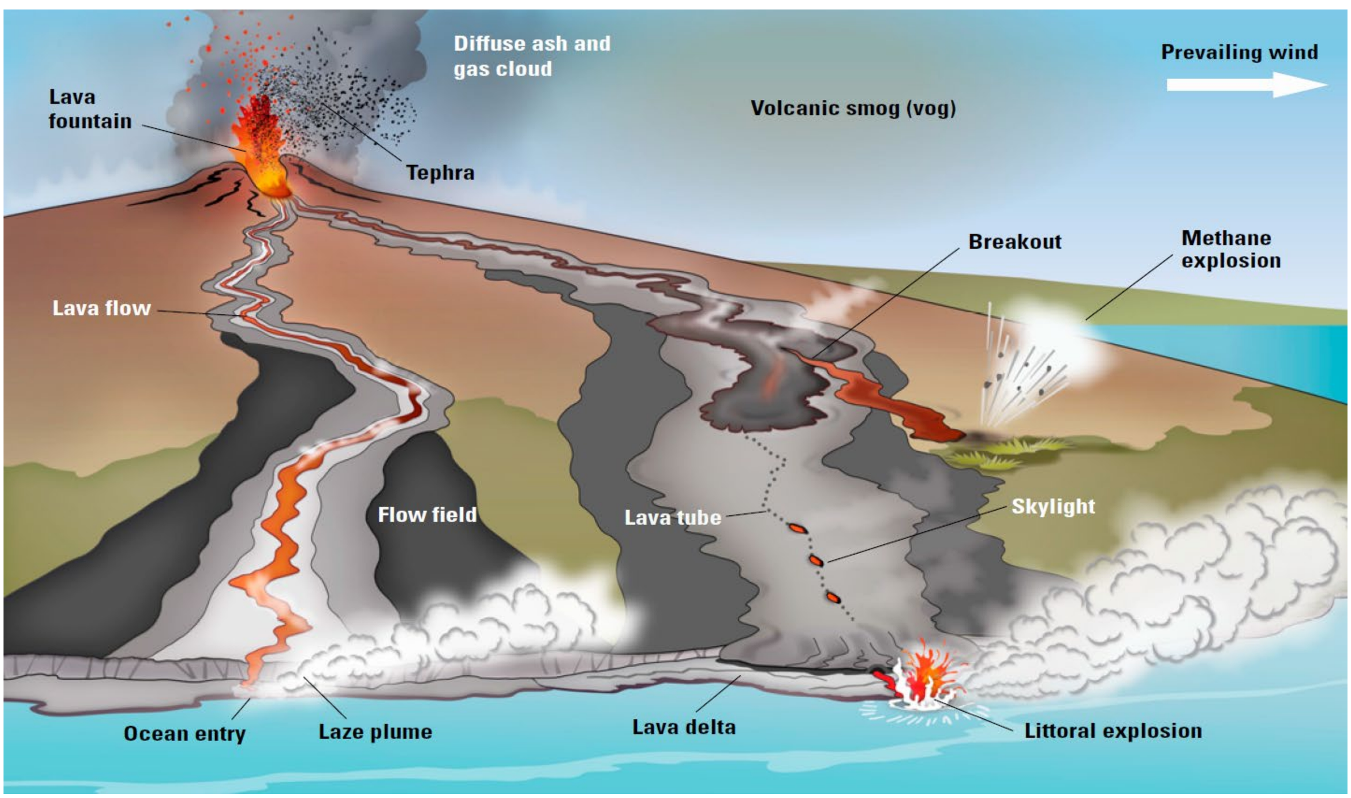


Figure 17-1. Features of a Shield Volcano with Lava Fields

17.1.2 Volcanic Hazards

The County of Hawaiʻi collaborated with the USGS Hawaiian Volcano Observatory (HVO) to identify the following volcanic hazards:

- Lava flow
- Laze
- Volcanic smog (vog)
- Acid rain
- Explosive eruption
- Ashfall
- Volcanic glass
- Earthquake
- Ground failure / subsidence
- Tsunami

The earthquake hazard is addressed in Chapter 10 of this hazard mitigation plan and tsunami is addressed in Chapter 16. The remaining volcano-related hazards are described in the sections below.

Lava Flow

Lava flows typically erupt from a shield volcano's summit (summit caldera) or along rift zones on its flanks. Rift zones are locations where the volcano is splitting apart ("rifting"). The rock in these zones is cracked and weak, so magma can rise through the zones to the surface. From there the lava flows downhill, following the slope of the surrounding land surface (University of Hawaiʻi, 2020). The very active Puʻu ʻŌʻō vent in Hawaiʻi County is in the eastern rift zone of the Kīlauea volcano.

Lava flows present potential threats to homes, infrastructure, natural and historic resources and entire communities. They travel downslope toward the ocean, burning and burying everything along the way. Steep slopes may allow lava to flow quickly from the vent to the ocean in a matter of hours (State of Hawaiʻi, 2013). Lava entering the ocean can build new land known as lava deltas, which can be unstable and prone to sudden collapse. A collapsing lava delta can trigger local explosive activity that hurls hot rocks hundreds of yards inland and/or seaward (USGS, 2017m). The types of explosions are known as hydrovolcanic explosions and can be deadly. Explosions of this type occurred periodically throughout Kīlauea's East Rift Zone eruption (USGS, 2020d).

Lava flow hazard zones are developed based on the location and frequency of historic and prehistoric eruptions, assuming that future eruptions will be similar to those in the past (Heliker, 1990). Historic eruptions are defined as those for which there are written records, beginning in the early 1800s, and those that are known from the oral traditions of Hawaiians. Knowledge of prehistoric eruptions is based on geologic mapping and dating of the old flows of each volcano. The hazard zones also take into account the larger topographic features of the volcanoes that affect the distribution of lava flows. Hazard zones are based on rate of coverage by lava, not probability (Wright et al., 1992). Actual hazard can vary in severity within a single hazard zone due to local topography.

Laze

Laze is formed when molten lava enters the ocean, creating a cloud of steam that contains other harmful components. The plume is an irritating mixture of gaseous hydrochloric acid (HCl), steam, and tiny volcanic glass particles. This product can travel with the wind and is considered a hazard for persons downwind or along the coasts and inland where winds blow it from lava ocean entries (USGS, 2019f).

Volcanic Smog

Vog is a hazy mixture of sulfur dioxide (SO_2) gas and aerosols (tiny particles or droplets), which are primarily sulfuric acid and other sulfate (SO_4) compounds. Aerosols are created when SO_2 and other volcanic gases combine in the atmosphere and interact chemically with oxygen, moisture, dust, and sunlight.

These airborne hazards created by volcanic activity exacerbate health hazards to people in any of the following "sensitive group" categories:

SO_2 is irritating to the eyes, nose, throat and respiratory tract. Short-term exposure to elevated levels may cause inflammation and irritation, resulting in burning of the eyes, coughing, difficulty in breathing and a feeling of chest tightness. Prolonged or repeated exposure to higher levels may increase the danger. Individuals who belong to any of the following "sensitive group" categories may respond to very low levels of SO_2 in the air:

- People with asthma or other respiratory conditions
- People with cardiovascular disease
- Older adults
- Infants and children
- New or expectant mothers

Sulfuric acid droplets in vog have the corrosive properties of diluted battery acid. They increase corrosion to any exposed metal along the path of the downwind plume. Even in relatively dry downwind areas, severe corrosion will generate significant economic losses. The most likely process driving the corrosion is dew formation; during the evening, as the dew point temperature is approached, the acid aerosols form a corrosive film on metallic surfaces. When vog mixes directly with moisture on the leaves of plants, it can cause chemical burns that can damage or kill the plants. SO_2 gas can also diffuse through leaves and dissolve to form acidic conditions within plant tissue.

Vog can have both short- and long-term economic consequences. Due to its respiratory effects on people, particularly severe occurrences of vog can disrupt the tourism industry. Visitors may cut trips short or spend more time indoors, causing a temporary dip in the local economy. Long-term effects of vog include corrosion of steel structures. Over the years, this corrosion can lead to structural instability that necessitates remedial action.

Acid Rain

Volcanic acid rain can be caused by plume gases and SO_2 released from volcanic eruptions (USGS, 2018j). Acid rain contains high concentrations of SO_2 in volcanic gas emissions. If SO_2 concentrations increase, there is a higher chance that acid rain will take place. Volcanic acid rain can cause a variety of problems for infrastructure and has negative health impacts (USGS, 2019i; USGS, 1997):

- Corrosion of infrastructure and impacts on drinking water
- Leaching of lead from roofing and plumbing materials, which can contaminate drinking water in rooftop rainwater-catchment systems
- Damage to eyes
- Impacts on the mucous membranes
- Health impacts on the respiratory system

The effects of acid rain can be exacerbated if SO_2 creates sulfate aerosols, which are extremely toxic in high concentrations (USGS, 2017o).

Explosive Eruption

Debris and hazardous materials from explosive eruptions can be ejected vertically to an altitude of 35,000 feet reaching the subtropical jet stream. These explosions can also create surges of pyroclastic flows—consisting of hazardous products like hot ash, hot gas, and hot lava—that hug the ground and can travel at hurricane speeds.

Explosive volcanic eruptions can produce a variety of ejecta products, some of which can affect communities and farmland across hundreds, or even thousands of miles. Ejected materials include the following (State of Hawaiʻi, 2018):

- Tephra—Fragments of rock that are ejected into the air when a volcano erupts explosively.
- Large fragments (blocks, bombs) of rock—Tephra larger than 2.5 inches that is usually deposited near the eruptive vent.
- Smaller fragments (lapilli) of ash—Tephra between 0.08 and 2.5 inches that can be carried upward within in a volcanic plume and downwind in a volcanic cloud.
- Very fine-grained material volcanic ash—Tephra smaller than 0.08 inches that is easily carried upward within the plume and downwind for very long distances.

Ashfall

Volcanic ash is a primary hazard from eruptions that can affect structures, power facilities, water systems, ground and air transportation, agriculture, and human health (USGS, 2018i). This hazard is dispersed by wind. It can also fall as a very wet and slick material that covers buildings and infrastructure.

Health experts advise the public to be aware of ashfall locations to minimize exposure. For fine ash particles, individuals with high exposure can breathe in ash and experience symptoms such as nasal irritation and discharge, throat irritation and sore throat, and airway irritation (IVHHN, 2019). Coarser ash particles can cause eye irritation and skin irritation (specifically for ash that is acidic). Even persons with high tolerance to ashfall can experience indirect health effects because it creates risks, such as reducing visibility during driving, shutting down critical infrastructure that depends on power supply, contaminating water or damaging water supplies, disabling municipal sanitation systems, or collapsing roofs due to its weight.

Volcanic Glass

Volcanic glass forms when molten lava cools too quickly for crystals to form, leaving a skin of glass on the lava surface. Molten lava that is ejected into the air forms bits of volcanic glass when cooled. Some of the molten droplets get spun in the air and form basaltic glass fibers called Pele's hair. These are also produced by spattering and/or fountaining lava in vents. HVO has issued warnings to avoid exposure because this type of glass can cause skin and eye irritation similar to volcanic ash (USGS HVO, 2018). Communities also have been warned to avoid walking along glassy lava flow surfaces, which are unstable and can cause cuts and abrasions due to the sharpness of the material.

Ground Failure / Subsidence

Underground magma injections and ground shaking from strong earthquakes can produce ground fractures and lead to subsidence, which impacts the environment, human activity, and infrastructure (USGS, 2018d). Subsidence most commonly occurs at the summits or rift zones of active volcanoes during magma intrusions and eruptions. Further, ground failure can occur in areas around active vents that have been drained of magma (USGS, 2018d). The lack of support can create pit craters that are dozens of yards across.

17.2 HAZARD PROFILE

17.2.1 Location

Volcano Locations and Descriptions

The USGS categorizes volcanoes as active if they have erupted in the last 10,000 years and have the potential to erupt again. There are five volcanoes located in the County of Hawai‘i, four of which are considered active. A sixth volcano, which is also active, is an underwater seamount just offshore from the island of Hawai‘i. Locations are shown in Figure 17-2.

Base Map from Google Maps

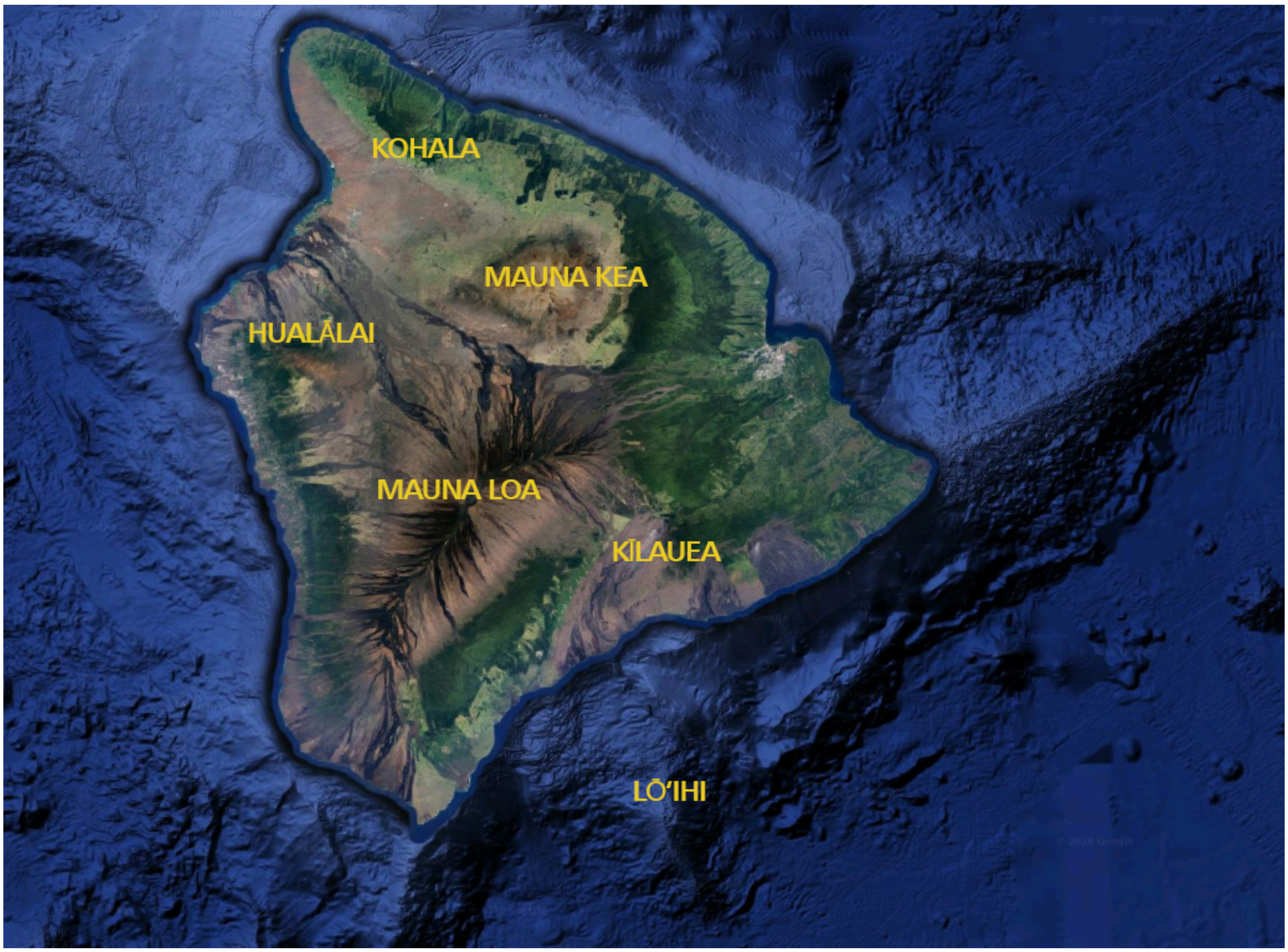


Figure 17-2. Volcanoes in the County of Hawai‘i (Lō‘ihi Underwater Detail at Right)

Kohala, considered unlikely to erupt, is the oldest volcano on the island and last erupted approximately 60,000 years ago. Lō‘ihi, the youngest, is 22 miles southeast of the Island of Hawai‘i, forming an intermittently active submarine volcano on the ocean floor. Kīlauea is in near constant, vigorous activity producing fluid basalts that are expanding the boundaries of the island to the south and encroaching on the southern flank of Mauna Loa. Mauna Loa, continues to discharge fluid basalts at much higher volume rates during its eruptive episodes. Mauna Kea, which last erupted about 4,500 years ago, and Hualālai are less active but typically produce more viscous and more explosive lavas (State of Hawai‘i, 2018). Table 17-1 summarizes basic information about each volcano.

Table 17-1. Volcanoes in or Near the County of Hawai‘i

Volcano	Age	Last Eruption	Threat Potential / Areas at Risk
Kīlauea	210,000 to 280,000 years	April to September 2018	Very high threat potential; areas at risk include portions of the Puna district; eruptions on the southwest flank of Kīlauea are a threat to land within the Hawai‘i Volcanoes National Park and the district of Ka’ū. Summit eruptions are a continued threat for surrounding areas in the Puna district, including Volcano Village.
Mauna Loa	0.6 to 1 million years; 300,000 years above sea level	1984 (eruption lasted 22 days)	Very high threat potential along rift zones and summit; areas at risk include the districts of South Hilo, Puna, Ka‘ū, South Kona, North Kona and South Kohala. Radial vents located on the southwest, west and north flanks (outside the rift and summit regions) pose serious potential risk to persons and property on the north, west and southwest flanks.
Mauna Kea	At least 1 million years	6,000 to 4,000 years ago	Moderate threat potential
Hualālai	>300,000 years above sea level	1801	High threat potential; areas at risk include the land within the North Kona district
Lō‘ihi (underwater)	<300,000 years	1996	Low to very low threat potential
Kohala		60,000 years ago	Considered unlikely to erupt

Mauna Loa is the largest active volcano on Earth. Its above-ground surface area of 1,900 square miles covers over half the County. Scientists have determined that this volcano emerged above sea level about 300,000 years ago and has been growing rapidly upward since then. This volcano also includes submarine flanks, which have been mantled by landslide deposits. It is believed that one of these deposits produced a giant tsunami about 105,000 years ago. A steep-sided rift zone of Mauna Loa’s southeastern flank, called the Nīnole Hills, has experienced erosion that created deep canyons and valleys where old flows occurred (USGS, 2017e). Mauna Loa has a summit caldera and two radiating rift or fracture zones. Its eruptions can occur at the summit, from vents on the southwest rift zone and the east rift zone, and on the north and northwest flanks of the volcano.

Kīlauea is one of the world’s most active volcanoes and over 90 percent of its surface is covered by lava less than 1,100 years old. All of its recent eruptions have occurred either at its summit, or along one of two rift zones that extend from the summit to the coastline on the east and southwest flanks of the volcanoes.

Hualālai has not erupted since 1801. That eruption produced lava flows that appear to have been more fluid than flows from similar eruptions on Kīlauea and Mauna Loa (USGS, 2017i). Eruption activity on Hualālai has been far less frequent, with 25 percent of the volcano covered by flows less than 1,000 years old. Hualālai has erupted near its summit, along the northwest and south-southeast rift zones and from vents on the north flank of the volcano.

Hazard-Specific Location Information

Lava Flow

The U.S. Geological Survey first prepared maps showing volcanic hazard zones in Hawai‘i County in 1974. The current (1992) revised map divides the island into zones that are ranked from 1 through 9 based on the historical probability of coverage by lava flows (see Figure 17-3). The mapped lava zone boundaries are approximate and not specific enough to determine the absolute degree of danger at any particular site. The lava-flow hazard zones are designed to show the relative hazard across the island and meant to be used for general planning purposes only (USGS HVO, 1992). Table 17-2 provides the definitions of the mapped lava flow hazard zones.

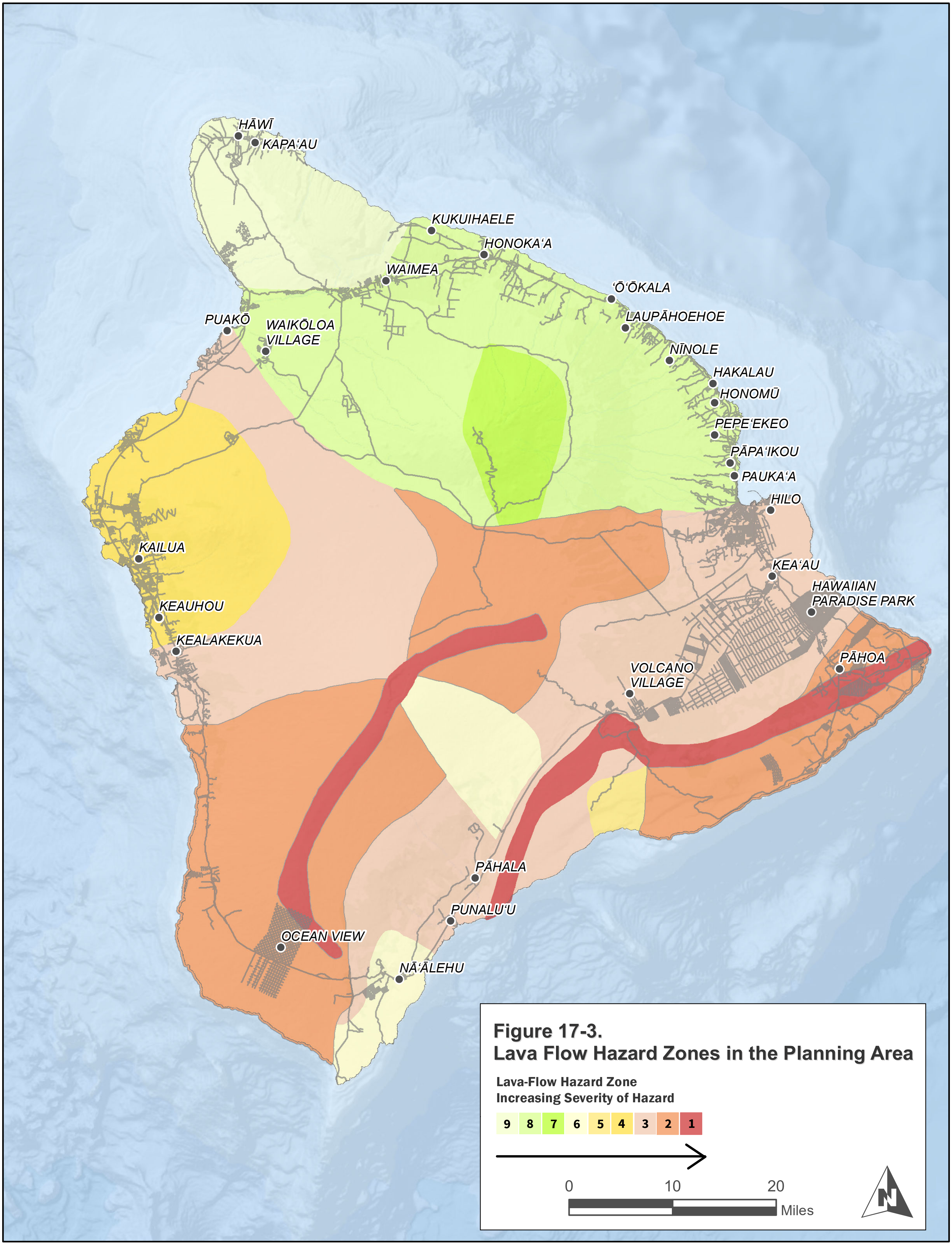


Figure 17-3.
Lava Flow Hazard Zones in the Planning Area

Table 17-2. Hazard Zones for Lava Flows

Zone	Percent of Area Covered by Lava Since 1800	Percent of Area Covered by Lava in Last 750 Years	Description
Zone 1	>25%	>65%	Includes the summits and rift zones of Kīlauea and Mauna Loa where vents have been repeatedly active in historic time.
Zone 2	15-25%	25-75%	Areas adjacent to and downslope of Zone 1.
Zone 3	1-5%	15-75%	Areas less hazardous than Zone 2 because of greater distance from recently active vents and/or because the topography makes it less likely that flows will cover these areas.
Zone 4	5%	<15%	Includes all of Hualālai, where the frequency of eruptions is lower than on Kīlauea and Mauna Loa. Flows typically cover large areas.
Zone 5	none	<5%	Areas on Kīlauea currently protected from lava flows by the topography of the volcano.
Zone 6	none	very little	Areas on Mauna Loa currently protected from lava flows by the topography of the volcano.
Zone 7	none	none	Younger part of Mauna Kea. 20% of this area covered by lava in the last 10,000 years.
Zone 8	none	none	Remaining part of Mauna Kea. Only a few percent of this area covered in the past 10,000 years.
Zone 9	none	none	No eruption in this area for the last 60,000 years.

Future large eruptions of Mauna Loa's southwest rift zone and Hualālai in Kona may evolve quickly and produce lava flows that travel up to tens of miles in a few hours or less, generally faster than velocities expected for typical flows at Kīlauea. Radial vent eruptions on Mauna Loa's north and west flank occur outside the rift zones and represent a high potential of impact within developed areas near the vents.

Laze

Downslope air flow from nighttime through early morning typically blows a laze plume off shore and out to sea. However, between mid-morning and late afternoon, the trade winds can blow the plume along the coast and inland, resulting in poor air quality (USGS, 2017p).

Vog

Volcanic emissions have become a major health hazard because of high emissions from Kīlauea since the 1980s. As shown on Figure 17-4, during prevailing trade winds, the nearly constant stream of vog produced by Kīlauea is blown to the southwest and west, where wind patterns carry it to the Kona coast. Once wind reaches the Kona coast, the vog becomes trapped by daytime and nighttime sea breezes (double-headed arrows on figure). However, when light Kona winds (red arrows on figure) blow, much of the vog is concentrated on the eastern side of the island. Depending on winds, vog from Kīlauea has the potential to reach the island of Oʻahu, which is more than 200 miles northwest of the island of Hawaiʻi (USGS, 2017p).

Acid Rain

The concentrations in parts per million (ppm) of sulfur dioxide after the 2018 eruption of the Kīlauea are highlighted in Figure 17-5.

Explosive Eruption

Recent work has clarified the explosive nature of Kīlauea eruptions. It is now known that Kīlauea can produce explosive eruptions from its summit caldera region lasting as long as centuries (Fiske et al., 2019). Deposits from an eruption dating back to 900 CE (common era) were found 6 to 10 miles from the vent and spread over 25 square miles southeast of the summit. Based on the size and distribution of rock deposits, the study concluded that the eruption could have only been explosive and that this is evidence that Kīlauea poses a significant hazard to the surrounding area. The 2018 Kīlauea eruption did not result in a big explosion, but small explosions occurred from the summit in May 2018.

Source: USGS 2017p

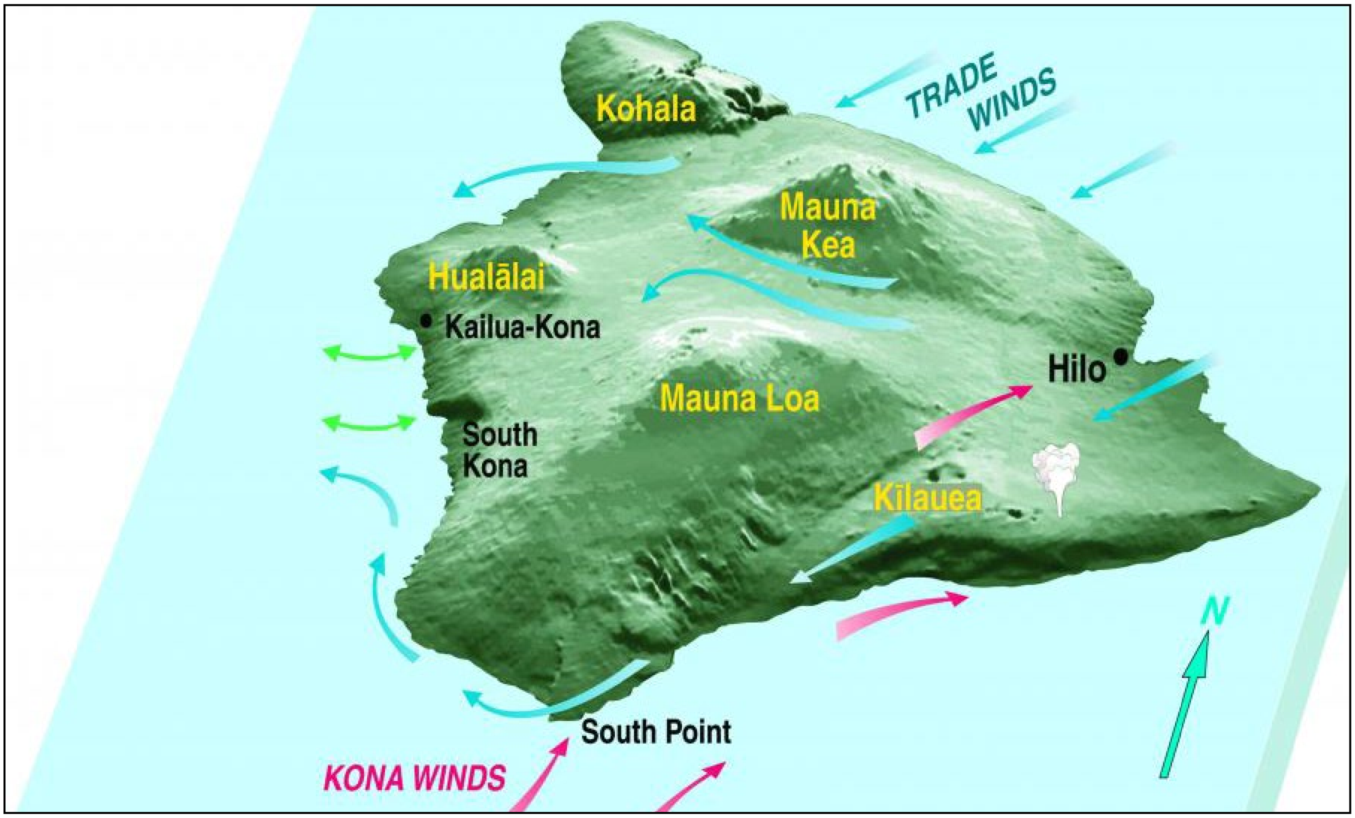


Figure 17-4. Wind Direction and Vog Conditions in the County of Hawai‘i

Source: http://weather.hawaii.edu/vmap/index.cgi

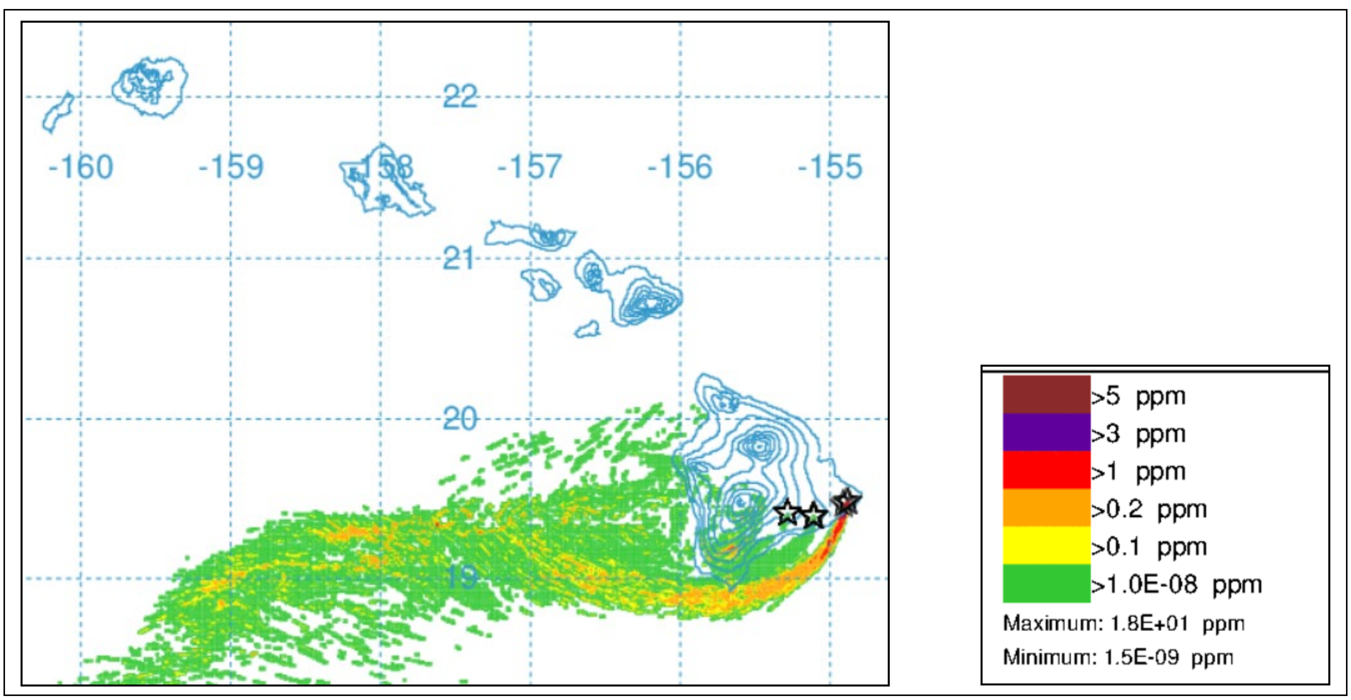


Figure 17-5. Measurements of Sulfur Dioxide Post-2018 Kīlauea

Mauna Loa has explosive eruption deposits on its summit crater rim. The source of much of the ash deposits on Mauna Loa’s flanks cannot be identified as either Mauna Loa or Kīlauea. However, research indicates ash can travel long distances; thus, the impact area is expansive.

Mauna Kea also has explosive potential. This volcano’s most recent eruption was 4,000 to 6,000 years ago, and it has had periods of dormancy for about 6,000 years between periods of activity. Almost every eruption documented from Mauna Kea was mildly explosive and resulted in cinder cones (Swanson and USGS, 2019).

Ground Failure/Subsidence

In 1965, the County witnessed large fractures develop in Hawai‘i Volcanoes National Park as magma rose to the surface. A broad, low area over the rising magma, known as a graben, formed between parallel fractures (USGS, 2018d). These cracks opened along broad areas after an eruption of Kīlauea’s East Rift Zone and damaged roads in Hawai‘i Volcanoes National Park. Recently, USGS and County-led field teams documented where open cracks and grabens formed in the Leilani Estates area leading up to and during the 2018 Kīlauea eruption (Figure 17-6). Gas venting, steaming, heat, can be released from these structures.

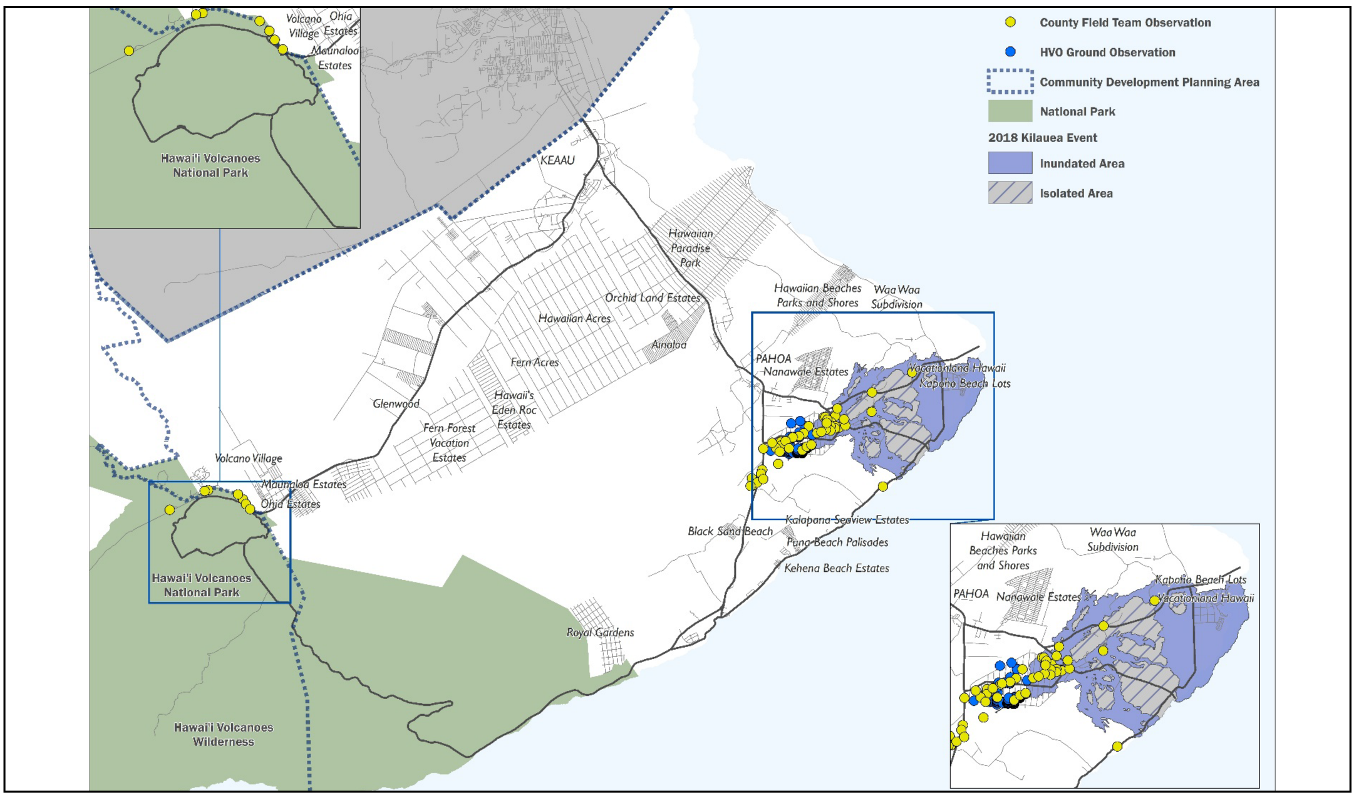


Figure 17-6. Overview of Observed Ground Cracks After the 2018 Kīlauea Eruption

17.2.2 Past Events

Figure 17-7 and Figure 17-8 show the extent of historical lava flows relative to the USGS lava-flow hazard zones for Mauna Loa and Kīlauea, respectively. The maps included in this figure are new from USGS (June 2020) and were not available at the time the spatial analysis was conducted for this report. Figure 17-9 shows a summary chronology of selected volcanic events on the island since 1700. The following sections summarize major volcanic eruption events, organized by volcano, beginning in the 1700s. Only the most significant events are included in these summaries. Additional information is available on the USGS HVO website.

Source: USGS, 2020h

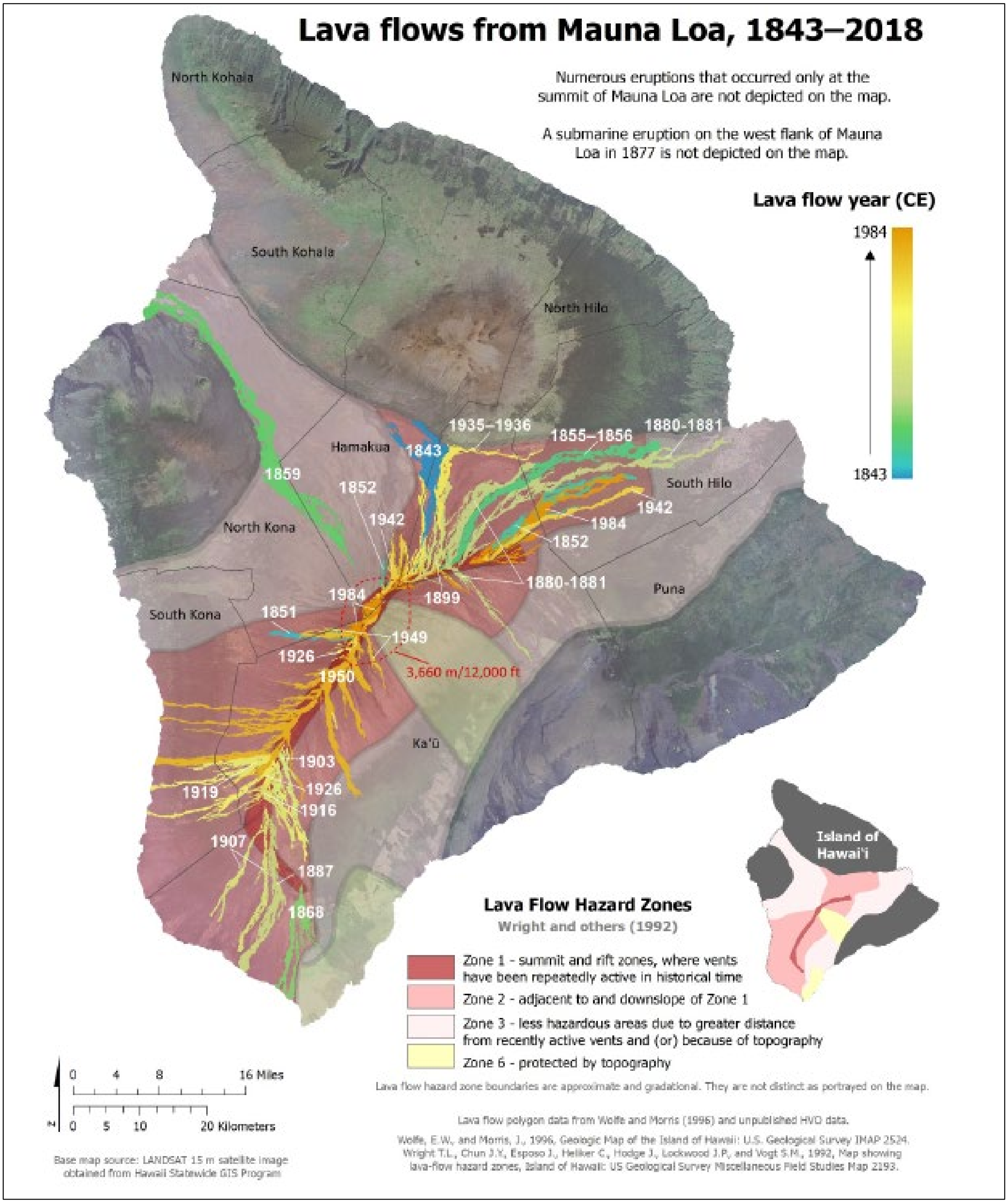


Figure 17-7. Mauna Loa Historical Lava Flows

Source: USGS, 2020g

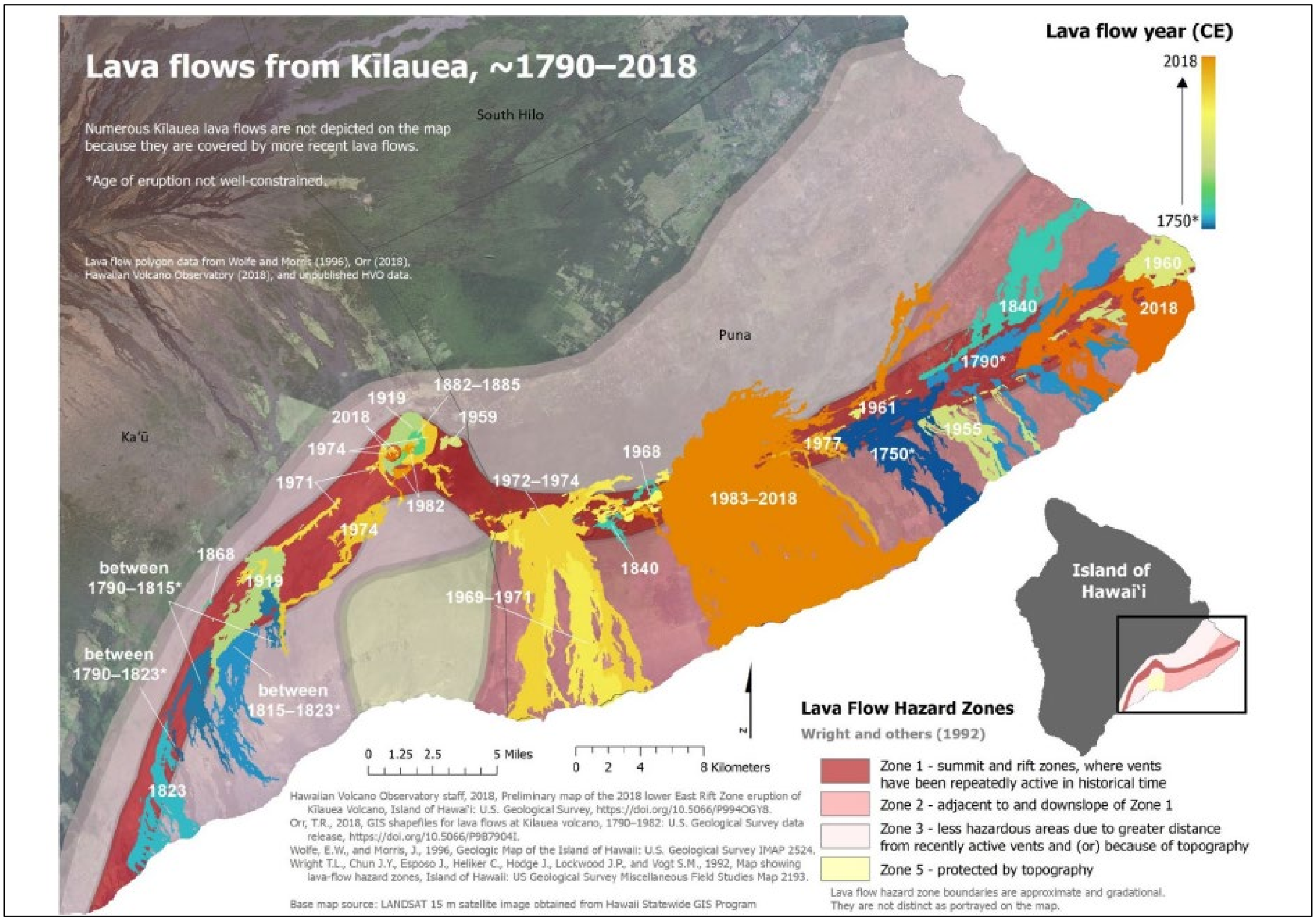
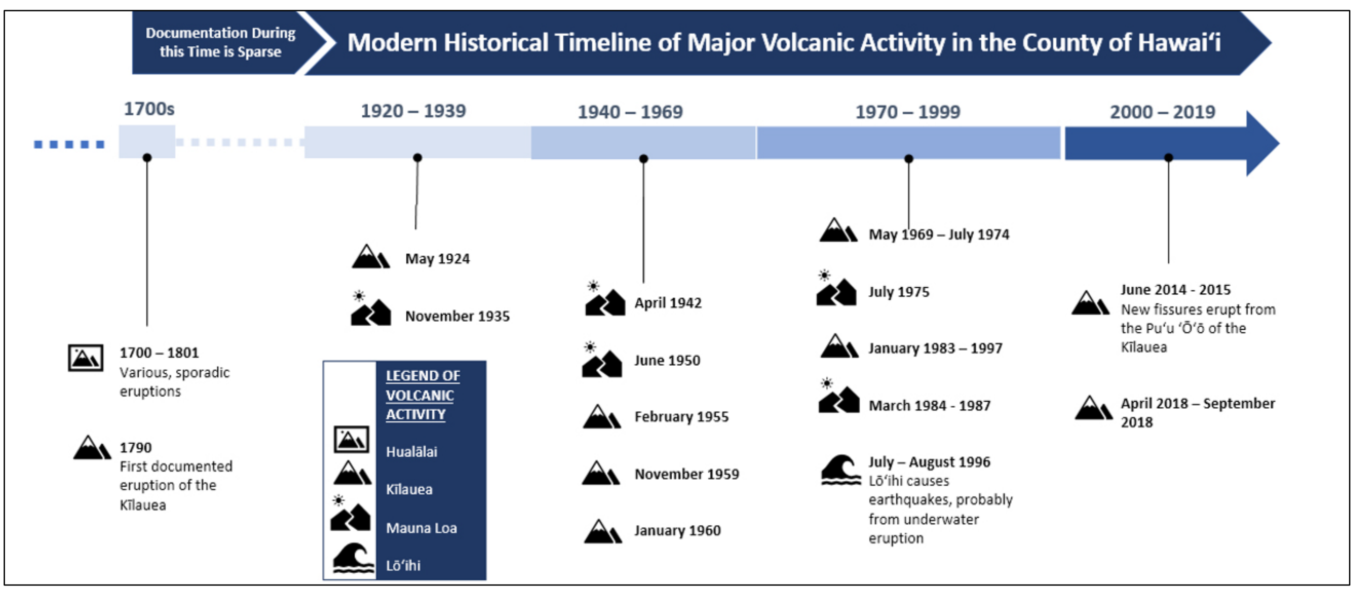


Figure 17-8. Kīlauea Historical Lava Flows



Note: This timeline represents a selection of major volcanic events between 1790-2018.

Figure 17-9. Historical Timeline of Volcanic Activity in the County of Hawai‘i

Kīlauea

Kīlauea has erupted 34 times since 1952 and is the most active volcano in the world today. From 1983 to 2018, the volcano's East Rift Zone, located in Puna, erupted nearly continuously. In 2018, the decades-long continuous activity on the middle East Rift Zone subsided, and the summit lava lake drained following an intrusion into Kīlauea's Lower East Rift Zone that resulted in a 4-month eruption. The 2018 eruption represents Kīlauea's largest eruption in approximately 200 years, accompanied by the largest caldera collapse at the summit within the same time period (USGS, 2019b). A summary of selected historical Kīlauea eruptions is provided below.

Pre-1790 Activity

Geologists have determined that there is a lack of old exposed rock at Kīlauea, which makes it difficult to piece together its complete eruption history. Ninety percent of the volcano's surface is covered by lava flows younger than 1,000 years, and about 20 percent of those flows are less than 200 years old (USGS, 2019e).

Research indicates that significant explosive eruptions occurred repeatedly between about 1500 and 1790, and between about 500 and 1000 CE. Explosive eruptions of Kīlauea between 1500 and 1790 included at least a dozen fast-moving, ground-hugging clouds of ash, rock, and volcanic gas. Such "pyroclastic surges" are among the most dangerous of volcanic phenomena—speeding at hurricane velocities and having temperatures of several hundred degrees Celsius. Although explosive eruptions at Kīlauea are infrequent in human terms, they are not rare geologically (USGS, 2019e)

1790 Explosive Eruption at Summit

A great explosive eruption in 1790 produced pyroclastic surges (turbulent clouds of hot gas and rock fragments) that originated at Kīlauea's summit and flowed several miles to the southwest. The 1790 eruption left deposits of rock fragments and ash up to 30 feet thick on the rim of Kīlauea's summit caldera. It was reported that a band of Hawaiian warriors traveling from Hilo to the Ka'ū district was overtaken by one of the pyroclastic surges and about 80 of them were killed (County of Hawaiʻi, 2015).

Based on 2019 field research by the USGS and the University of Hawaiʻi at Mānoa, a sequence of explosive deposits made up the 1790 event and there were at least three explosive surges. It is estimated that an equivalent event today would affect all of Puna and Ka'ū, and ash plumes could endanger flights to and from Hawaiʻi.

1924 Halema'uma'u

In May 1924, Kīlauea's largest crater, Halema'uma'u, was the site of more than 50 explosive events during a 2.5-week period. The lava lake within Halema'uma'u drained in February and was followed by earthquake activity, cracking in the ground, faulting, coastal subsidence, and hundreds of felt earthquakes in the Lower East Rift Zone. The explosive events in May created clouds of rock particles, wet ash, and steam and doubled the diameter of the Halema'uma'u. Ash plumes from the larger explosions reached as high as 5.5 miles. Rock fragments as heavy as 400 pounds were ejected from the rim of the crater. Wet ash from these events disrupted a rail line and destroyed rooftops. Large cracks occurred along the coastline and roadways. There was one fatality, and many people evacuated the Puna district because of the destruction created by these volcanic hazards (USGS, 2018h).

1955 Lower Puna

In February 1955, eruption of the Lower East Rift Zone along Kīlauea lasted for 88 days. The lava flows from this event covered more than 6 miles of public roads, cut off all access to lower Puna, and required evacuation of most coastline residents. Several homes and thousands of acres of land were covered by lava (USGS, 2018e). A federal disaster declaration for this event was issued on April 1, 1955.

1959 Kīlauea Iki

An eruption from the Kīlauea Iki Crater in November 1959 provided some of the first measurable data about the magma reservoir system at Kīlauea. Three months prior to the eruption, following deep earthquakes below the volcano, the summit reservoir began to fill with new magma. Eventually, a fissure broke through Kīlauea Iki Crater, sending lava to the bottom of the crater where it formed a lava lake. A single erupting vent contributed to the lava lake. Lava fountains reached 1,900 feet in height—the greatest recorded height in the 20th century—and damaged roads and guardrails. After 16 episodes of fountaining, the lava lake started to drain back into the open vent. The summit reservoir ultimately gained 13 million cubic yards of magma by the end of this event (USGS, 2018b).

1960 Kapoho

More than 1,000 earthquakes were recorded north of Kapoho on January 12, 1960. The volcano erupted on January 13, destroying the villages of Koa'e and Kapoho. Methane explosions occurred as lava flowed through vegetation. Dark steam clouds carrying high amounts of ash were released as lava interacted with groundwater. Lava flows reached the ocean by January 15, creating new land beyond the old shoreline (USGS, 2018c). A federal disaster declaration for this event was issued on January 21, 1960.

1969 to 1974 Mauna Ulu

The Mauna Ulu eruption in May 1969 was the longest-lasting and most voluminous eruption on Kīlauea's flank in at least 2,200 years (USGS, 2017b). The eruption lasted until July 1974 and produced 450 million cubic yards of lava. About nine months prior to the eruption, increased seismic activity and short-lived eruptions broke out along the East Rift Zone of the volcano. The main eruption started along a long fissure system but moved to where the Mauna Ulu was built between two pit craters, ʻĀlo'i Crater and ʻAlae Crater. Eleven fountaining events took place, reaching heights exceeding 1,700 feet. Lava flows spilled into the ocean and into the ʻAlae Crater. By August 1969, the ʻAlae Crater was nearly full, and cracks suddenly opened releasing lava flows far down the rift zone. The Mauna Ulu continued to release lava into the ʻAlae Crater, which created the lava shield that eventually matured into the Mauna Ulu edifice seen today. By June 1971, the activity ended until Kīlauea's summit inflated from pressurization. By February 1972, lava began to enter the summit crater of Mauna Ulu and spilled from the crater into a trench entering a lava tube of the ʻAlae Crater. Lava flows continued to flow along the land and frequently entered the sea. From December 1973 to July 1974, the remaining eruptive activity came from the Mauna Ulu. The shield of the Mauna Ulu continued to grow, and the lava lake became increasingly stagnant, ending the long-running eruption (USGS, 2017b).

1983 to 2018 Puʻu ʻŌʻō

The Puʻu ʻŌʻō eruption that began in 1983 ranks as the longest period in the last 200 years of lava flow from the Kīlauea's East Rift Zone (35 years). Over the extended course of this ongoing eruption, two federal disaster declarations were issued—one on May 18, 1990 and one on November 3, 2014. The lava flows from this eruption have drastically changed the landscape and caused many issues for County residents.

This event started with an eruption in January 1983. Throughout the next three years, more than 40 lava fountaining episodes formed Puʻu ʻŌʻō and some of the surrounding lava flow fields. By the late 1980s, activity localized at Kupaianaha. The lava flows that helped to create the Puʻu ʻŌʻō impacted the surrounding communities, destroying several homes (USGS, 2019g).

The eruption took a turn in 1990 when breakouts from a lava tube progressively entered the Kalapana community. This community was completely buried beneath lava by the end of the year. Lava flows that were sent to the ocean built a series of lava deltas on Kīlauea's southeast coast, which added about 418 acres of new land to the County (USGS, 2019g).

In 1997, the Puʻu ʻŌʻō Crater experienced more lava eruptions from new vents outside its crater on the flanks of its cone. This led to various lava events ranging from several months to several years that occurred from Puʻu ʻŌʻō over the next 10 years (USGS, 2019g). Figure 17-10 shows the extent of lava flow from 1983 to 2008.

Source: Orr, 2011

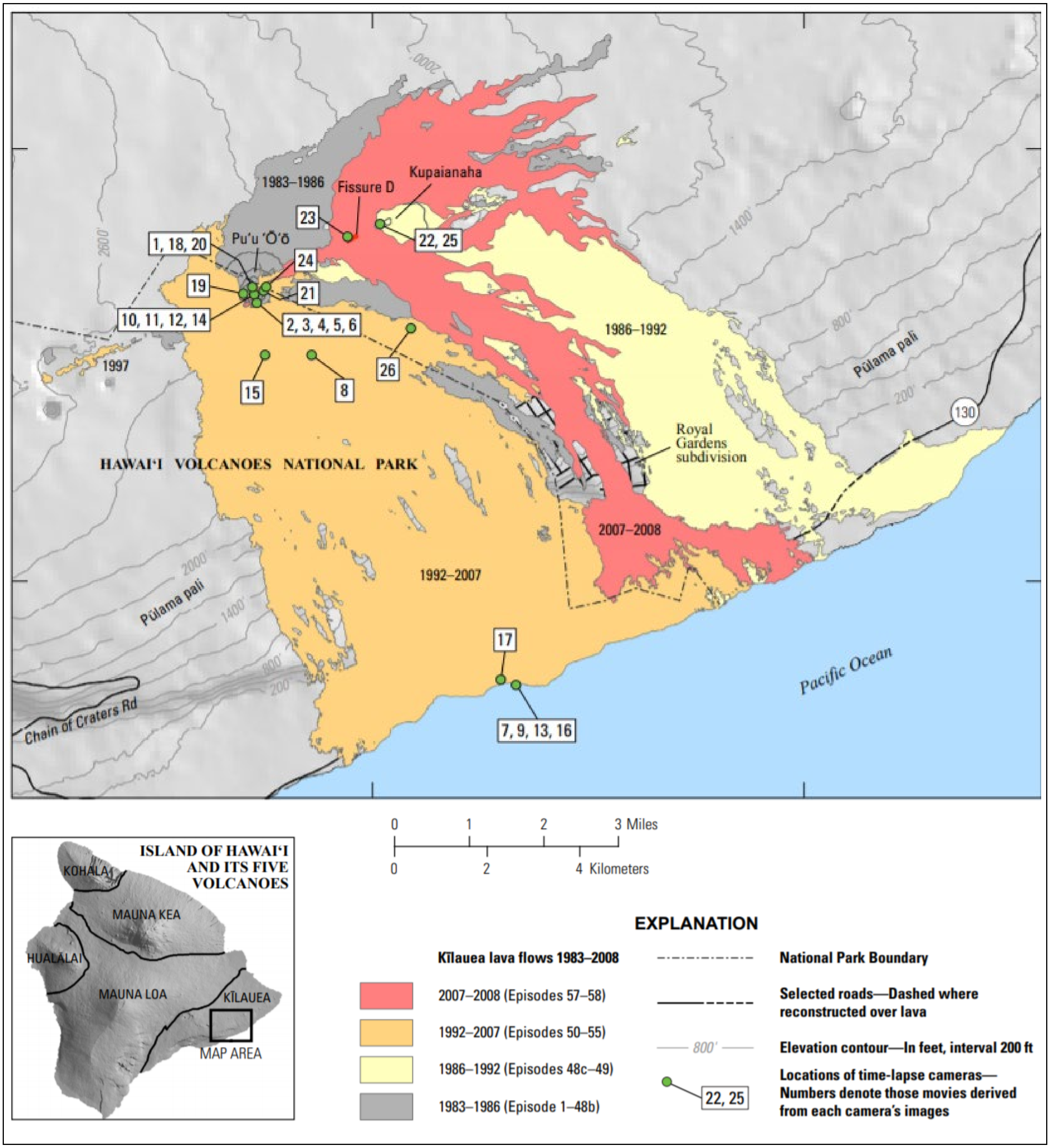


Figure 17-10. 1983 to 2008 Puʻu ʻŌʻō Lava Inundation Extent

The Puʻu ʻŌʻō continued activity after new fissures erupted on its east flank in June 2014 and a new lava flow rapidly advanced to the east. The flow nearly reached Highway 130, the only transit route for nearly 10,000 people who live in the lower Puna District. Ultimately, the lava flow halted and cooled just prior to reaching Pāhoa Village Road (USGS, 2019g). Figure 17-11 shows the Puʻu ʻŌʻō lava flow from 2014 to 2015.

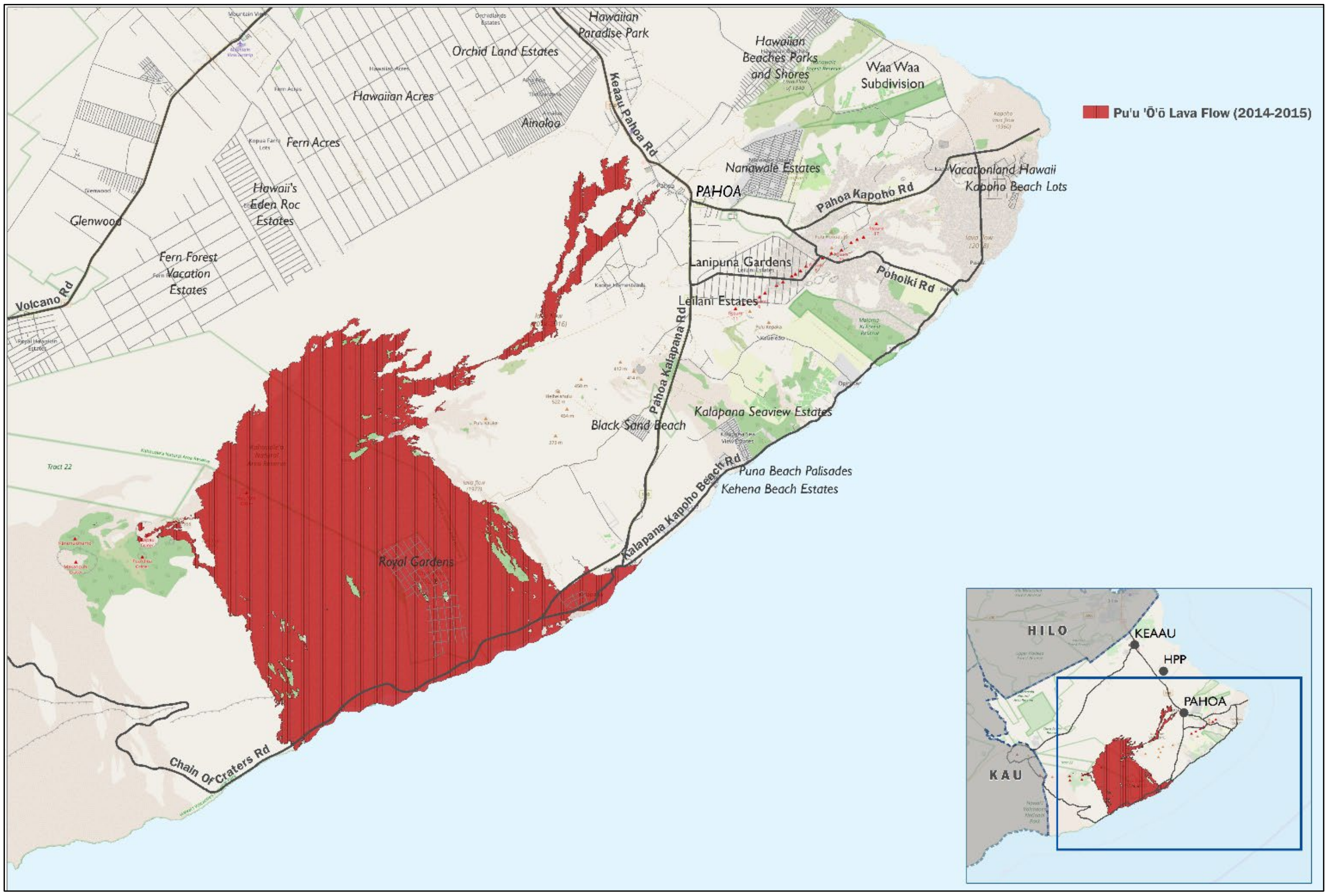


Figure 17-11. Puʻu ʻŌʻō 2014 to 2015 Lava Flow Inundation Extent

On May 24, 2016, a new breakout from the east flank of Puʻu ʻŌʻō formed a new flow to the south. The flow reached the base of the Pūlama pali by the end of June and entered the sea at Kamokuna on July 26, 2016. On April 30, 2018, the crater floor and lava lake of Puʻu ʻŌʻō catastrophically collapsed, marking the end to the eruption of Puʻu ʻŌʻō.

2018 Kīlauea Lower East Rift Zone

On April 30, 2018, the Puʻu ʻŌʻō crater floor collapsed, indicating that magma, which had been accumulating beneath the cone, had drained from the area. On May 1, 2018, Kīlauea's summit began to deflate and on May 2, 2018, the lava lake within Halemaʻumaʻu crater started to drain. The collapse of Puʻu ʻŌʻō, the draining of Kīlauea's summit lava lake, and the migration of earthquakes down Kīlauea's East Rift Zone all indicated that magma was advancing underground through the East Rift Zone toward the Leilani Estates subdivision (USGS, 2020e). On May 3, lava broke through the surface in Leilani Estates, resulting in a lava fountain spewing from the initial fissure. On May 4, a 6.9-magnitude earthquake preceded the opening of several more fissures. On May 9, HVO warned of potential explosions at the summit of Kīlauea. A federal disaster declaration was issued on May 11. There have been no active lava flows since August 2018, though lava was last seen inside Fissure 8 in Leilani Estates on September 5, 2018. The extent of lava flow from this eruption can be seen in Figure 17-12.

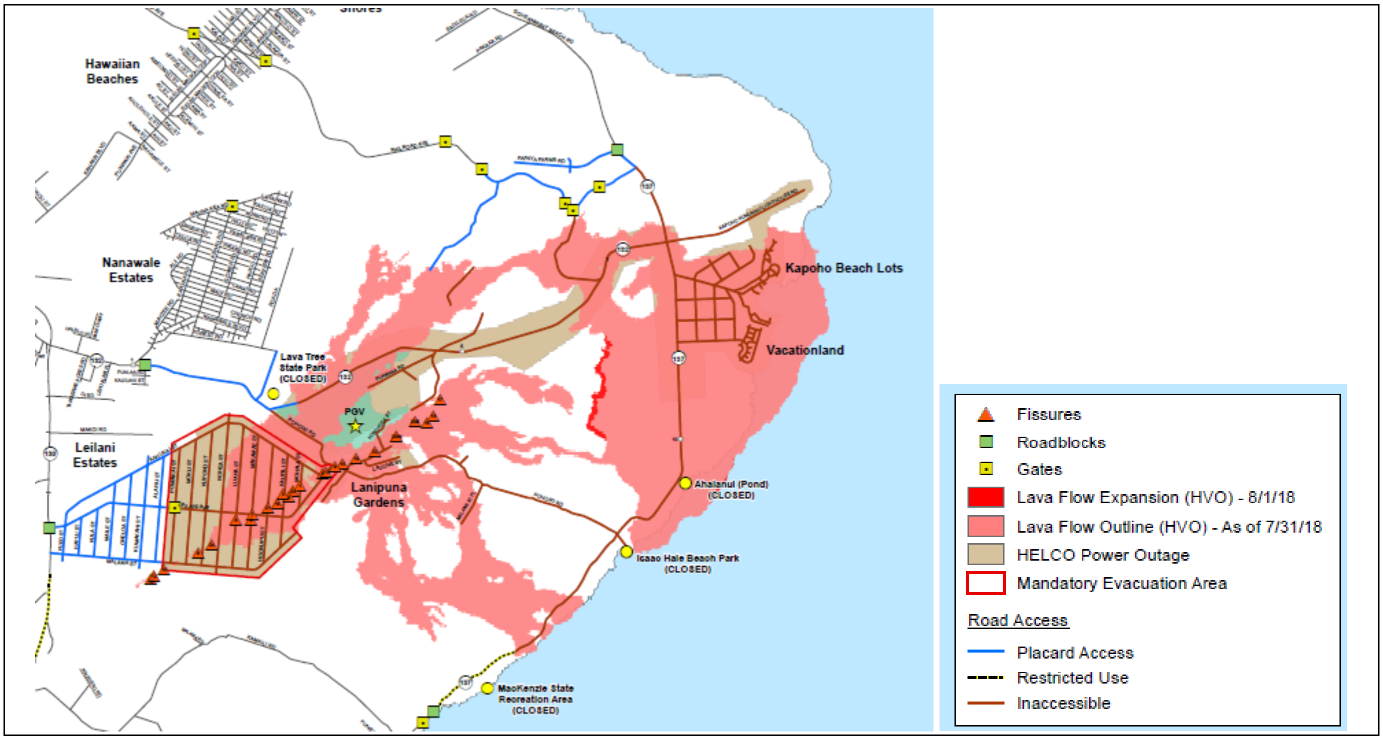


Figure 17-12. Roadblocks and Gates Established for Controlling Access During 2018 Kīlauea Event

Kīlauea’s summit experienced its largest collapse in 200 years, with a total of 1,640 feet of subsidence (U.S. Department of the Interior Strategic Sciences Group, 2018). During this period of eruption, HVO reported a total of 24 known fissures, 60,000 earthquakes, and an eruption equivalent to 8 years of Kīlauea’s magma supply. The Puna District suffered significant losses especially from lava inundation. Entire neighborhoods, schools, and beach parks, were covered with lava. In addition, earthquakes and air pollutants affected residents across the island and state. The eruption impacted residential, agricultural, business, tourist, and scientific areas. Hawai‘i Volcanoes National Park closed. Several roads and critical facilities were inundated or isolated by lava causing multiple road blocks in the County (see Figure 17-12). Lava covered more than 41 miles of roadways in the Puna District. Although there were no fatalities, the event was quite destructive in terms of displacement of residents, structure destruction, land coverage, and cultural and environmental resources impact.

Mauna Loa

Mauna Loa is not known to have produced an explosive eruption since 1843 (USGS, 2017e). However, evidence from four debris fans made up of fragmented rock deposits indicate that an explosive eruption is possible. The following is a selection of historical Mauna Loa eruptions documented by the USGS:

- **1859—**An 1859 eruption on the northwest flank of Mauna Loa lasted 300 days and reached the ocean north of Kīholo Bay in the North Kona district (County of Hawai‘i, 2015).
- **1935—**Mauna Loa erupted in November 1935. Pāhoehoe lava (smooth, billowy, or ropey) traveled one mile east per day toward Hilo after flowing through the saddle area between Mauna Loa and Mauna Kea (USGS, 2016a).
- **1942—**The April 1942 eruption of Mauna Loa began on the western rim of Mauna Loa and migrated down the Northeast Rift Zone. The eruption ended in May after reaching within 7 miles of the upper Waiākea Uka area of Hilo (USGS, 2017a).
- **1950—**Earthquake swarms under Mauna Loa occurred throughout 1949, and a large 6.4-magnitude earthquake was felt in May 1950. In June 1950, a fissure erupted on Mauna Loa’s Southwest Rift Zone,

leading to multiple parallel fissures along the rift zone. The eruption destroyed the Ho'okena-mauka village in South Kona with the swiftly flowing lava traveling 14 miles in only 3 hours. Residents of the village escaped unharmed. Lava passed through commercial and residential areas, over highways, and through forests, continuing down into the ocean and creating clouds of steam. This eruption lasted for 23 days and erupted 490 million cubic yards of lava (USGS, 2018a).

- **1975—**Mauna Loa experienced a short-lived eruption in July 1975 (USGS, 2017c). Lava fountains erupted from fissures extending across the length of Mauna Loa's summit caldera, Moku'āweoweo, and into the upper ends of the volcano's Northeast and Southwest Rift Zones. Six hours of activity lasted in the caldera. Lava fountaining continued along the Northeast Rift Zone (see Figure 17-13) for less than a day before completely ending.
- **1984—**Mauna Loa erupted in 1984 following a three-year period of increasing earthquake activity. The eruption began in March 1984 after fissures appeared rapidly down to the southwest rift zone across the southern half of Moku'āweoweo. Eventually, four parallel flows moved down the northeast flank and all eruptive activity became confined to these vents. Lava flows from these vents started to move toward Hilo, though it never reached the community. Researchers conclude that this event shows that dense vegetation, gentle slopes, and low temperature of erupted lava can slow down the flow of lava, which is valuable insight to mitigate the risk of future eruptions (USGS, 2016c).

Source: USGS, https://volcanoes.usgs.gov/volcanoes/mauna_loa/geo_hist_1975.html

Figure 17-13. The 1975 Mauna Loa Eruption, with Lava Fountains up to 65 Feet High on North Flank

Mauna Kea

Mauna Kea erupted most recently between about 6,000 and 4,500 years ago from at least seven separate summit-area vents, producing lava flows and cinder cones. Mauna Kea is in the advanced post-shield stage (Hawai'i-substage); geologic research has concluded that eruptions from this volcano are less frequent, and the chemistry of the lava has changed as the volcano moved away from the source of magma generation. The oldest rocks on the surface of this volcano erupted between 200,000 to 250,000 years ago. The steep and more irregular shaped surface of this volcano are evidence that post-shield magma, which has higher viscosity, erupted from the cones of Mauna Kea. Eruptions that formed prominent cinder cones were likely sporadic clusters of events that produced large volumes of tephra and ashfall (USGS, 2018g). Geologists indicate that Mauna Kea could erupt again after being inactive for 4,500 years; the USGS rates it as a moderate threat volcano (USGS, 2020f).

Hualālai

Hualālai is the third youngest volcano in the County. The USGS has documented that six different vents erupted lava between the late 1700s and 1801. Lava flows from two of these events created land on the west coast of the island, including the area where the Keāhole Airport is located. About 80 percent of Hualālai’s surface has been covered by lava flows over the past 5,000 years. Over the last few decades, resorts, homes, and commercial buildings have been built on the volcano’s flanks. The most recent activity was a series of earthquakes in 1929 that did not result in an eruption. Geologists consider Hualālai a potentially dangerous volcano that is likely to erupt again (USGS, 2017i).

Kohala

The Kohala volcano is the oldest above-water volcano in the County. Scientists believe that this volcano erupted more than 65,000 years ago. Kohala is an elongated mountain that runs northwest to southeast. It is believed that a huge avalanche consumed a slice of this volcano’s northeast flank nearly 300,000 years ago, spilling debris more than 80 miles out into the ocean floor (Bays and SOEST, 2015).

Lō‘ihi

The Lō‘ihi volcano is an active volcano on the sea floor south of Kīlauea. It rises 3,189 above the sea floor and generates frequent earthquake swarms. The summit of this volcano is a caldera-like depression that is 1.7 miles wide and 2.3 miles long (USGS, 2017l).

The most recent confirmed eruption of Lō‘ihi occurred in 1996; it was associated with an earthquake swarm that quickly intensified. Thousands of earthquakes, including over a dozen with magnitudes greater than 4.5, were recorded from beneath the summit and south flank of the volcano between July and September 1996. Scientists’ observations and mapping of the Lō‘ihi summit region showed that a significant portion of it had collapsed. Fresh pillow lavas and glassy fragments collected during submersible dives also confirmed the occurrence of an eruption (USGS, 2017r). The most recent pit, now called Pele’s Pit, was created during the 1996 earthquake.

The Lō‘ihi volcano has grown from eruptions along its rift zone, but it is not known when it will reach above sea level. At the current estimated growth rate of 16.4 feet per 1,000 years, it may be as much as 200,000 years before it breaches the ocean surface (USGS, 2017l). Because Lō‘ihi is still deep beneath the ocean’s surface, the USGS regards it as a low- to very low-threat volcano.

If Lō‘ihi were to erupt, it could cause partial draining of its summit magma chamber and summit collapse, as happened in 1996. If an eruption or stronger earthquakes occur, very small tsunami waves may affect southeast shores of the island of Hawai‘i (USGS, 2020c)

17.2.3 Frequency

Hawai‘i County has experienced six FEMA disaster declarations associated with volcanic hazards since 1954—roughly once every 10 years. Since 1823, there have been nearly 100 volcanic eruptions; with varying severity and impacts—roughly one every two years (State of Hawai‘i, 2018). The USGS Volcano Hazards Program website rates the potential threat from the volcanoes in or near Hawai‘i County as follows (USGS HVO, 2017b; Bays and SOEST, 2015):

- Kīlauea—Very High. Last erupted in 2018 and considered certain to erupt again.
- Mauna Loa—Very High. Last erupted in 1984 and considered certain to erupt again.
- Hualālai—High. Likely to erupt again.
- Mauna Kea—Moderate.
- Lō‘ihi—Low (because the impacts of the eruptions are underwater).
- Kohala—Low. Volcano is not active.

The long-term lava-flow threat is greatest on Kīlauea and Mauna Loa, the two most active volcanoes, followed by Hualālai (USGS, 2017j). The likelihood that future lava flows from Kīlauea and Mauna Loa will interfere with human activity and infrastructure increases as communities and other development encroach on these active volcanoes (State of Hawai‘i, 2018). The following is a summary of event frequency for the individual volcanoes on the island:

- **Kīlauea—**Kīlauea was almost continuously erupting at its summit caldera from the beginning of historic records up until 1924. Since 1955, most of the activity has occurred along the east rift zone. The southwest rift zone has been less active with only five eruptions in the past 200 years; the latest was in 1974.
- **Mauna Loa—**Mauna Loa is undergoing a period of eruptive quiescence, having erupted only twice during the last 60 years. Prior to that, Mauna Loa was much more active, erupting, on average, about every five years. Mauna Loa has had 33 eruptions since 1843. From 1832 to 1950, Mauna Loa averaged one eruption every 3.6 years. Since 1950, eruption activity on Mauna Loa has slowed considerably. The two eruptions since 1950 include a 1-day summit eruption in 1975 and a 3-week eruption on the northeast rift zone which advanced to within 4 miles of Hilo. Six eruptions from Mauna Loa have reached the ocean since 1859. Between 1868 and 1950, five lava flows have reached the ocean from eruptions on the southwest rift zone of Mauna Loa (County of Hawai‘i, 2015).
- **Hualālai—**The Hualālai volcano, although still considered active, erupted most recently in 1801. Hualālai poses more of a threat than Mauna Kea (Kauahikaua, 2019).
- **Lō‘ihi—**Lō‘ihi has been consistently monitored since 1996 by HVO’s on-land seismic network. This growing seamount may eventually break the surface, adding a new island to the Hawaiian Island chain, with an estimate of 200,000 years based on a growth rate of 16.4 feet per 1,000 years. However, there are currently no estimated potential impacts on residents and infrastructure from Lō‘ihi (State of Hawai‘i, 2018).
- **Mauna Kea—** Mauna Kea is considered active/potentially active, having last erupted about 4,500 years ago.
- **Kohala—**Kohala is unlikely to erupt.

17.2.4 Severity

Lava Flow

Lava flows on the island of Hawai‘i may be erupted in huge volumes. On steep slopes, the fluid lava can rapidly travel many miles from its source. Lava flows present potential threats to homes, infrastructure, natural and historic resources and entire communities. The areas exposed to the highest hazard from lava flows are summit calderas, those situated downslope and those close to the active rift zones of Mauna Loa and Kīlauea. Steep slopes may allow lava flows to move quickly from the summit to the ocean in a matter of hours. Besides the direct threat of inundation, lava flows may also cut across a community’s single roadway escape route, limiting the amount of time available for evacuation.

Laze

The harmful properties of laze can have immediate impacts on persons who have been exposed. These plumes produce acid rain with a pH ranging between 1.5 and 3.5 and have the corrosive properties of dilute battery acid. As a result, the plumes can cause skin irritation, eye irritation, breathing difficulties, and less frequently, death (USGS, 2017p).

Vog

Near Kīlauea’s active vents, vog consists mostly of SO_2 gas. Along the Kona coast on the west side of the island of Hawai‘i and in other areas far from the volcano, vog is dominated by an aerosol of sulfuric acid and other sulfate compounds (USGS HVO, 2012). Recent historical emissions have been as follows:

- **Kīlauea's summit—**Sulfur dioxide released at Kīlauea's summit was small—150 to 200 tons each day—until mid-2007, when SO_2 emission rates began to increase. By the time a new gas vent opened in Halemaʻumaʻu Crater on March 12, 2008, summit SO_2 emissions had reached 2,000 tons per day—the highest recorded at Kīlauea's summit since measurements began in 1979. As of June 2008, summit SO_2 emissions have fluctuated between 500 and 1,500 tons per day.
- **Puʻu ʻŌʻō vent—**From 1983 to 2018, Kīlauea's Puʻu ʻŌʻō vent emitted around 1,500 to 2,000 tons of SO_2 daily.
- **Lower East Rift Zone—**Starting in May 2018, the Lower East Rift Zone released more than 50,000 tons of SO_2 gas per day, which is more than 50 times the emissions from the top SO_2-producing U.S. power plant.

Farmers in the County, particularly in the Ka'ū District, recently reported losses of agricultural crops and flowers as a result of the high SO_2 emissions from the 2018 eruption (USGS, 2017f).Future volcanic events may include emissions concentrations that reach levels considered unhealthy by U.S. regulatory agencies (U.S. Department of the Interior Strategic Sciences Group, 2018).

Explosive Eruption

Explosive eruptions from Hawaiian volcanoes have the potential to severely impact surrounding communities. Although most historical eruptions have not been explosive, the geologic record contains evidence that Kīlauea and perhaps Mauna Loa have produced destructive explosive eruptions from their summit areas in the past. Should such activity return to Kīlauea, ashfall and pyroclastic surges would threaten areas around the summit.

Ashfall

Nuisance ash has been a common hazard of volcanic eruptions in the County. The ash thickness produced by large explosions can be in millimeters, or in some areas, in centimeters.

17.2.5 Warning Time

HVO conducts volcanic monitoring and surveillance based on the movement of molten rock or volcanic gas beneath a volcano, which will precede any large eruption. HVO uses three primary techniques of volcano monitoring (USGS 2005; 2019k):

- **Monitoring of volcanic earthquakes**—Any movement of magma requires it to push its way through the rocks of the earth's crust. This causes fracturing of rock, and movement along faults, resulting in earthquakes that can be detected at the earth's surface. Specific types of seismicity can be "mapped" to particular regions under the volcano, allowing scientists to plot the passage of magma.
- **Monitoring of ground deformation**—As the magma approaches the surface of the earth, and moves into the conduit below the vent of a volcano, the displacement of the surrounding rocks to make way for the magma causes the ground surface to move and the volcano to swell. This rising or swelling can then be used to assess the depth of the magma body and often give some idea of its volume.
- **Monitoring of the chemistry of volcanic gases**—Magma contains dissolved gases. As magma rises to shallow levels, these gases are released, rise rapidly to the surface, and are discharged through gas vents. The composition and temperature of these gases give clues as to how close magma is to the surface.

The USGS volcano-alert system is based on data analyzed from monitoring networks, direct observations, and satellite sensors (USGS, 2017q; 2018k). HVO has 65 seismic stations on the island of Hawaiʻi to monitor volcanic earthquake activity, as well as scores of ground-movement monitoring stations. All field instruments radio signals to HVO in real time for evaluation and interpretation. HVO aims to provide weeks to months of warning guidance of potential eruptions at Mauna Loa and hours to days warning at Kīlauea. Precursors before an eruption of Hualālai may last for hours to weeks, though this time period has not been tested because no eruption has occurred since monitoring was started on Hualālai.

General information about volcanoes is provided to the public as alert notifications accompanied by specific text, as summarized in Table 17-3. County Residents can sign up for the USGS alert notifications via email, look up alerts using an interactive map indicating volcano status published on the volcano hazards program website, review the regional volcano observatory websites, or go online and follow social media accounts that are created for all regions of the United States. The USGS alert system issues separate alerts for persons on the ground (Table 17-4) and for aviators (Table 17-5) (USGS, 2017j). The aviation alerts use an international color code system to indicate changes in volcanic activity that may affect the aviation sector.

Table 17-3. Volcanic Notification Types Delivered by Volcano Observatory

Notification Types	
Volcano Activity Notice	Announces alert-level changes or significant volcanic activity within an alert level; covers all volcanic hazards—volcanic mudflows, lava flows, ashfall, airborne ash, surges, pyroclastic flows
Daily, Weekly, or Monthly Update	Scheduled update providing steady situational awareness
Status Report	Update about volcanic behavior or monitoring activities during ongoing events of unrest or eruption
Volcano Observatory Notice for Aviation	Aviation-sector specific (for pilots, dispatchers, air-traffic managers, meteorologists); focuses on ash emissions
Information Statement	Topical information such as explanation of non-volcanic events at a volcano, changes in monitoring installations, long-term prognoses, etc.

Source: USGS 2018k

Table 17-4. USGS Alert-Level Terms

A volcano activity notice is issued when the alert-level is changed	
Normal	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to noneruptive background state
Advisory	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase
Watch	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, or eruption is underway but poses limited hazards
Warning	Hazardous eruption is imminent, underway, or suspected

Source: USGS 2017j

Table 17-5. USGS Volcano Alert Levels/Aviation Color Codes

A volcano observatory notification is issued when the volcano color code changes		
Green	Normal	Volcano is in typical background, noneruptive state or, after a change from a higher level, volcanic activity has ceased, and volcano has returned to noneruptive background state
Yellow	Advisory	Volcano is exhibiting signs of elevated unrest above known background level or, after a change from a higher level, volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase
Orange	Watch	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, or eruption is underway with no or minor volcanic-ash emissions (ash-plume height specified, if possible)
Red	Warning	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely, or eruption is underway or suspected with significant emission of volcanic ash into the atmosphere (ash-plume height specified, if possible)

Source: USGS 2020b

The County and the State of Hawai'i Department of Health (DOH) also have created a warning system to help the community take protection actions based on levels of volcanic SO_2 (see Table 17-6). The color code is based on a forecast of data and uses volcanic emission levels, weather, wind, and historical data. Although changing conditions make it difficult to predict protective measures, forecasting is intended to provide advanced warning and advice to help prepare for an emergency.

Table 17-6. Sulfur Dioxide Information

Condition	Recommended Response
GREEN (Trace)	Sensitive groups[a]: Highly sensitive individuals may be affected at these levels.
	Everyone else: Potential health effects not expected.
YELLOW (Light)	Sensitive groups: Avoid outdoor activity.
	Everyone else: Potential health effects not expected, however actions to reduce exposure to vog may be useful.
ORANGE (Moderate)	Sensitive groups: Avoid outdoor activity and remain indoors.
	Everyone else: Potential health effects not expected, however actions to reduce exposure to vog may be useful.
RED (High)	Sensitive groups: Avoid outdoor activity and remain indoors.
	People experiencing respiratory-related health effects: Consider leaving the area.
	Everyone else: Avoid outdoor activity
PURPLE (Extreme)	Sensitive groups: Avoid outdoor activity and remain indoors.
	People experiencing respiratory-related health effects: Leave the area and seek medical help.
	Everyone: Leave the area if directed by Civil Defense.

a. Sensitive Groups are defined in this instance as children, and individuals with pre-existing respiratory conditions such as asthma, bronchitis, emphysema, lung or heart disease.

Source: State of Hawai'i, 2020a

17.2.6 Secondary Hazards

Ground movement that often accompanies volcanic eruption can result in subsidence, surface ruptures, earthquakes, and tsunamis.

17.3 EXPOSURE

A quantitative assessment of exposure to the lava hazard was conducted using the lava hazard zone mapping (Figure 17-3), the historical lava inundation area mapping (Figure 17-7 and Figure 17-8), and the asset inventory developed for this plan. Population exposure was estimated by calculating the number of buildings in each hazard area as a percent of total planning area buildings, and then applying this percentage to the estimated planning area population. Detailed results by district are provided in Appendix F; results for the total planning area are presented below.

17.3.1 Population and Property

Table 17-7 summarizes the estimated population living in mapped lava hazard Zones 1 and 2 and the historical lava inundation area, and the estimated property exposure.

17.3.2 Critical Facilities

Figure 17-14 summarizes the exposed critical facilities in the planning area.

Table 17-7. Exposed Population and Property in Lava Hazard Zones and Historical Inundation Area

	Lava Inundation Zone 1	Lava Inundation Zone 2	Historical Lava Inundation Area
Population			
Population Exposed	2,263	15,315	7,656
% of Total Planning Area Population	1.2%	8.0%	4.0%
Property			
Number of Buildings Exposed	974	6,555	3,115
Value of Exposed Structures	$176,200,000	$1,165,660,000	$658,970,000
Value of Exposed Contents	$90,930,000	$629,130,000	$335,790,000
Total Exposed Property Value	$267,140,000	$1,794,790,000	$994,760,000
Total Exposed Value as % of Planning Area Total	0.5%	3.1%	1.71%

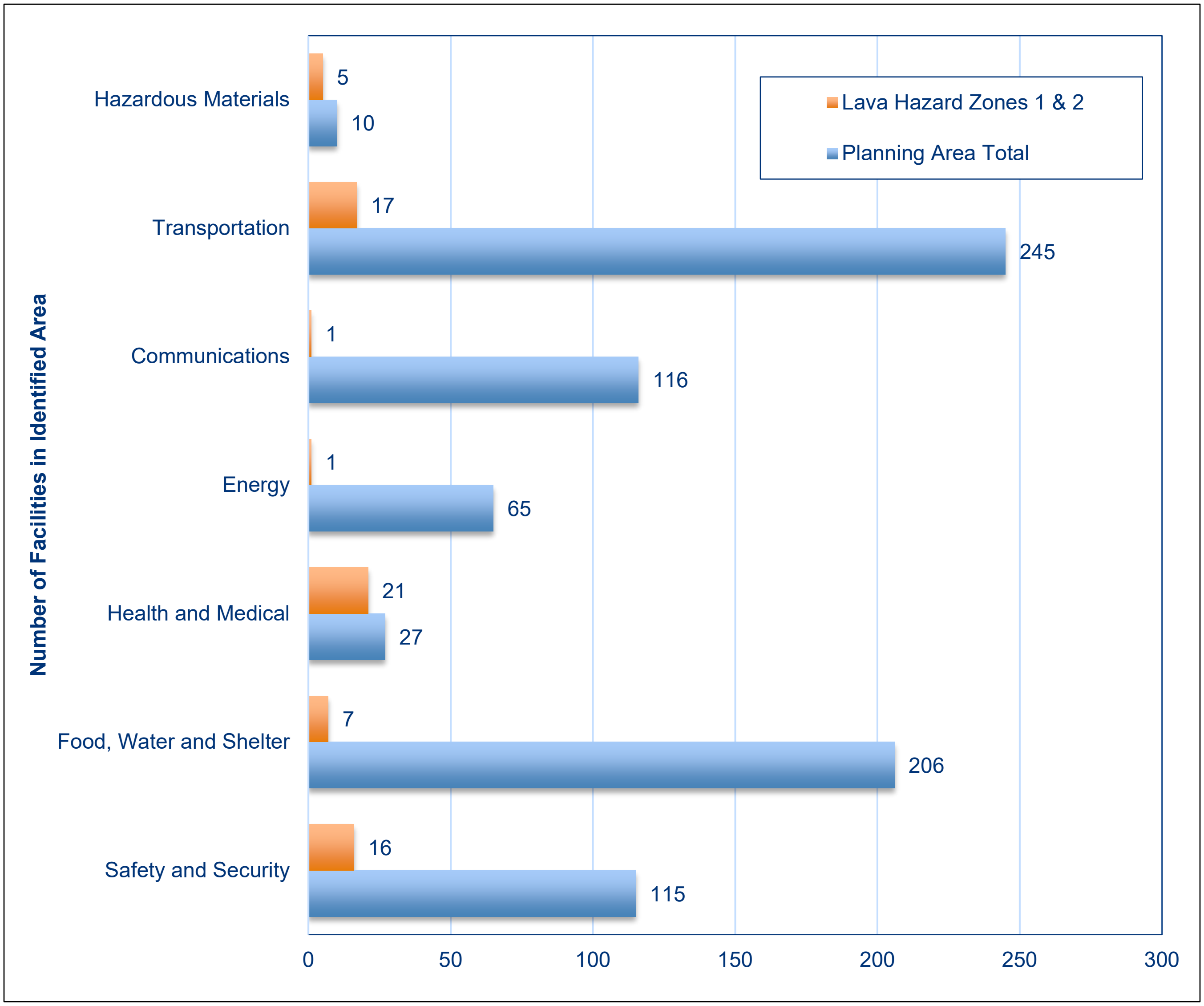


Figure 17-14. Critical Facilities in Lava Hazard Zones 1 and 2

17.3.3 Environment

The environment is highly exposed to the effects of a volcanic eruption. Natural environments and habitat in the path of a lava flow would be subject to destruction and wildlife would be displaced. Vog events expose the local environment to many effects such as lower air quality, and many other elements that could harm local vegetation and water quality.

17.4 VULNERABILITY

17.4.1 Population

Lava Flow

There is generally warning time before a volcanic event, but the population vulnerable to the lava flow hazard consists of those who are displaced by a lava flow, choose not to evacuate, or are unable to evacuate. The latter includes the elderly, the very young and other populations with access or functional needs.

Vog

The entire population of the planning area is vulnerable to the damaging effects of vog on an annual basis. The elderly, very young and those who experience ear, nose and throat problems are especially vulnerable to the vog hazard.

17.4.2 Property

Lava Flow

There are currently no generally accepted damage functions for volcanic hazards in risk assessment platforms such as Hazus. Therefore the planning team was not able to generate damage estimates for this hazard. The most vulnerable structures would be those that are located in Lava Zone 1. Loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 17-8 shows the general building stock loss estimates in Lava Flow Hazard Zone 1.

Table 17-8. Loss Potential for Lava Flow Hazard Zone 1

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Loss = 10% of Exposed Value	$267,140,000	$26,714,000	0.05%
Loss = 30% of Exposed Value		$80,142,000	0.15%
Loss = 50% of Exposed Value		$133,570,000	0.25%

Vog

All of the property exposed to nature in the planning area is exposed to the effects of a vog. Among these properties, the most vulnerable structures are those that are not as structurally sound and may have experience the compounded acidic effects associated with years of vog exposure.

17.4.3 Critical Facilities

Lava Flow

All critical facilities that are within the path of lava flow would be vulnerable, unless facilities can be relocated or lava flows diverted. Transportation routes that intersect with the highest risk lava flow zones are most vulnerable. Hazus identified four bridges that are located in lava flow hazard zones. Additionally, the following major roads in the planning area pass through Lava Hazard Zones 1 and 2 and thus are exposed:

- Hawaiʻi Belt Road (Māmalahoa Highway)
- Kalapana-Kapoho Beach Road
- Kapoho Road
- Kaūmana Drive
- Keaʻau-Pāhoa Road
- Māmalahoa Highway
- Pāhoa - Kalapana Road
- Pāhoa By-Pass Road
- Pāhoa Village Road
- Queen Kaahumanu Highway
- Saddle Road

Vog

All critical facilities are exposed to vog, but the threat to buildings is not great. On roadways, vog could create hazardous, low visibility driving conditions and hinder evacuations and response.

17.4.4 Environment

Vog can affect animals with respiratory health issues and cause death to animals that ingest water or grass that has been heavily contaminated by volcanic particles. Sulfur dioxide and residual acid aerosols also have been found to have broad detrimental impacts on vegetation (although there is some evidence that native plants have developed a degree of resistance to sulfur dioxide and/or the acid constituents in the plume.) If sulfur dioxide penetrates a plant's natural openings in leaf surfaces that regulate gas exchange, it can be combined with water in the moist mesophyll tissue and be converted to sulfuric acid, which burns plant tissue. The general effects of sulfur dioxide exposure to plants may vary and depend upon plant species, age, and the sulfur dioxide dosage.

17.5 FUTURE TRENDS IN DEVELOPMENT

17.5.1 Lava Flow

Lava hazard zones are mapped in the planning area. As such, development in potentially affected areas remains monitored. In Hilo, extensive residential development continues on Mauna Loa lavas that erupted in 1881; Highway 200, a major cross-island corridor is built across Mauna Loa lavas that erupted in 1855-56, 1880-81, 1899, and 1935 (County of Hawaiʻi, 2015). Figure 17-15 shows the distribution of land use by area in Lava Hazard Zones 1 and 2. Conservation, agricultural and rural uses make up all but about 2 percent of these zones.

17.5.2 Vog

All future development in the planning area will be susceptible to potential impacts from vog. While this potential impact on the built environment is not considered to be significant, the economic impact on industries that rely on machinery and equipment, such as agriculture or civil engineering projects, could be significant. Since the extent and location of this hazard is difficult to gauge because it is dependent upon many variables, the ability to institute land use recommendations based on potential impacts of this hazard is limited. While the impacts of vog are sufficient to warrant risk assessment for emergency management purposes, they are not sufficient to dictate land use decisions.

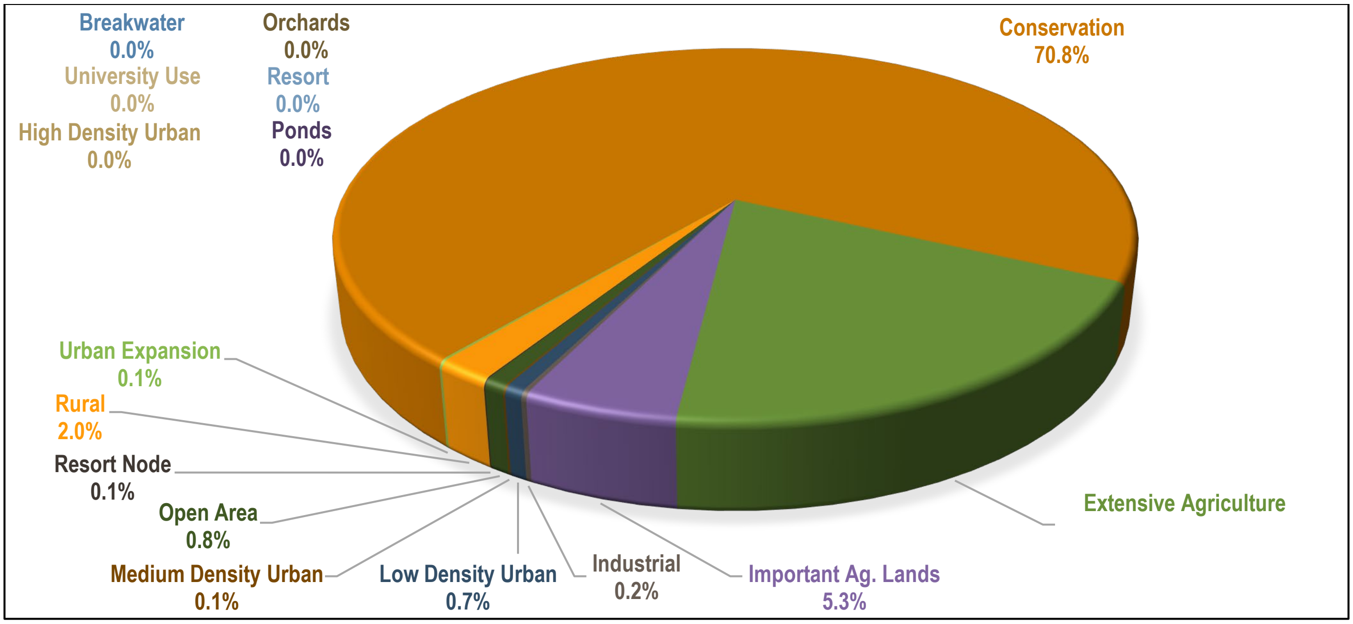


Figure 17-15. Land Use Distribution by Area in Lava Hazard Zones 1 and 2

17.6 SCENARIO

17.6.1 Lava Flow

In the event of a volcanic eruption in the planning area, there would probably not be any loss of life, due to adequate warnings and the generally slow movement of lava flows. However, there could be great loss of property, especially in Lava Hazard Zones 1 and 2, and a large and prolonged impact on the local economy. There would also be the possibility of severe environmental impacts due to lava flows in area rivers and streams.

17.6.2 Vog

A large area could be affected by vog. The most severe impacts would be on individuals, particularly those suffering from respiratory illness. Local hospitals may see an increase in respiratory-related acute illness, potentially causing a surge event. This impact is dependent upon the prevailing wind direction during and after the event. Businesses and non-essential government may be closed during particularly severe vog events.

17.7 ISSUES

Important issues associated with the volcano hazard include but are not limited to the following:

- **Lava Flow Intersection Mapping**—The lava hazard zones provide a general guideline for potential lava hazard areas during an eruption. More detailed mapping that shows the intersection of transportation corridors, critical facilities, and private property could serve to develop a more focused picture.
- **Tourism Outreach**—Tourists visiting Hawaiʻi County may not be immediately aware of the threat that vog poses to their health. Developing informational pamphlets on vog facts and safety may assist in minimizing respiratory emergencies from visitors.
- **Vog Action Plan**—The County may consider a Vog Action Plan that delineates specific community actions based on the anticipated level of a severe vog event. Such plans could include measures for sheltering in place, providing emergency shelter to the County's homeless population, and assisting known individuals with disabilities, access, or functional needs that may be exacerbated by vog.

18. WILDFIRE

18.1 HAZARD DESCRIPTION

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

The potential for significant damage to life and property exists in areas designated as "wildland urban interface (WUI) areas," where development is adjacent to densely vegetated areas. Fires in WUI areas tend to be more damaging than urban structural fires, are often more difficult to control, and behave differently from structural fires. When these fires erupt, people and structures must take priority, often at a devastating expense to natural resources. People who live in these areas often come directly from urban areas and may have little understanding of wildfire cycles and dangers. Homes and other structures are built and maintained in a manner that leaves them and their occupants vulnerable. Thus, fire becomes a significant threat to both humans and natural resources.

NOAA identifies four types of wildfires based on position relative to the ground (see Figure 18-1):

- **Ground Wildfires**—These wildfires burn in natural litter, duff, roots, or sometimes high-organic soils. Once they start, they are very difficult to detect and control. In addition, ground fires may rekindle.
- **Surface Wildfires**—These wildfires burn in grasses and low shrubs (up to 4 feet tall) or in the lower branches of trees. Surface wildfires may move rapidly, and the ease of control depends upon the fuel involved.
- **Crown Wildfires**—These wildfires burn on the tops of trees. Once started, they are very difficult to control since wind plays an important role in their spread.
- **Spotting Wildfires**—These wildfires occur when large burning embers are thrown ahead of a crown fire by wind and atmospheric conditions. Once spotting begins, the wildfire is very difficult to control.

Source: County of Maui, 2015

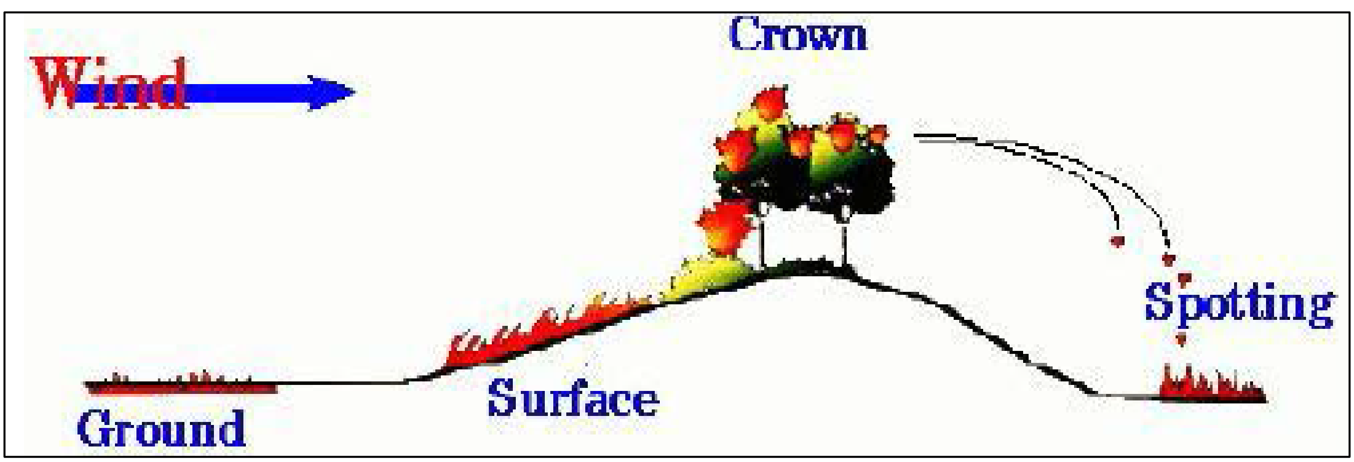


Figure 18-1. Types of Wildfires

FEMA defines four categories of wildfires based on location, severity or purpose (FEMA, 1997):

- **Wildland Fires**—Wildland fires are fueled mostly by natural vegetation. They typically occur in national forests and parks, where federal agencies are responsible for fire management and suppression.
- **Interface Fires**—Interface fires are urban/wildland fires in which vegetation and the built-environment provide fuel.
- **Firestorms**—Firestorms are events of such extreme intensity that effective suppression is virtually impossible. Firestorms occur during extreme weather and generally burn until conditions change or the available fuel is exhausted.
- **Prescribed Fires and Natural Burns**—Prescribed fires are intentionally set and natural burns are selected natural fires that are allowed to burn for beneficial purposes.

18.2 HAZARD PROFILE

18.2.1 Past Events

Table 18-1 lists recorded wildfire events in Hawaiʻi County between 2010 and 2019.

Table 18-1. Wildfires from 2010 to 2019

Date Started	Area	Acres Burned	Impacts
05/22/2010	North Kohala	300	Grass and kiawe burned
06/10/2010	Hawaiian Ocean View Estates	80	2 homes, 2 vehicles, 1 ag building burned; 50 people evacuated
06/27/2010	South Point near Green Sands Beach	350	Dry brush burned
07/04/2010	North Kona near Puʻuanahulu	500	Brush burned
08/22/2010	Near Pōhakuloa Training Area	1,400	Critical habitat and food sources for native palila forest birds burned
11/05/2010	South Kohala near Anekona Estates	130	Farm structure burned; residence damaged
03/05/2011	Hawaiʻi Volcanoes National Park	2,000	Brush burned
05/31/2011	Puʻuanahulu	500	Fountain grass burned
07/12/2011	Hawaiian Paradise Park	70	Brush burned
08/03/2011	Punaluʻu	85	Dry brush burned / temporary closure of Highway 11
10/04/2011	Pōhakuloa Training Area	1,150	Dry brush burned/ Temporary closure of Saddle Road
02/07/2012	Kailua-Kona near Pines neighborhood	38	Dry brush burned; residents evacuated
02/18/2012	Waikoloa near Paniolo Estates	80	Dry brush burned
06/18/2012	Pāhala	5,200	Dry brush, macadamia and coffee farms burned; Kaʻū Hospital evacuated; temporary closure of Highway 11
07/04/2012	Kailua-Kona near Hina Lani Street	430	Dry brush burned
07/20/2013	Kailua-Kona near Hulikoa Drive	1,000	Dead trees and dry brush burned; 300 residents evacuated
11/25/2013	Kona along Highway 190	700	Dry brush burned
01/12/2014	Puʻuwaʻawaʻa Forest Reserve	150	Brush burned
06/01/2014	Kaaulau Bay	1,022	Brush burned
10/06/2014	Puna District near ʻĀinaloa Estates	300	Lava flow ignited brush
01/13/2015	Pāhoa	800	Lava flow ignited dry brush
05/04/2015	Highway 11 in Kaʻū	200	Dry brush burned; temporary closure of Highway 11
05/11/2015	Nāʻālehu	15	1 residence burned; 10 other homes evacuated; dry brush burned
07/04/2015	North Kona	200	Brush burned; voluntary evacuations
07/17/2015	Parker Ranch Land south of Waimea	200	Brush burned
08/08/2015	Kawaihae	5,000	Brush burned; homes evacuated; temporary closure of North Kohala Road

Date Started	Area	Acres Burned	Impacts
01/20/2016	Palamanui near Hawai'i Community College	200	Fountain grass burned; residents, people at college voluntarily evacuated
02/11/2016	Daniel K. Inouye Highway; Highway 190 between Kailua-Kona and Waimea	1,100	Dry brush and fountain grass; road closures
03/23/2016	Pu'uanahulu along Highway 190	1,800	Brush burned
03/24/2016	Pōhakuloa Training Area	200	Brush burned
06/06/2016	Waiki'i Ranch; Pōhakuloa Training Area	400	Brush burned
02/01/2017	Pōhakuloa Training Area	770	Dry brush burned
02/06/2017	Nā'ālehu along Highway 11	200	Dry brush and grass burned
07/07/2017	Waimea	2,200	1 house burned; 1 vehicle burned; pastureland burned
09/21/2017	Ka'ū District	1,645	Dry brush burned
02/10/2018	South Kohala/North Kona along Highway 190	1,000	Brush burned; temporary highway closure
06/27/2018	Near Mauna Lani resort	52	Brush and kiawe burned
08/05/2018	Hawai'i Volcanoes National Park, Mauna Loa	3,739	Threatened valued park resources like the Kīpukakī and Kīpukapuaulu Special Ecological Areas, cultural heritage areas and rare forest habitat for endangered species.
08/01/2018	Near Waikoloa	18,000	Brush burned
12/28/2018	North Kona near Hina Lani Street and Ane Keohokalole Highway	50	Brush burned
02/05/2019	Pōhakuloa Training Area	110	Brush burned

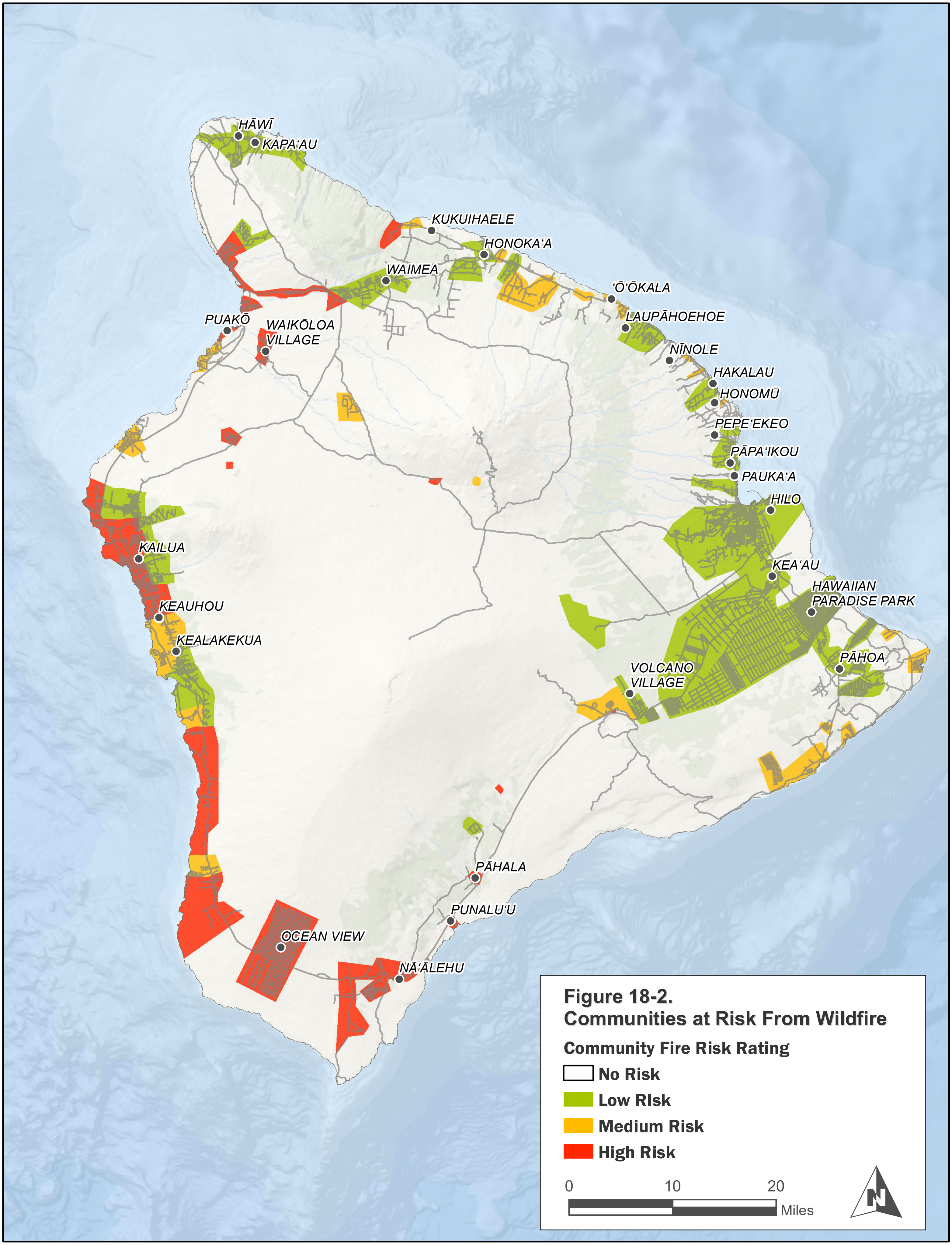
18.2.2 Location

Wildfire potential varies with location base on the following factors:

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, lightning, and the stability of the atmosphere. Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of landforms (fire spreads more easily uphill than downhill).

Historically, on the island of Hawai'i, the area between South Kohala and North Kona along with Ka'ū are most prone to wildfires due to little precipitation and a frequent history of drought. Areas near Kīlauea have been subject to lava outbreaks and vulnerable to wildfires ignited by hot magma.

The Hawai'i Wildfire Management Organization has developed mapping of Communities at Risk from Wildfire (CARW), which was used for the wildfire risk assessment. CARW maps delineate communities that share similar environmental conditions, land use characteristics, fuel types, hazards, and general wildfire issues. They provide ratings to characterize generalized hazards in each area. The state DLNR has developed streamlined community boundaries for its CARW maps. Figure 18-2 shows the CARW map for Hawai'i County.


HĀWĪ
KAPAʻAU
KUKUIHAELE
HONOKAʻA
WAIMEA
ʻŌʻŌKALA
LAUPĀHOEHOE
NĪNOLE
HAKALAU
HONOMŪ
PEPEʻEKEO
PĀPAʻIKOU
PAUKAʻA
HILO
KEAʻAU
HAWAIIAN
PARADISE PARK
PĀHOA
VOLCANO
VILLAGE
PUAKŌ
WAIKŌLOA
VILLAGE
KAILUA
KEAUHOU
KEALAKEKUA
PĀHALA
PUNALUʻU
OCEAN VIEW
NĀʻĀLEHU
Figure 18-2.
Communities at Risk From Wildfire
Community Fire Risk Rating
No Risk
Low RIsk
Medium Risk
High Risk
0
10
20
Miles
N

18.2.3 Frequency

Naturally occurring wildfires are most likely in dry periods. In Hawaiʻi, the fire season typically consists of the dry months of April through October. However, periods of drought can extend the season. According to government authorities, humans caused the highest percentage of wildfires in the County of Hawaiʻi either accidentally or intentionally. Major causes of accidentally induced wildfires are debris burning, land clearing (i.e. sugar cane burning), smoking, and campfires. In the County of Hawaiʻi, wildfires most often start in fields, open areas, transportation areas, or wooded lands. Wildfires are usually extinguished while smaller than1 acre but can spread to thousands of acres.

18.2.4 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Fire warning and response are generally sufficient so that the likelihood of injuries and casualties caused directly by a wildfire is minimal. However, smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. First responders are exposed to risks from the initial incident and after-effects from smoke inhalation and heat stroke.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure.

Economic impacts due to wildfires include costs and losses due to burned agricultural crops, damaged public infrastructure and private property, interrupted transportation corridors, and disrupted communication lines. They also include diminished real property values and thus tax revenues, loss of retail sales, and relocation expenses of temporarily or permanently displaced residents. Currently there is no measure in place to quantify the potential economic impacts due to wildfires besides historical data.

18.2.5 Warning Time

Humans often cause wildfires, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has contributed to a significant improvement in warning time.

In coordination with Civil Defense, drought and other fire-hazard conditions are constantly monitored, and actions such as burning bans and closures are instituted when needed. The public is informed of these restrictions by radio announcements and newspaper notices. New tools, such as satellite observation of bums, are being examined.

18.2.6 Firefighting Resources

The County of Hawaiʻi is divided into five Fire Response Zones. The Hawaiʻi County Fire Department, Division of Forestry and Wildlife (Department of Land and Natural Resources), Hawaiʻi Volcanoes National Park, and

U.S. Army are each assigned as the primary responder to one or more Fire Response Zones. The Hawaiʻi County Fire Department and the Division of Forestry and Wildlife provide co-response to the Fire Response Zones in which they do not have the primary responsibility, because they have resources dispersed across the island. The Hawaiʻi County Fire Department is often the first organization to respond to a wildland fire, as it receives the 911 calls reporting fires. The Hawaiʻi County Fire Department Dispatch Office provides the organization with primary responsibility for the Fire Response Zone with the 911 information, while also dispatching Hawaiʻi County Fire Department assets in response to the 911 call.

Given Hawaiʻi County's widely distributed population, response times can be long and the weight of response (number of firefighters and engines) can be limited. Hawaiʻi County has many areas where the roads accessing communities and residential clusters do not meet emergency access standards for road width (to allow residential population evacuation and incoming emergency apparatus) and where alternative access routes are not available.

For wildfire and rural use, the Fire Department is equipped with 10 tank trucks deployed around the island, which have a total capacity of 13,850 gallons. The department also has two special brush trucks for wildfire use. It also operates a rescue helicopter and an ambulance helicopter that can dump water when necessary. When more air support is needed, small and medium size private helicopters are hired.

The National Guard maintains five large helicopters (Blackhawks) in Hilo that have water bucket kits and have occasionally been hired from the state (the National Guard is a state agency). Federal firefighters may be available from a station in the National Park or the Army's Pōhakuloa Training Area. The park and Pōhakuloa occupy about 8 percent of the land area of the island. Occasionally, there are extensive fires in Hawaiʻi Volcanoes National Park that require assistance from fire crews flown in from the mainland.

18.2.7 Secondary Hazards

Wildfires can lead to secondary hazards such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Vulnerability to flooding increases due to the destruction of watersheds. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

Wildfires can cause direct economic losses in the reduction of harvestable crops and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs and destroy transmission lines.

18.3 EXPOSURE

18.3.1 Population

Population was estimated using the residential building count in each mapped CARW hazard area and multiplying by the 2018 estimated average population per household (U.S. Census American Community Survey). Using this approach, the estimated population living in the high and medium CARW wildfire risk areas is 32.4 percent of the planning area population (62,065 people), as shown in Table 18-2. In addition to populations who reside in risk areas where fires may occur, hikers and campers in the mountains may be exposed to wildfires. The entire population of the planning area has the potential to be exposed to smoke from nearby wildfires.

Table 18-2. Population Exposure to the Wildfire Hazard

CARW Zone	Population Exposed	% of Total Population
High	46,762	24.4%
Medium	15,303	8%
Total	**62,065**	**32.4%**

18.3.2 Property

Property damage from wildfires can significantly alter entire communities. Structures in WUI areas and those not designed with fire-smart principles in mind are particularly vulnerable. The total replacement value of property in the high and medium CARW wildfire risk areas is $18.5 billion—31.8 percent of the planning area total:

- High fire hazard: $14.2 billion
- Medium fire hazard: $4.3 billion

18.3.3 Critical Facilities and Assets

Critical facilities in the medium and high wildfire risk zones represent 30 percent of the total critical infrastructure and facilities in the planning area. The breakdown of exposure by facility type is shown in Figure 18-3.

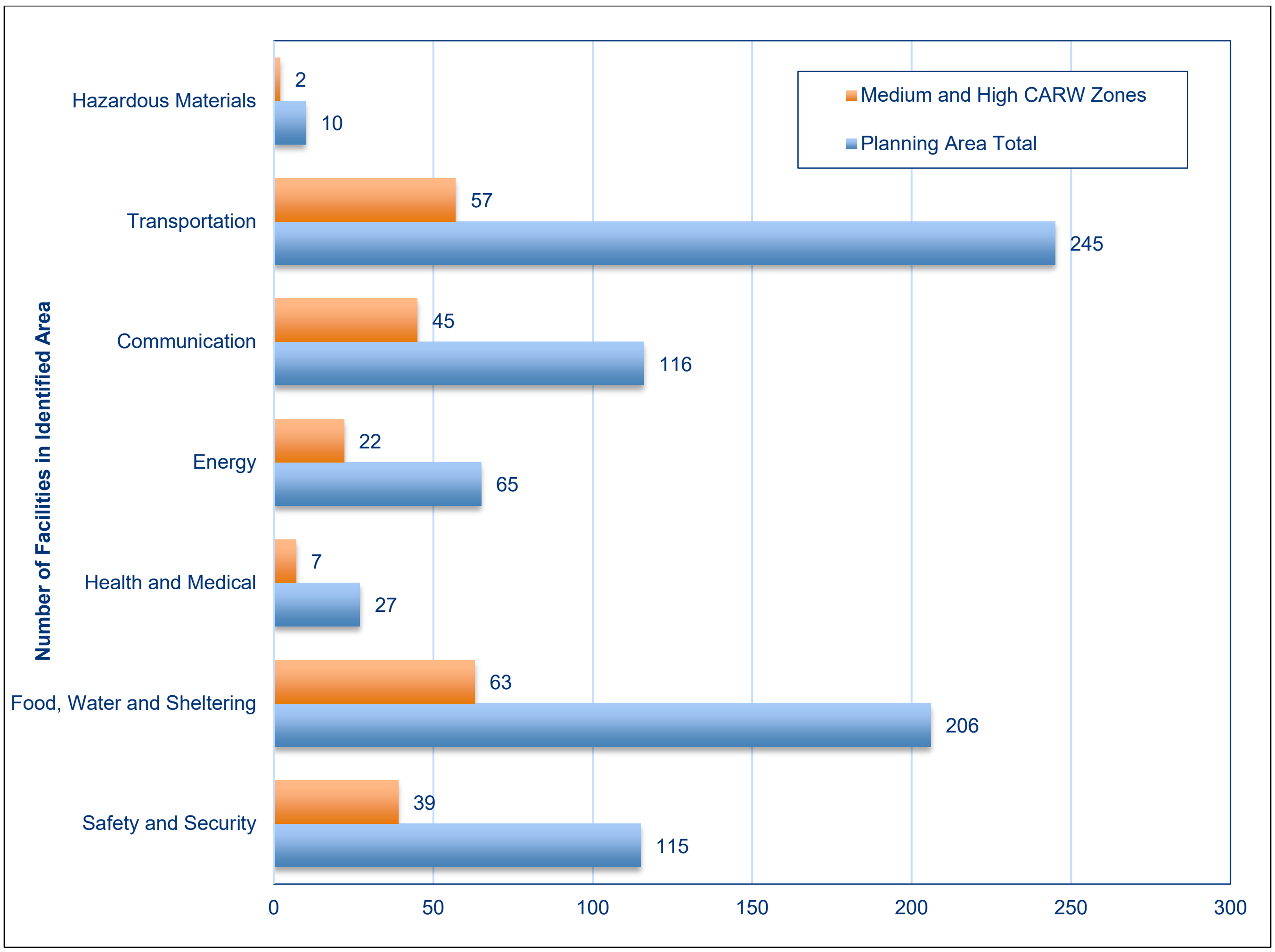


Figure 18-3. Critical Facilities in Medium and High CARW Zones and Countywide

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning.

There are likely to be several facilities containing hazardous materials exposed to the wildfire hazard. During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

18.3.4 Environment

All natural areas within the mapped CARW higher-risk areas are exposed to the wildfire hazard.

18.4 VULNERABILITY

18.4.1 Population

All people exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. Persons with access and functional needs, the elderly and very young may be especially vulnerable to a wildfire if there is not adequate warning time for them to evacuate if needed. In addition, people outside the mapped risk areas are susceptible to health hazards associated with smoke and air pollution from wildfires, especially sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. In addition, wildfires threaten the health and safety of those fighting the fires.

18.4.2 Property

All property exposed to the wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, estimates of potential loss were developed representing 1 percent, 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 18-3 shows the general building stock loss potential estimates in the high and medium CARW wildfire risk areas.

Table 18-3. Loss Potential for High and Medium CARW Wildfire Risk Areas

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Loss = 1% of Exposed Value	$18.5 billion	$184.7 million	Less than 1%
Loss = 10% of Exposed Value		$1.8 billion	3.17%
Loss = 30% of Exposed Value		$5.5 billion	9.52%
Loss = 50% of Exposed Value		$9.2 billion	15.87%

18.4.3 Critical Facilities and Assets

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

Hazardous materials sites located in proximity to wildfires are at particular risk for compounding issues. Hazardous materials facilities often contain large quantities of flammable materials. Should a wildfire reach one of these facilities, the result could be catastrophic.

18.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. However, under a specific set of circumstances, it can also cause severe environmental impacts, such as the following:

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat—**Wildfire can have negative consequences for endangered species by degrading their habitat.
- **Soil Sterilization**—Some wildfires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost.
- **Reduced Agricultural Resources**—Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs.
- **Damaged Cultural and Historical Resources**—The destruction of cultural and historic resources may occur, scenic vistas can be damaged, and access to recreational areas can be reduced.

18.5 FUTURE TRENDS IN DEVELOPMENT

The highly urbanized portions of the planning area have little or no wildfire risk exposure. Urbanization tends to alter the natural fire regime and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of WUI areas can be managed with strong land use and building codes. The planning area is well equipped with these tools. Land use in the planning area will be directed by the general plan and community plans adopted under state law. The natural hazard elements of the general plans establish standards and policies for the protection of the community from hazards.

Figure 18-4 shows the land use distribution by area in high and medium CARW severity zones. Agricultural and rural uses make up about 60 percent of these zones. Urban uses make up less than 13 percent.

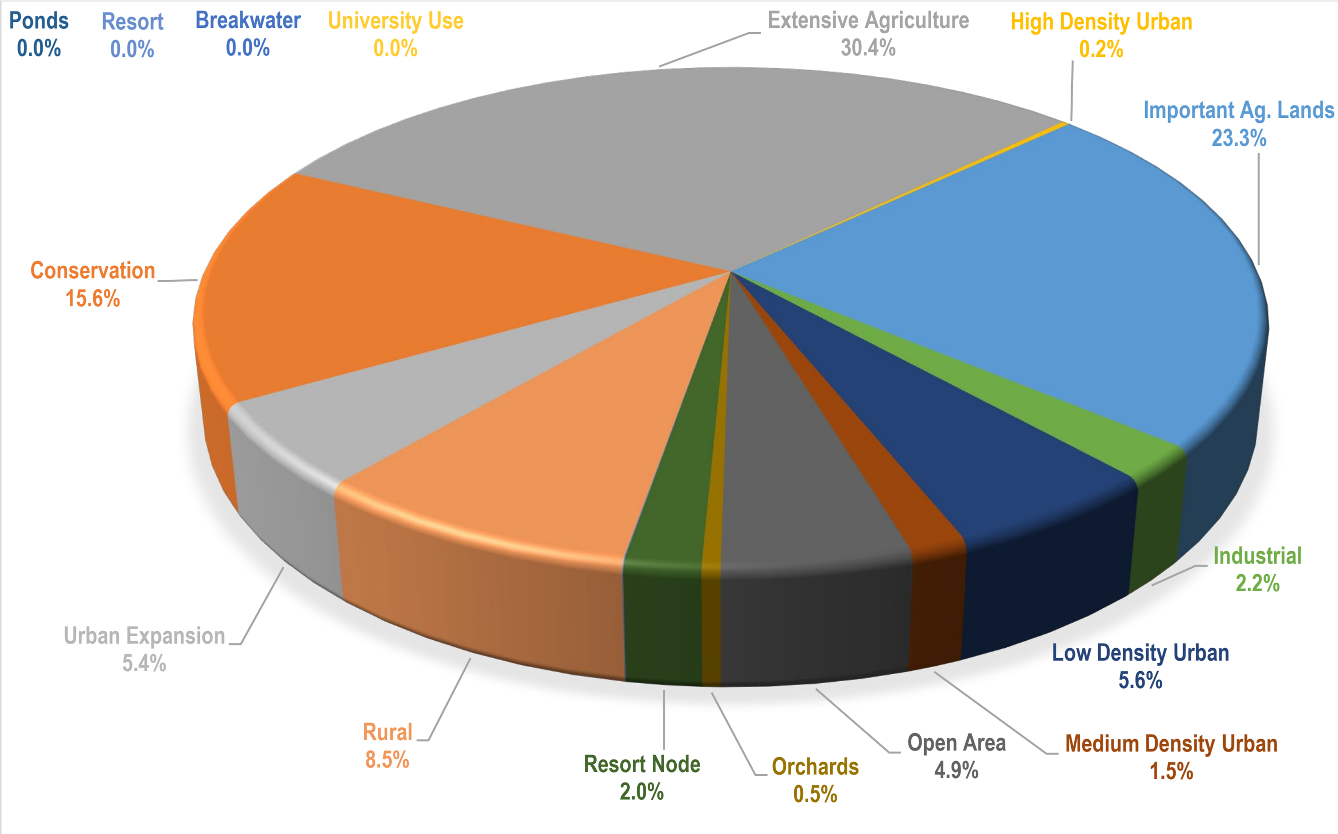


Figure 18-4. Land Use Distribution by Area in the High and Medium CARW Severity Zones

18.6 SCENARIO

A major conflagration in the planning area might begin with a wet spring, contributing to extensive growth of grasses and similar flash fuels. A dry summer could follow the wet spring, exacerbated by dry hot winds. The summer could see the onset of insect infestation. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried by hot, dry winds into forests and WUI zones. New small fires there would eventually merge. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The Hawai‘i County Fire Department responds to wildland fires, brush fires, and wildfires almost exclusively. Structure fires are rare on the island of Hawai‘i. The County does not have real-time access to federal resources such as the National Interagency Fire Center. The initial response to a major wildfire on the island would be exclusively local and state resources.

To further complicate this scenario, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

18.7 ISSUES

The major issues for wildfire are the following:

- **WUI Public Information**—Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- **Management of Development**—Future growth into WUI areas should continue to be managed with special development considerations.
- **Continued Responder Training** —Area fire districts need to continue to train on WUI events.
- **Vegetation Management Activities**—Such activities would include enhancement through expansion of the target areas as well as additional resources. Controlled burns of sugarcane fields would continue to be monitored to mitigate against potential major uncontrolled conflagrations
- **Responder Qualifications**—Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.

19. OTHER HAZARDS OF INTEREST

Hazard mitigation plans are required to include a risk assessment of natural hazards that can or have impacted a planning area (Section 201.6(c)(2)(i) 44 CFR). Plans have the option, but are not required, to include an assessment on non-natural hazards as well. The Steering Committee decided that for this update, the *County of Hawaiʻi Multi-Hazard Mitigation Plan* would include a profile of potential non-natural hazards that could impact the planning area. This creates an opportunity for plan integration and linkage between planning processes. The non-natural hazards addressed in this chapter are profiled but not fully assessed like the natural hazards addressed elsewhere in this plan. These hazards are not included in the risk ranking.

19.1 INVASIVE SPECIES

In Hawaiʻi, the term "invasive species" typically refers to species that were introduced by human assistance rather than by their own means of introduction and are harmful to the environment, economy, or human health. Table 19-1 and Table 19-2 list invasive species on the island of Hawaiʻi that have been designated for research, prevention or control. The following sections provide additional detail on species of particular concern.

Table 19-1. Plant Species Designated for Funding for Research or Prevention and Control Actions

Name	Regulatory Status	Prevention/Control Category[a]
Albizia (*Falcataria moluccana*)		BIISC Target Species
Banana Poka (*Passiflora tarminiana)*	Hawaiʻi Noxious Weed List	
Barbados Gooseberry (*Pereskia aculeata*)		BIISC Target Species
Black Wattle (*Acacia mearnsii*)	Hawaiʻi Noxious Weed List	
Bronze-Leaved Clerodendrum (*Clerodendrum quadriloculare*)		
Butterfly bush (*Buddleja davidii*)		
Cherokee Rose (*Rosa laevigata*)		
Chinese Tallow Tree (*Sapium sebiferum*)		BIISC EDRR Species
Christmas Berry (*Schinus terebinthifolius*)		
Cissus (*Cissus repens*)		
Cogon Grass (*Imperata cylindrica*)	Hawaiʻi Noxious Weed List; Federal Noxious Weed List	
Cotoneaster (*Cotoneaster pannosus*)		BIISC Target Species
Dahoon Holly (*Ilex cassine*)		BIISC Target Species
Feathery Senna (*Senna artemisioides*)		
Fire Tree (*Morella faya*)	Hawaiʻi Noxious Weed List	
Flame Vine (*Pyrostegia venusta*)		
Florida Blackberry (*Rubus argutus)*		
Fountain Grass (*Pennisetum setaceum*)	Hawaiʻi Noxious Weed List	BIISC Target Species
French Broom (*Genista monspessulana*)		
Gorilla Ogo (*Gracilaria salicornia*)		
Gorse (*Ulex europaeus*)	Hawaiʻi Noxious Weed List	

Name	Regulatory Status	Prevention/Control Category[a]
Himalayan Ginger (*Hedychium gardnerianum*)		
Himalayan Raspberry (*Rubus ellipticus*)	Hawai‘i Noxious Weed List	
Hiptage (*Hiptage benghalensis*)		
Hookweed (*Hypnea musciformis*)		
Ivy Gourd (*Coccina grandis*)	Hawai‘i Noxious Weed List	
Jerusalem thorn (*Parkinsonia aculeata*)		
Kappaphycus Algae (*Kappaphycus sp.*)		
Long-thorn Kiawe (*Prosopis julifloria*)	Hawai‘i Noxious Weed List	
Maile pilau (*Paederia foetida*)		
Mangrove, Red (*Rhizophora mangle*)		
Medinilla Genus (*Medinilla sp.*)		
Melastoma Genus (*Melastoma sp.*)	Hawai‘i Noxious Weed List	
Mexican feather grass (*Nassella tenuissima*)	Federal Noxious Weed	
Mexican Flame Vine (*Pseudogynoxys chenopodioides*)		
Miconia (*Miconia calvescens*)	Hawai‘i Noxious Weed List	BIISC Target Species
Molucca Raspberry (*Rubus sieboldii*)		
Mule's Foot Fern (*Angiopteris evecta*)		
Mullein (*Verbascum thapsus*)	Hawai‘i Noxious Weed List	
Mysore Raspberry (*Rubus niveus*)	Hawai‘i Noxious Weed List	
Night Blooming Jasmine (*Cestrum sp.*)		
Nile Tulip (*Markhamia lutea*)		BIISC EDRR Species
Oriental Bittersweet (*Celastrus orbiculatus*)		
Pampas Grass (*Cortaderia jubata, selloana*)	Hawai‘i Noxious List	BIISC Target Species
Plume Poppy (*Bocconia frutescens*)	Hawai‘i Noxious Weed List	
Poison Devil's Pepper (*Rauvolfia vomitoria*)		BIISC Target Species
Princess Tree (*Paulownia tomentosa*)		
Purple Toadflax (*Linaria purpurea*)		BIISC EDRR Species
Rubbervine (*Cryptostegia sp.*)		BIISC Target Species
Ruby grass (*Melinis nerviglumis*)		
Scotch Broom (*Cytisus scoparius*)		
Smoke Bush (*Buddleja madagascariensis*)		
Spanish Broom (*Spartium junceum*)		
Spiked Pepper (*Piper aduncum*)	Hawai‘i Noxious Weed List	
Stranvaesia Photinia (*Photinia davidiana*)		BIISC Target Species
Strawberry Guava (*Psidium cattleianum*)		
Sweet Autumn Clematis (*Clematis terniflora*)		
Tibouchina Genus (*Tibouchina sp.*)	Hawai‘i Noxious Weed List	BIISC EDRR Species
Tree of Heaven (*Ailanthus altissima*)		
Tumbleweed/ Russian thistle (*Salsola kali*)	Hawai‘i Noxious Weed List	
Wax Myrtle (*Morella cerifera*)		BIISC Target Species

a. BIISC = Big Island Invasive Species Committee
Source: Hawai‘i Invasive Species Commission, BIISC, 2020

Table 19-2. Animal Species Designated for Funding for Research or Prevention and Control Actions

Name	Regulatory Status[a]	Prevention/Control Category[b]
VERTEBRATES		
Axis Deer (*Axis axis*)		BIISC Target Species
Barn Owl (*Tyto alba*)	Hawai‘i Injurious Wildlife	
Brown Tree Snake (*Boiga irregularis*)	Hawai‘i Injurious Wildlife; Federal Injurious Wildlife	
Coqui (*Eleutherodactylus coqui*)	Hawai‘i Injurious Wildlife	
Feral cats (*Felis catus*)		
Jackson’s Chameleon (*Chameleo jacksonii*)	Hawai‘i Injurious Wildlife	
Mongoose (*Herpestes javanicus*)	Hawai‘i Injurious Wildlife; Federal Injurious Wildlife	
Red-masked Parakeet (*Aratinga erythrogenys*)	Hawai‘i Injurious Wildlife	
Red-vented Bulbul (*Pycnonotus cafer*)	Hawai‘i Injurious Wildlife	
Red-whiskered Bulbul (*Pycnonotus jocosus*)	Hawai‘i Injurious Wildlife; Federal Injurious Wildlife	
Rodents	Hawai‘i Injurious Wildlife	
Rose-ringed Parakeet (*Psittacula krameri*)	Hawai‘i Injurious Wildlife	
Snakes	Hawai‘i Injurious Wildlife	
Ungulates	Hawai‘i Injurious Wildlife	
Veiled Chameleon (*Chameleo calyptratus*)	Hawai‘i Injurious Wildlife	
INVERTEBRATES		
Africanized Honeybee (*Apis mellifera scutellata*)	Hawai‘i Injurious Wildlife	
Apple Snail (***Pomacea canaliculata***)		
Argentine Ant (*Linepithema humile*)		
Big-headed Ant (*Pheidole megacephala*)	HDOA Pest for Control	
Black Twig Borer (*Xylosandrus compactus*)	HDOA Pest for Control	
Coconut Rhinoceros Beetle (*Oryctes rhinoceros*)	Hawai‘i Injurious Wildlife; HDOA Pest for Control	
Coffee Berry Borer (*Hypothenemus hampei*)	Hawai‘i Injurious Wildlife; HDOA Pest for Control	
Erythrina Gall Wasp (*Quadrastichus erythrinae*)		
Fruit Flies		
Little Fire Ant (*Wasmannia auropunctata*)	Hawai‘i Injurious Wildlife; HDOA Pest for Control	
Mosquitos	Hawai‘i Department of Health—Vector Control Branch	
Naio Thrips (*Klambothrips myopori*)		
Nettle Caterpillar (*Darna pallivitta*)	Hawai‘i Injurious Wildlife; HDOA Pest for Control	
Rat Lungworm (*Angiostrongylus cantonensis*)		
Red Imported Fire Ant (*Solenopsis invicta*)	Hawai‘i Injurious Wildlife; HDOA Pest for Control	
Small Hive Beetle (*Aethina tumida*)	Hawai‘i Injurious Wildlife	
Snowflake Coral (*Carijoa riisei*)		
Tropical Fire Ant (*Solenopsis geminata*)		
Varroa Mite (*Varroa destructor*)	Hawai‘i Injurious Wildlife	
PATHOGENS AND DISEASES		
Banana bunchy top virus (*Babuvirus banana bunchy top virus*)	HDOA Pest for Control	
‘Ōhi‘a rust (*Austropuccinia psidii*)		
Rapid ‘Ōhi‘a Death, ROD (*Ceratocystis fimbriata*)		
West Nile Virus (*West Nile Virus*)		

a. HDOA = Hawai‘i Department of Agriculture
b. BIISC = Big Island Invasive Species Committee
Source: Hawai‘i Invasive Species Commission; BIISC, 2020

19.1.1 Albizia Trees

Albizia is notorious for its tendency to lose large, heavy limbs in even mild winds. Even before Tropical Storm Iselle, during which dozens of people were trapped for hours and several homes crushed, the residents of Puna had long dealt with the hazard of falling albizia. Outbuildings, fences, and cars were among the common casualties of albizia limbs. Albizia is prone to “sudden limb drop,” where hidden weaknesses in the limbs can cause branches to fall even with no apparent disturbance.

The cost to taxpayers and utility customers from albizia impacts is high. Besides the cost of removing trees that are direct threats, the state Department of Transportation, the County, and the Hawaiian Electric Co. routinely must deal with the impacts of trees falling from private property onto roads and power lines. Hawaiian Electric Co. estimates that it spent $13 million responding to damage from Iselle, and the Hawai‘i County branch of the state Department of Transportation estimates that 90 percent of all received calls about fallen trees are for albizia. Costs to individual property owners from trees falling onto adjoining properties have not been compiled but are likely in the millions of dollars.

19.1.2 Coqui Frogs

The distinctive “KO-kee” call that gives the frog its name can reach 100 decibels, louder than many power tools and lawn equipment, and can be very disruptive for residents in infested areas.

19.1.3 Little Fire Ants

Little fire ants are listed among the world’s 100 worst invasive species. They are easily transported on cars, building material, plant materials, and produce. Stings have been compared to the feeling of an electrical burn.

19.1.4 Queensland Longhorn Beetle

The Queensland Longhorn Beetle, from the Queensland area of Australia, appears to have first arrived in Hawai‘i about a decade ago. The first sample was turned in from the Orchidland area in 2009, but for several years after, there were no reports. However, in 2013, the Hawai‘i Department of Agriculture received three more submissions, with a handful of beetles appearing each subsequent year. By 2017, it appeared that the beetles had begun to spread, with specimens collected in Hawaiian Acres, Kea’au, and Kurtistown. In summer of 2018, specimens were captured in Pāhoa and Hilo, indicating the beetle may be expanding its territory.

Adult beetles will feed on the bark, branches, and leaves of preferred plants, but the real damage is caused by the larvae. The females lay eggs in wood, usually in stressed, dying, or weakened trees. The emerging larvae tunnel through the tree’s vascular system, creating tunnels that weaken the wood and interrupt the plant’s ability to transport nutrients and water. In one case in Puna, an infested Sago palm became so weak it collapsed under its own weight. In addition to cacao, citrus, kukui, and Sago palms, this beetle may attack other hardwoods in Hawai‘i, from important crop trees to native forest species.

19.1.5 Rat Lungworm

Rat lungworm poses a danger to any human who accidentally eats a slug or snail that has been infected with the parasite’s larvae. Disease symptoms range from mild illness to severe debilitation, coma, and even death. Many survivors of rat lungworm report permanent injury from the disease. All snails and slugs—including endangered native snails—can carry the parasite. One slug in particular—*Parmarion martensi*, or semi-slug—has been shown to have the ability to carry a very high parasite load. As of early 2019, the semi-slug has been confirmed as established from Volcano to Kalapana to Hilo and up the coast into North Kohala, and is quickly continuing to spread across the Big Island.

19.1.6 Two-Lined Spittle Bug

The two-lined spittle bug was discovered in Kona in late 2016, when a rancher in upper-elevation Hualālai first reported widespread die-off of pastures. Initial surveys found nearly 2,000 acres were already affected. By 2018, further surveys revealed that the insect had impacted 125,000 acres of rangeland from Makalei to Kēōkea. Spittle bugs feed by sucking nutrients and fluids from the plant stem, weakening and potentially killing the grass. Although Hawaiʻi already has introduced spittle bugs, none have had such severe impacts. Like many invasive pests that arrive in Hawaiʻi, the new bug, a native of the southeastern United States, was likely brought in accidentally on imported plant materials. Now, it is attacking kikuyu and pangola grasses: critical forage that support nearly 70 percent of Hawaiʻi's beef cattle industry.

19.2 FOOD SUPPLY

Hawaiʻi is 2,500 miles from the continental United States. About 85 to 90 percent of the state's food is imported, which makes it particularly vulnerable to natural disasters and global events that might disrupt shipping and the food supply.

Despite a year-round growing season, only 15 percent of the food supply is grown locally. The rest arrives on container ships, putting the state in peril in the event of a tropical cyclone or shipping strike, such as in 2012, when a California port strike led to bare store shelves in Hawaiʻi (US News, 2020). University studies have estimated there is only an 11-day supply of food in the state at any given time (University of Hawaiʻi, 2014a).

Food security in Hawaiʻi is often understood in terms of possible interruptions to food imports, but there are other threats as well. For example, such things as local climate change, bee mites, and disruptions in water supply could threaten Hawaiʻi's agriculture. Local economic weaknesses of various kinds can lead to sharp reductions in local food production.

19.3 MASS EVENTS

According to the World Health Organization, an event counts as a mass gathering if the number of people it brings together is so large that it has the potential to strain the planning and response resources of the health system in the community where it takes place. This is based on the location and duration of the event as well as the number of participants. For example, if the event takes place over several days on a small island such as the island of Hawaiʻi where the capacity of the health system is limited, then even a few thousand participants could place a strain on the health system.

Mass gatherings of people at sporting or other events are linked to numerous health hazards, including the transmission of infectious diseases, physical injuries, and an impact on local health systems and services. Mass gathering-related disasters are the product of the management of different hazards, levels of exposure, and vulnerability of the population and environment. (Aitsi-Selmie et al., 2016). Planning for mass gatherings should focus on the following:

- Ensuring that correct standards are applied to risk assessment, surveillance and response, including outbreak management, infection control and vaccination

HAWAIʻI COUNTY ANNUAL MASS GATHERING EVENTS

Ironman World Championship

- Annual triathlon event each fall, drawing international attendance.
- Based in Kona, with the cycling leg of the race traveling up the Kohala coast to Hawi.
- Approximately 2,400 participant athletes, 5,000 volunteers, thousands of spectators, members of the media, vendors, and other staff providing support services.

Merrie Monarch Festival

- Annual cultural festival and hula competition each spring, with international attendance.
- Based in Hilo at the Edith Kanaka'ole Stadium
- Tickets sell out every year for the stadium with a capacity of 5,000 seats
- Dozens of hālau hula invited to perform and compete.

- Planning for the management of mass casualties and emergencies in local communities at event venues
- Ensuring that adequate diagnostic capacities are in place, including human resources and transport
- Ensuring that procedures are in place to provide updated health advice and guidance for visitors on topics such as vaccinations, food and water safety, and emergency contact numbers;
- Carrying out activities before and during mass gatherings to encourage healthy behaviors, such as increased physical activity, cessation of tobacco use, avoidance of excess alcohol and safe sex practices.

19.4 CYBER

A cyber threat is an intentional and malicious crime that compromises the digital infrastructure of a person or organization, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital mediums or sometimes social engineering to target human operators. Generally, attacks last minutes to days, but large-scale events and their impacts can last much longer. As information technology continues to grow in capability and interconnectivity, cyber threats become increasingly frequent and destructive. In 2014, internet security teams at Symantec and Verizon indicated that nearly 1 million new pieces of malware—malicious code designed to steal or destroy information—were created every day (Harrison, 2015).

Cyber threats differ by motive, attack type and perpetrator profile. Motives range from the pursuit of financial gain to political or social aims. Cyber threats are difficult to identify and comprehend. Types of threats include using viruses to erase entire systems, breaking into systems and altering files, using someone's personal computer to attack others, or stealing confidential information. The spectrum of cyber risks is limitless, with threats having a wide-range of effects on the individual, community, organizational, or nation (FEMA, 2013). The following sections describe cyber-attacks in general and, more specifically, cyberterrorism.

19.4.1 Cyber-Attacks

Public and private computer systems are subject to a variety of cyber-attacks, from blanket malware infection to targeted attacks on system capabilities. Cyber-attacks seek to breach IT security measures designed to protect an individual or organization. The initial attack is followed by more severe attacks for the purpose of causing harm, stealing data, or financial gain. Organizations are prone to attacks that can be either automated or targeted. Table 19-3 describes the most common cyber-attack mechanisms faced by organizations today.

Since 2013, a type of cyber-attack called cyber ransom has become increasingly common against individuals and small- and medium-sized organizations. Cyber ransom occurs when an individual downloads ransom malware, or ransomware, often through phishing or drive-by download, and the subsequent execution of code results in encryption of all data and personal files stored on the system. The victim then receives a message that demands a fee in the form of electronic currency or cryptocurrency, such as Bitcoin, for the decryption code. In October 2015, the FBI said that commonly used ransomware is so difficult to override, that victims should pay the ransom to retrieve their data (Danielson, 2015).

With millions of threats created each day, the importance of protection against cyber-attacks becomes a necessary function of everyday operations for individuals, government facilities, and businesses. The increasing dependency on technology for vital information storage and the often automated method of infection means higher stakes for the success of measurable protection and education.

19.4.2 Cyberterrorism

Cyberterrorism is the use of computers and information, particularly over the Internet, to recruit others to a cause, cause physical or financial harm, or cause a severe disruption of service. It can be driven by religious, political, or other motives. Like traditional terrorism tactics, cyberterrorism seeks to evoke strong emotional reactions, but it does so through information technology rather than a physically violent or disruptive action.

Table 19-3. Common Mechanisms for Cyber Attacks

Type	Description
Socially Engineered Trojans	Programs designed to mimic legitimate processes (e.g. updating software, running fake antivirus software) with the end goal of human-interaction caused infection. When the victim runs the fake process, the Trojan is installed on the system.
Unpatched Software	Nearly all software has weak points that may be exploited by malware. Most common software exploitations occur with Java, Adobe Reader, and Adobe Flash. These vulnerabilities are often exploited as small amounts of malicious code are often downloaded via drive-by download.
Phishing	Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
Password Attacks	Third party attempts to crack a user's password and subsequently gain access to a system. Password attacks do not typically require malware, but rather stem from software applications on the attacker's system. These applications may use a variety of methods to gain access, including generating large numbers of generated guesses, or dictionary attacks, in which passwords are systematically tested against all of the words in a dictionary.
Drive-by Downloads	Malware is downloaded unknowingly by the victims when they visit an infected site.
Denial of Service Attacks	Attacks that focus on disrupting service to a network in which attackers send high volumes of data until the network becomes overloaded and can no longer function.
Man in the Middle	Man-in-the-Middle attacks mirror victims and endpoints for online information exchange. In this type of attack, the attacker communicates with the victims, who believe they are interacting with a legitimate endpoint website. The attacker is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the attacker obtains entered and received information from both the victim and endpoint.
Malvertising	Malware downloaded to a system when the victim clicks on an affected ad.
Advanced Persistent Threat	An attack in which the attacker gains access to a network and remains undetected. Advanced persistent threat attacks are designed to steal data instead of cause damage.

Cyberterrorism has three main types of objectives (Kostadinov, 2012):

- **Organizational**—Cyberterrorism with an organizational objective includes functions other than cyber-attacks. Terrorist groups today use the internet every day for recruitment, training, fundraising, communication, or planning. Organizational cyberterrorism can use platforms such as social media as a tool to spread a message beyond country borders and instigate physical forms of terrorism. Organizational efforts may include system attacks as a tool for training new members of a faction in cyber warfare.
- **Undermining**—Cyberterrorism with undermining as an objective seeks to hinder the normal functioning of computer systems, services, or websites. Such methods include defacing, denying, and exposing information. These attacks aim to undermine the victim's high dependence on online structures to support vital operational functions. They typically do not result in grave consequences unless undertaken as part of a larger attack. Undermining attacks on computers include the following:

  - Physical attack against computer equipment, a computer facility, or transmission lines to disrupt the reliability of equipment.
  - Using electromagnetic energy, usually in the form of an electromagnetic pulse, to attack computer equipment or data transmissions. By overheating circuitry or jamming communications, an electronic attack disrupts the reliability of equipment and the integrity of data.
  - Using malicious code directed against computer processing code, instruction logic, or data. The code can generate malicious network packets that disrupt data or logic. This type of cyber-attack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications (Wilson, 2008).

- **Destructive**—The destructive objective for cyberterrorism is what organizations fear most. Through the use of computer technology and the Internet, the terrorists seek to inflict destruction or damage on tangible property or assets, and even death or injury to individuals. There are no cases of pure cyberterrorism as of the date of this plan.

19.5 PANDEMIC OUTBREAKS

An outbreak is defined by the U.S. Centers for Disease Control and Prevention (CDC) as the occurrence of more cases of disease than normally expected within a specific place or group of people over a given period of time. State and local regulations require immediate reporting of any known or suspected outbreaks by health care providers, health care facilities, laboratories, veterinarians, schools, child day care facilities, and food service establishments. An epidemic is a localized outbreak that spreads rapidly and affects a large number of people or animals in a community. A pandemic is an epidemic that occurs worldwide or over a very large area and affects a large number of people or animals.

NOTE REGARDING COVID-19

As this planning process was being completed, Hawaiʻi County, the State of Hawaiʻi and the remainder of the world was just beginning to deal with the impacts from the COVID-19 global pandemic. COVID-19 is the name of the disease caused by the virus whose name is SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2)

The impacts from this event will be long term and change the way society as a whole views, prepares for and responds to pandemics.

Data on the impacts from this event and the development policies to respond were in their infancy as of this writing and were not fully vetted enough to inform this plan update. It is anticipated that future updates to this plan will have well informed, expanded dialogue on this subject matter.

19.5.1 Identified Hazards

The Hawaiʻi Department of Health Disease Outbreak Control Division has identified the conditions described in the sections below as human diseases that could contribute to a serious epidemic in the state.

Animal Transmitted

These are diseases that are transmitted by domestic or non-domestic animals. Diseases of this type identified by Hawaiʻi Department of Health include the following:

- Brucellosis (undulant fever)
- Campylobacteriosis
- Cat scratch disease
- Cryptosporidiosis
- Escherichia coli (E. coli)
- Giardiasis
- Middle Eastern Respiratory Syndrome (MERS)
- Plague
- Psittacosis (ornithosis, parrot fever)
- Q Fever
- Rabies
- Ringworm
- Salmonellosis
- Toxoplasmosis
- Tularemia

Bioterrorism Related

Bioterrorism agents are divided into three categories based on their ease of spread and the severity of illness they cause. Category A agents are most dangerous, and Category C agents are current emerging threats:

- Category A pathogens—Organisms or biological agents that pose the highest risk to national security and public health because they:
    - Can be easily spread or transmitted from person to person
    - Result in high death rates and have the potential for major public health impact
    - Might cause public panic and social disruption
    - Require special action for public health preparedness.
- Category B pathogens—The second highest priority organisms/biological agents. They:
    - Are moderately easy to disseminate
    - Result in moderate morbidity rates and low mortality rates
    - Require specific enhancements for diagnostic capacity and enhanced disease surveillance.
- Category C pathogens—The third highest priority, including emerging pathogens that could be engineered for mass dissemination in the future because of:
    - Availability
    - Ease of production and dissemination
    - Potential for high morbidity and mortality rates and major health impact.

Bloodborne

Viruses, bacteria and parasites that can be carried in blood and cause disease are known as bloodborne pathogens. Transmission of these diseases may be from direct blood contact, needle sticks, intravenous drug use, high risk sexual behavior or by insects or other vectors. Bloodborne diseases include the following:

- Ebola
- Hepatitis C
- Malaria

Community-Acquired Infections

Community-acquired infections are infections that are contracted outside of a hospital or are diagnosed within 48 hours of admission without any previous health care encounter. Types of community acquired infections include the following:

- Adenovirus
- Bed Bugs
- Body Lice
- Campylobacteriosis
- Conjunctivitis (pink eye)
- Common cold viruses
- Enterovirus, non-polio
- Hand, foot, and mouth disease
- Head Lice (ʻukus)
- Impetigo

- Influenza (flu)
- Invasive Group A Streptococcus (necrotizing fasciitis)
- Legionnaires' Disease/Pontiac Fever
- Methicillin-Resistant Staphylococcus Aureus (MRSA)
- Norovirus
- Pinworm disease
- Respiratory syncytial virus
- Ringworm
- Scabies
- Smallpox
- Staphylococcus aureus
- Strep throat/scarlet fever
- Streptococcus, Group B
- Tularemia
- Viral meningitis

Foodborne

Many diseases can be contracted by eating contaminated food or beverages. Most of these are spread when food becomes contaminated with fecal matter containing bacteria, viruses, or parasites. This contamination can happen at a farm, manufacturing plant, restaurant, or home. Foodborne diseases usually result in gastrointestinal illness, which can include symptoms such as diarrhea, vomiting, nausea, stomachache, and fever. People who are ill with a foodborne disease can give the infection to others, so proper hygiene and hand washing practices are essential to limit the spread of disease, and people experiencing gastrointestinal symptoms should not prepare or handle food for others. Foodborne diseases include the following:

- Amebiasis
- Angiostrongyliasis (rat lungworm)
- Anisakiasis
- Botulism
- Brucellosis (undulant fever)
- Campylobacteriosis
- Cholera
- Ciguatera fish poisoning
- Cryptosporidiosis
- Cyclosporiasis (cyclospora infection)
- Escherichia coli (E. coli)
- Giardiasis
- Listeriosis
- Norovirus
- Salmonellosis
- Scombroid
- Shigellosis
- Tularemia
- Typhoid Fever
- Vibriosis
- Yersinia enterocolitica (Yersiniosis), non-pestis

Influenza

Influenza is an infectious viral disease of birds and mammals commonly transmitted through airborne aerosols such as coughing or sneezing. Symptoms are chills, headache, fever, nausea, muscle pain and occasionally pneumonia. New flu strains caused pandemics in the late 19th and 20th centuries: Russian flu, 1918 Spanish flu, Asian flu, Hong Kong flu, and A/H1N1 or the swine flu. According to the CDC, avian influenza occurs naturally among wild aquatic birds worldwide and can infect domestic poultry and other bird and animal species. Avian flu viruses do not normally infect humans. The recent avian flu strains H5N1 and H7N9 have caused human deaths but have not escalated to pandemic proportions.

Mosquito-Transmitted

Mosquito-borne diseases are not felt to be an immediate threat in Hawai‘i because travelers are usually vaccinated (yellow fever) or disease spread requires a sick bird to travel all the way from the mainland (West Nile virus). Some mosquito-transmitted diseases (e.g., malaria or Japanese encephalitis virus) are not likely to ever be a threat because the mosquito species needed to spread the disease are not found in Hawai‘i. However, it is important for travelers to be aware of these serious diseases and where they occur in the world so they may protect themselves.

Respiratory Viruses

Respiratory viruses are responsible for influenza-like illness morbidity within the community. Respiratory viruses can also cause the common cold. Respiratory viruses include the following:

- Adenovirus
- Coronaviruses (including SARS and MERS CoV)
- Influenza (flu)
- Parainfluenza
- Parvovirus B19 (fifth disease)
- Respiratory syncytial virus
- Rhinovirus (common cold)
- Measles
- Pertussis (also known as whooping cough)

The virus that has caused the COVID-19 pandemic at the time this hazard mitigation plan is being prepared (SARS-CoV-2) also is a respiratory virus.

These viruses are usually mild in illness. People at high risk (those with certain underlying conditions, the elderly, the very young, and pregnant women) could develop severe illness that could result in hospitalization or death. The best way to protect oneself is by proper hand hygiene and avoiding contact with sick individuals. The best way for those who are infected to protect others is to cover their nose and mouth when sneezing and coughing, use good hand hygiene, and stay home from work or school.

Waterborne Diseases

Waterborne diseases are conditions caused by pathogenic micro-organisms that are transmitted in water. These diseases can be spread while bathing, washing, drinking water, or eating food exposed to contaminated water. Waterborne diseases include the following:

- Cholera
- Giardiasis
- Legionnaires’ Disease /Pontiac Fever
- Leptospirosis

- Typhoid Fever
- Vibriosis

Sexually Transmitted Disease

Sexually transmitted diseases include the following:

- Chlamydia
- Genital warts
- Gonorrhea
- Hepatitis A, B, and C
- Herpes
- Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS)
- Human papillomavirus
- Syphilis
- Zika

HIV/AIDS, chlamydia, gonorrhea, and syphilis are the predominant infections handled by the Hawaiʻi State Department of Health Harm Reduction Services Branch, whose responsibilities include awareness, prevention, and control of these infections.

19.5.2 Location, Extent and Magnitude

Health hazards that affect the residents of Hawaiʻi County may arise in a variety of situations, such as during a communicable disease outbreak, after a natural disaster, or as the result of a bioterrorism incident. All populations in Hawaiʻi County are susceptible to bioterrorism or pandemic events. Populations who are young or elderly or have compromised immune systems are likely to be more vulnerable. The relative ease of world-wide travel in addition to the world's expanding global food industry ensures that all countries are vulnerable to pandemic events at any time.

19.5.3 Planning Capability for Pandemic

The State of Hawaiʻi Department of Health's Disease Outbreak Control Division comprises the Disease Investigation Branch and Immunization Branch. These programs work together to monitor, investigate, prevent, and control infectious diseases in Hawaiʻi, especially those preventable through immunizations, and to ensure Hawaiʻi's ability to respond to emergencies that threaten the public's health. Toward these goals, they work to strengthen the relationships between the Department of Health and other partners, including laboratories, hospitals, schools, emergency response agencies, private organizations, and the military.

20. RISK RANKING

A risk ranking was performed for the hazards of concern described in this plan. This risk ranking assesses the probability of each hazard's occurrence as well as its likely impact on the people, property, and economy of the planning area. The risk ranking methodology and results were reviewed, discussed, and approved by the working group. When available, estimates of risk were generated with data from Hazus or GIS analysis using methodologies promoted by FEMA. For hazards of concern with less robust datasets, qualitative assessments were used. The results are used in establishing mitigation priorities.

Numerical ratings of probability and impact were based on the hazard profiles and exposure and vulnerability evaluations presented in Chapters 7 through 15. Using that data, the County ranked the risk of all the natural hazards of concern described in this plan. When available, estimates of risk were generated with data from Hazus or GIS. For hazards of concern with less specific data available, qualitative assessments were used. As appropriate, results were adjusted based on local knowledge and other information not captured in the quantitative assessments. The hazards of interest described in Chapter 19 were not ranked for the following reasons:

- A key component of risk as defined for the planning effort is probability of occurrence. While it is possible to assign a recurrence interval for natural hazards because of historical occurrence, it is not feasible to assign recurrence intervals for the other hazards of interest, which lack such historical precedent.
- Federal hazard mitigation planning regulations do not require the assessment of non-natural hazards (44 CFR, 201.6). It is FEMA's position that this is a local decision.

Risk ranking results are used to help establish mitigation priorities. The County used its risk ranking to inform the development of an action plan, identifying mitigation actions, at a minimum, to address each hazard with a "high" or "medium" risk ranking. Actions that address hazards with a low or no hazard ranking are optional.

20.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a probability factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0).

The assessment of hazard frequency is generally based on past hazard events in the area. Table 20-1 summarizes the probability assessment for each hazard of concern for this plan. For this risk ranking exercise, the two volcanic hazards, lava flow and vog, are ranked separately. This method was determined because of the significant difference in probability of occurrence for each type of volcanic hazard.

Table 20-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Climate Change/Sea Level Rise	High	3
Dam Failure	Low	1
Drought	High	3
Earthquake	High	3
Flood	High	3
High Surf/Storm Surge/Coastal Flood	High	3
High Windstorms	High	3
Landslide	High	3
Tropical Cyclone	Medium	2
Tsunami	Medium	2
Volcanic Eruption	High	3
Wildfire	High	3

20.2 IMPACT

Hazard impacts will be assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors are assigned as follows:

- **People**—Values are assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners could use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:
    - High—30 percent or more of the population is exposed to a hazard (Impact Factor = 3)
    - Medium—15 percent to 29 percent of the population is exposed to a hazard (Impact Factor = 2)
    - Low—14 percent or less of the population is exposed to the hazard (Impact Factor = 1)
    - No impact—None of the population is exposed to a hazard (Impact Factor = 0).
- **Property**—Values are assigned based on the percentage of the total ***property value exposed*** to the hazard event:
    - High—25 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
    - Medium—10 percent to 24 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
    - Low—9 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
    - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0).
- **Economy**—Values are assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total assessed value of the property exposed to the hazard. For some hazards, such as wildfire and landslide, vulnerability will be considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates will be generated for the earthquake, flood hazards, and tropical cyclones using Hazus.

- High—Estimated loss from the hazard is 15 percent or more of the total exposed property value (Impact Factor = 3)
- Medium—Estimated loss from the hazard is 5 percent to 14 percent of the total exposed property value (Impact Factor = 2)
- Low—Estimated loss from the hazard is 4 percent or less of the total exposed property value (Impact Factor = 1)
- No impact—No loss is estimated from the hazard (Impact Factor = 0).

The impacts of each category are assigned a weighting factor to reflect its significance: impact on people is given a weighting factor of 3; impact on property is given a weighting factor of 2; and impact on the economy is given a weighting factor of 1. Table 20-2, Table 20-3 and Table 20-4 summarize the impacts for each hazard.

Table 20-2. Impact on People from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Climate Change/Sea Level Rise	Low	1	1x3=3
Dam Failure	Low	1	1x3=3
Drought	None	0	0x3=0
Earthquake	High	3	3x3=9
Flood	Medium	2	2x3=6
High Surf/Storm Surge/Coastal Flood	Low	1	1x3=3
High Windstorms	High	3	3x3=9
Landslide	Medium	2	2x3=6
Tropical Cyclone	High	3	3x3=9
Tsunami	Low	1	1x2=2
Volcanic Eruption	Medium	2	2x3=6
Wildfire	High	3	3x3=9

Table 20-3. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Climate Change/Sea Level Rise	Medium	2	2x2=4
Dam Failure	Low	1	1x2=2
Drought	None	0	0x2=0
Earthquake	High	3	3x2=6
Flood	Medium	2	2x2=4
High Surf/Storm Surge/Coastal Flood	Medium	2	2x2=4
High Windstorms	Medium	2	2x2=4
Landslide	Medium	2	2x2=4
Tropical Cyclone	High	3	3x2=6
Tsunami	Low	1	1x2=2
Volcanic Eruption	Low	1	1x2=2
Wildfire	High	3	3x2=6

Table 20-4. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Climate Change/Sea Level Rise	Medium	2	2x1=2
Dam Failure	Low	1	1x1=1
Drought	Medium	2	2x1=2
Earthquake	Medium	2	2x1=2
Flood	Low	1	1x1=1
High Surf/Storm Surge/Coastal Flood	Low	1	1x1=1
High Windstorms	Medium	2	2x1=2
Landslide	Low	1	1x1=1
Tropical Cyclone	High	3	3x1=3
Tsunami	Low	1	1x1=1
Volcanic Eruption	Medium	2	2x1=2
Wildfire	Medium	2	2x1=2

20.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 20-5.

Table 20-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Climate Change/Sea Level Rise	3	3+4+2=9	3x9=27
Dam Failure	1	3+2+1=6	1x6=6
Drought	3	0+0+2=2	3x2=6
Earthquake	3	9+6+2=17	3x17=51
Flood	3	6+4+1=11	3x11=33
High Surf/Storm Surge/Coastal Flood	3	3+4+1=8	3x8=24
High Windstorms	3	9+4+2=15	3x15=45
Landslide	3	6+4+1=11	3x11=33
Tropical Cyclone	2	9+6+3=18	2x18=36
Tsunami	2	2+2+1=5	2x5=10
Volcanic Eruption	3	6+2+2=10	3x10=30
Wildfire	3	9+6+2=17	3x17=51

Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards ranked as being of highest concern are tsunami, earthquake and high windstorm. Hazards ranked as being of medium concern are tropical cyclone, flood, wildfire and coastal erosion. The hazards ranked as being of lowest concern are vog, drought, high surf, landslide, debris flow and rockfall, dam and reservoir failure and lava flow. Table 20-6 shows the hazard risk ranking.

Table 20-6. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Score
High	Wildfire	51
High	Earthquake	51
High	High Windstorms	45
High	Tropical Cyclone	36
High	Flood	33
High	Landslide	33
High	Volcanic Eruption	30
Medium	Climate Change/Sea Level Rise	27
Medium	High Surf/Storm Surge/Coastal Flood	24
Low	Tsunami	10
Low	Dam Failure	6
Low	Drought	6

County of Hawai‘i Multi-Hazard Mitigation Plan

PART 3—MITIGATION STRATEGY

21. GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards, as outlined in 44 CFR Section 201.6(c)(3)(i). As part of the plan update process, the working group reviewed the goals and objectives of the 2010 plan. After discussion, the group determined that the goals and objectives should be revisited and revised in order to more fully align with other community objectives and priorities. Through several facilitated discussions and exercises, the working group established an updated set of goals and measurable objectives for the hazard mitigation plan. The resulting goals, objectives and initiatives in this plan update all support each other. Goals were selected based on their relevance and connection to other planning efforts. Objectives were selected that met multiple goals. Mitigation initiatives were prioritized based on the initiative meeting multiple objectives.

21.1 GOALS

The following are the mitigation goals for this plan:

1. Utilize state-of-the-art methods and technologies as well as local knowledge to identify hazards, risks, and capabilities.
2. Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly.
3. Protect natural and cultural resources to the extent practicable while mitigating hazards.
4. Promote actions that support land use planning and regulations designed to ensure long-term resiliency.
5. Promote community risk reduction and preparedness through public education, training and awareness.
6. Improve capabilities to implement response protocols and continuity of operations and services.
7. Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of hazards.

The effectiveness of a mitigation strategy is evaluated by determining how well these goals are achieved.

21.2 OBJECTIVES

Each selected objective meets multiple goals, serving as a stand-alone measurement of the effectiveness of a mitigation action, rather than as a subset of a goal. The objectives also are used to help establish priorities. The objectives are as follows:

1. Improve warning and emergency communications systems.
2. Conduct studies to determine locations, potential impacts, and links among threats, hazards, and vulnerabilities to support the identification and implementation of mitigation and protection measures in Hawaiʻi County.
3. Utilize the best available data, science and technology to identify and communicate the risk exposure to hazards and ways to increase the planning area's capability to prepare for, respond to, recover from, and mitigate the impacts of hazard events.

4. Promote and implement the retrofit, hardening, or replacement of at-risk structures and lifelines to increase community resilience.
5. Support hazard mitigation measures that promote and enhance natural processes and minimize adverse impacts on the ecosystem.
6. Research, develop, promote, adopt and enforce codes and standards that are affordable and feasible for life and property protection.
7. Establish and maintain partnerships among all levels of government, the private sector, community groups, and institutions of higher learning that improve and implement methods to protect life, property and the environment in the planning area.
8. Minimize impacts of hazard events on the economic drivers for the County.
9. Incentivize and implement mitigation measures for hazard risk and repetitive loss areas to address repairs, major alternations, development plans and practices.
10. Integrate local hazard mitigation plans with the general plan other local plans, and provide training and guidance to integrate and strengthen the linkages between the plans.
11. Advance community resilience through preparation, adoption, and implementation of state, county and local multi-hazard mitigation plans and projects.
12. Promote and implement mitigation measures such as fire breaks around communities and along roadways as needed to mitigate the risk of wildfires.

22. MITIGATION BEST PRACTICES AND ADAPTIVE CAPACITY

22.1 MITIGATION BEST PRACTICES

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs for each hazard are listed in Table 22-1 through Table 22-11. The catalogs present alternatives that are categorized in two ways:

- By what the alternative would do:
  - Manipulate a hazard
  - Reduce exposure to a hazard
  - Reduce vulnerability to a hazard
  - Build local capacity to respond to or prepare for the hazard
- By who would have responsibility for implementation:
  - Individuals
  - Businesses
  - Government.

Hazard mitigation initiatives recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of Hawaiʻi County to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk of the flood hazard within the planning area. Initiatives in the catalog that are not included for the action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

No actions were reviewed for the hazard other than public education actions, since there is very little development exposed to this hazard within the planning area.

Table 22-1. Potential Mitigation Actions for Climate Change

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ Modify at-home practices to reduce carbon footprint • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Retrofit home to elevate them above potential sea level rise levels • **Build local capacity to respond to or prepare for the hazard:** ❖ Become educated about the climate change hazard and ways to reduce greenhouse gas emissions ❖ Create a retrofit savings account	• **Manipulate the hazard:** ❖ Modify business practices to reduce carbon footprint • **Reduce exposure to the hazard:** ❖ Preserve open space to benefit natural resources and reduce risk to structures from potential sea level rise • **Reduce vulnerability to the hazard:** ❖ Retrofit structures to elevate them above potential sea level rise levels • **Build local capacity to respond to or prepare for the hazard:** ❖ Educate employees about the climate change hazard and ways to reduce greenhouse gas emissions ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• **Manipulate the hazard:** ❖ Adopt goals and policies for reduction of greenhouse gases • **Reduce exposure to the hazard:** ❖ Manage development in areas at risk of sea level rise ❖ Prevent infrastructure expansion in areas at risk of sea level rise ❖ Acquire and demolish or relocate structures in areas at risk of sea level rise ❖ Preserve open space to benefit natural resources and reduce risk to structures from potential sea level rise ❖ Examine the appropriate use of beach nourishment, sand scraping, dune-gap plugs, etc., for coastal hazards. ❖ Implement dune restoration, plantings, and use of natural materials. ❖ Examine the appropriate use of sediment-trapping vegetation, sediment mounds, etc., for coastal hazards. ❖ Plant sediment-trapping vegetation to buffer the coast against coastal storms by collecting sediment in protective features such as dunes. ❖ Use bulldozers to deposit the top foot of sand above the high-tide line—to reinforce the beach without adding new sand. • **Reduce vulnerability to the hazard:** ❖ Retrofit structures to elevate them above potential sea level rise levels • **Build local capacity to respond to or prepare for the hazard:** ❖ Map and assess vulnerability to sea level rise ❖ Improve public awareness of risks due to sea level rise through outreach activities

See Section 22.2 for additional alternatives related to climate change.

Table 22-2. Potential Mitigation Actions for Dam Failure

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate out of dam failure inundation areas • **Reduce vulnerability to the hazard:** ❖ Elevate home to appropriate levels • **Build local capacity to respond to or prepare for the hazard:** ❖ Learn about risk reduction for the dam failure hazard ❖ Learn the evacuation routes for a dam failure event ❖ Educate yourself on early warning systems and the dissemination of warnings	• **Manipulate the hazard:** ❖ Remove dams ❖ Harden dams • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures • **Reduce vulnerability to the hazard:** ❖ Flood-proof facilities within dam failure inundation areas • **Build local capacity to respond to or prepare for the hazard:** ❖ Educate employees on the probable impacts of a dam failure ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ Remove dams ❖ Harden dams • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures ❖ Relocate critical facilities out of dam failure inundation areas ❖ Consider open space land use in designated dam failure inundation areas • **Reduce vulnerability to the hazard:** ❖ Adopt higher floodplain standards in mapped dam failure inundation areas ❖ Retrofit critical facilities within dam failure inundation areas • **Build local capacity to respond to or prepare for the hazard:** ❖ Map dam failure inundation areas ❖ Enhance emergency operations plan to include a dam failure component ❖ Institute monthly communications checks with dam operators ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas ❖ Consider the probable impacts of climate change in assessing the risk associated with the dam failure hazard ❖ Establish early warning capability downstream of listed high hazard dams ❖ Consider the residual risk associated with protection provided by dams in future land use decisions

Table 22-3. Potential Mitigation Actions for Drought

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) ❖ For homes with on-site water systems: increase storage, utilize rainwater catchment • **Build local capacity to respond to or prepare for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce private water system losses ❖ Support alternative irrigation techniques to reduce water use and encourage use of climate-sensitive water supplies ❖ For businesses with on-site water systems: increase storage, utilize rainwater catchment • **Build local capacity to respond to or prepare for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ Groundwater recharge through stormwater management ❖ Develop a water recycling program ❖ Increase “above-the-dam” regional natural water storage systems • **Reduce exposure to the hazard:** ❖ Identify and create groundwater backup sources • **Reduce vulnerability to the hazard:** ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits ❖ increase conventional storage that is filled during high-flow periods • **Build local capacity to respond to or prepare for the hazard:** ❖ Public education on drought resistance ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Develop drought contingency plan ❖ Develop criteria “triggers” for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques ❖ Consider the probable impacts of climate change on the risk associated with the drought hazard

Table 22-4. Potential Mitigation Actions for Earthquake

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area (off soft soils) • **Reduce vulnerability to the hazard:** ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design • **Build local capacity to respond to or prepare for the hazard:** ❖ Practice “drop, cover, and hold” ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate or relocate mission-critical functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • **Build local capacity to respond to or prepare for the hazard:** ❖ Adopt higher standard for new construction; consider “performance-based design” when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards • **Build local capacity to respond to or prepare for the hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components.

Table 22-5. Potential Mitigation Actions for Flood

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures • **Build local capacity to respond to or prepare for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • **Build local capacity to respond to or prepare for the hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• **Manipulate the hazard:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • **Reduce exposure to the hazard:** ❖ Locate or relocate critical facilities outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff ❖ Preserve undeveloped and vulnerable shoreline ❖ Restore existing flood control and riparian corridors • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities ❖ Facilitate managed retreat from, or upgrade of, the most at-risk areas ❖ Require accounting of sea level rise in all applications for new development in shoreline areas ❖ Implement Assembly Bill 162 (2007) requiring flood hazard information in local general plans • **Build local capacity to respond to or prepare for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Consider participation in the Community Rating System ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable impacts of climate change on the risk associated with the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ Enforce National Flood Insurance Program requirements ❖ Adopt a Stormwater Management Master Plan ❖ Develop an adaptive management plan to address the long-term impacts of sea level rise

Table 22-6. Potential Mitigation Actions for High Surf, Storm Surge, Coastal Flood, Tropical Cyclone

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Protect, preserve and restore beaches and dunes • **Reduce exposure to the hazard:** ❖ Participate in voluntary property acquisition/relocation programs sponsored by federal, state or local agencies • **Reduce vulnerability to the hazard:** ❖ Elevate home. ❖ Retrofit your home to meet current building code standards for wind driven forces. • **Build local capacity to respond to or prepare for the hazard:** ❖ Buy flood Insurance ❖ Stockpile property protection measures to be utilized once your receive notice of pending coastal storms.	• **Manipulate the hazard:** ❖ Protect, preserve, restore wetlands. ❖ Protect, preserve and restore beaches and dunes • **Reduce exposure to the hazard:** ❖ Participate in voluntary property acquisition/relocation programs sponsored by federal, state or local agencies • **Reduce vulnerability to the hazard:** ❖ Retrofit facilities to meet current building code standards for wind driven forces. ❖ Maintain drainage facilities that service your property. • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop a continuity of operations plan to address operations before, during and after coastal storm events. ❖ Buy flood Insurance ❖ Partner with personal scale and government scale partners to provide property protection components such as plywood and water resistant barriers in the preparedness phase pending coastal storms.	• **Manipulate the hazard:** ❖ Protect, preserve, restore wetlands. ❖ Protect, preserve and restore beaches and dunes ❖ Structural flood control, such as floodwalls, berms and levels • **Reduce exposure to the hazard:** ❖ Consider open space land uses in areas of high risk exposure to coastal storms. ❖ Acquire or relocate vulnerable properties in high risk areas impacted by coastal storms. ❖ Place utilities underground when and where appropriate. ❖ Consider low-density land use in high risk coastal zones. • **Reduce vulnerability to the hazard:** ❖ Consider appropriate higher regulatory standards to the risk exposure to coastal storms such as: higher freeboard, enclosure prohibitions, coastal zone setbacks, lower substantial damage thresholds, non-conversion deed restrictions ❖ Elevate vulnerable properties in high risk areas impacted by coastal storms. ❖ Adopt/amend building codes such that they will address pre-existing properties. ❖ Implement tree management programs. ❖ Elevate roads that are vital/critical to evacuation and local community operations. ❖ Design or enhance existing drainage systems for higher design storms to provide increased capacity of the drainage system. ❖ Maintain the drainage infrastructure to levels that equal or exceed their design specifications. • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop or enhance existing plans to include comprehensive evaluation of coastal storms and the reduction of their impacts at the local level. Seek to coordinate all levels of planning with this regard. ❖ Support/enhance code enforcement programs at the local level. ❖ Continue to develop, enhance and implement existing emergency response plans to utilize new and developing technology/ information as it become available. ❖ Develop a post-disaster action plan for coastal storm events that will address the local government operations post disaster. ❖ Promote the purchase of flood insurance ❖ Adopt regulations that require the disclosure of ocean-related hazards at the time of the purchase or sale of real property. ❖ Implement measures that will provide or help to provide property protection measures to property owners prior to the arrival of coastal storms. ❖ Utilize the best available technology to provide early warning of pending coastal storms to provide ample time to implement property protection measures. ❖ Educate the public on ways to protect their property before and during coastal storms, and where they can acquire the appropriate property protection measures.

Table 22-7. Potential Mitigation Actions for High Windstorm

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Trim trees away from structures • **Reduce vulnerability to the hazard:** ❖ Build home in compliance with building codes ❖ Incorporate building design standards to minimize wind damage ❖ Retrofit home to reduce future wind damage • **Build local capacity to respond to or prepare for the hazard:** ❖ Create a retrofit savings plan	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate or underground electrical infrastructure • **Reduce vulnerability to the hazard:** ❖ Build facilities in compliance with building codes ❖ Incorporate building design standards to minimize wind damage ❖ Retrofit facilities to reduce future wind damage • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop a continuity of operations plan to address operations before, during and after coastal storm events.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate or underground electrical infrastructure • **Reduce vulnerability to the hazard:** ❖ Adopt and enforce building codes to prevent wind damage ❖ Promote or require site and building design standards to minimize wind damage ❖ Regularly maintain utilities to prevent wind damage ❖ Retrofit public buildings and critical facilities to reduce future wind damage • **Build local capacity to respond to or prepare for the hazard:** ❖ Assess vulnerability to severe wind ❖ Improve public awareness of severe wind through outreach activities

Table 22-8. Potential Mitigation Actions for Landslide

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit home • **Build local capacity to respond to or prepare for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit at-risk facilities • **Build local capacity to respond to or prepare for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • **Build local capacity to respond to or prepare for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives. ❖ Consider the probable impacts of climate change on the risk associated with the landslide hazard

Table 22-9. Potential Mitigation Actions for Tsunami

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though. • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a household evacuation plan ❖ Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk ❖ Understand tsunami warning signs and signals	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible • **Reduce vulnerability to the hazard:** ❖ Mitigate personal property for the impacts of tsunami • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a corporate evacuation plan ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	• **Manipulate the hazard:** ❖ Build wave abatement structures (e.g. the "Jacks" looking structure designed by the Japanese) • **Reduce exposure to the hazard:** ❖ Locate structure or functions outside of hazard area whenever possible ❖ Harden infrastructure for tsunami impacts ❖ Relocate identified critical facilities located in tsunami high hazard areas • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area ❖ Utilize tsunami mapping to guide development away from high risk areas through land use planning • **Build local capacity to respond to or prepare for the hazard:** ❖ Use probabilistic tsunami mapping and land use guidance from the state when published ❖ Provide incentives to guide development away from hazard areas ❖ Improve the tsunami warning and response system ❖ Provide residents with tsunami inundation maps ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard

Table 22-10. Potential Mitigation Actions for Volcano

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ None • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a household evacuation plan	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate mission critical functions outside of hazard area whenever possible • **Reduce vulnerability to the hazard:** ❖ None • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a corporate evacuation plan ❖ Inform employees through corporate sponsored outreach	• **Manipulate the hazard:** ❖ Limited success has been experienced with lava flow diversion structures • **Reduce exposure to the hazard:** ❖ Locate critical facilities and functions outside of hazard area whenever possible • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical facilities and functions • **Build local capacity to respond to or prepare for the hazard:** ❖ Develop emergency response plans and evacuation routes for lava flows ❖ Public outreach, awareness. ❖ Tap into state volcano warning system to provide early warning to residents

Table 22-11. Potential Mitigation Actions for the Wildfire Hazard

Individuals	Businesses	Government
• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-resistant building materials ❖ Create defensible spaces around home • **Build local capacity to respond to or prepare for the hazard:** ❖ Employ techniques from the National Fire Protection Association's Firewise USA program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials and implement other strategies to harden homes from embers and flame impingement	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-resistant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. • **Build local capacity to respond to or prepare for the hazard:** ❖ Support Firewise USA community initiatives. ❖ Create /establish stored water supplies to be utilized for firefighting.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-resistant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. ❖ Consider higher regulatory standards (such as Class A roofing) ❖ Establish biomass reclamation initiatives ❖ Reintroduce fire (controlled or prescribed burns) to fire-prone ecosystems ❖ Manage fuel load through thinning and brush removal ❖ Establish integrated performance standards for new development to harden homes. • **Build local capacity to respond to or prepare for the hazard:** ❖ More public outreach and education efforts, including an active Firewise USA program ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes and establish where needed ❖ Seek alternative water supplies ❖ Become a Firewise USA community ❖ Use academia to study impacts/solutions to wildfire risk ❖ Establish/maintain mutual aid agreements between fire service agencies ❖ Develop, adopt, and implement integrated plans for mitigating wildfire impacts in wildland areas bordering on development ❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions ❖ Establish a management program to track forest and rangeland health ❖ Provide incentives to for existing structures to be hardened against wildfire.

22.2 ADAPTIVE CAPACITY

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014). This term is typically used while discussing climate change adaptation; however, it is similar to the alternatives presented in the tables for building local capacity. In addition to hazard-specific capacity building, the following list provides general alternatives that the County considered to build capacity for adapting to both current and future risks:

- Incorporate climate change adaptation into relevant local and regional plans and projects.
- Establish a climate change adaptation and hazard mitigation public outreach and education program.
- Build collaborative relationships between regional entities and neighboring communities to promote complementary adaptation and mitigation strategy development and regional approaches.
- Establish an ongoing monitoring program to track local and regional climate impacts and adaptation strategy effectiveness.
- Increase participation of low-income, immigrant, non-English-speaking, racially and ethnically diverse, and special-needs residents in planning and implementation.
- Ask local employers and business associations to participate in local efforts to address climate change and natural hazard risk reduction.
- Conduct a communitywide assessment and develop a program to address health, socioeconomic, and equity vulnerabilities.
- Focus planning and intervention programs on neighborhoods that currently experience social or environmental injustice or bear a disproportionate burden of potential public health impacts.
- Use performance metrics and data to evaluate and monitor the impacts of climate change and natural hazard risk reduction strategies on public health and social equity.
- Develop coordinated plans for mitigating future flood, landslide, and related impacts through concurrent adoption of updated general plan safety elements and local hazard mitigation plans.
- Update the general plan safety element to reflect existing hazards and projected climate change impacts on hazards.
- Implement general plan safety element through zoning and subdivision practices that restrict development in floodplains, landslide, and other natural hazard areas.
- Identify and protect locations where native species may shift or lose habitat due to climate change impacts (sea level rise, loss of wetlands, warmer temperatures, drought).
- Collaborate with agencies managing public lands to identify, develop, or maintain corridors and linkages between undeveloped areas.
- Promote economic diversity.
- Incorporate consideration of climate change impacts as part of infrastructure planning and operations.
- Conduct a climate impact assessment on community infrastructure.
- Identify gaps in legal and regulatory capabilities and develop ordinances or guidelines to address those gaps.
- Identify and pursue new sources of funding for mitigation and adaptation activities.
- Hire new staff or provide training to current staff to ensure an adequate level of administrative and technical capability to pursue mitigation and adaptation activities.

23. HAZARD MITIGATION ACTION PLAN

23.1 STATUS OF PREVIOUS PLAN ACTIONS

23.1.1 Mitigation Actions

The 2015 County of Hawaiʻi Multi-Hazard Mitigation Plan identified 26 mitigation actions for implementation. These actions were reviewed for the current update, and for each action it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2020 update or removed from the plan due to a change in priorities, capabilities, or feasibility. Table 23-1 lists the status of all 26 actions from the 2015 plan.

Four of the identified actions (15 percent) have been started or completed, 12 (46 percent) are carried over to the 2020 update, and 10 (38 percent) have been withdrawn. The reasons for withdrawal of actions ranged from the action no longer being considered feasible to the action being identified as a core capability by the 2020 planning process.

The County is using the current plan update process as an opportunity for a functional reset of the action plan. While some of the prior actions have been carried over, all have been reframed and re-prioritized to a different schedule from prior plans. Each carried over has a new action number assigned to it for the 2020 update, and many were reworded to more clearly state their intent.

23.1.2 Plan Incorporation Actions

As a demonstration of progress in local hazard mitigation efforts, 44 CFR 201.6(c)(4)(ii) requires plan updates to describe completed steps to incorporate the mitigation plan into other planning mechanisms as appropriate. The maintenance strategy for the 2015 County of Hawaiʻi Multi-Hazard Mitigation Plan called for incorporation into other planning mechanisms, but no clear actions or metrics were identified to measure successful incorporation. The capability assessment performed for this update identifies some links between the County's hazard mitigation planning and its core capabilities, but no information is available on specific actions related to incorporation during the past performance period for this plan.

Of the 26 mitigation actions in the 2015 plan, one action relates to incorporation of the mitigation plan into other planning mechanisms. Action #6 called for a review the General Plan natural hazard policies in light of this mitigation plan and American Planning Association suggested policies. This action has been carried over to this plan update.

This plan update identifies clear actions for plan incorporation with clear metrics to monitor their completion; therefore, meeting the objectives of 44 CFR 201.6(c)(4)(ii) for future updates should be easier for the County.

Table 23-1. Prior Action Status

Action Item from Previous Plan	Completed	Removed; No Longer Feasible	Carried Over to Plan Update	
			Check if Yes	Action # in Update
1. Update the building code from the 2006 IBC to the 2012 IBC		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
2. Update tsunami evacuation maps: Tsunami Inundation and Run-up Mapping: Analysis of the island of Hawai‘i based on State Civil Defense scenarios from tsunami-genic source regions in the Aleutian Islands.		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
3. Identify hardening projects to implement 2009 seismic evaluation study of critical facilities			✓	HC15
Comment: *This action has been reframed and will be replaced by HC15*				
4. Study hardening requirements for fuel storage and distribution to critical facilities			✓	HC15
Comment: *This action has been reframed and will be replaced by HC15*				
5. Develop policies and procedures for establishing site specific hazard mitigation design criteria for critical facilities			✓	HC15
Comment: *This action has been reframed and will be replaced by HC15*				
6. Review the General Plan natural hazard policies in light of this mitigation plan and American Planning Association suggested policies			✓	HC20
Comment: *This action has been reframed and will be replaced by HC20*				
7. Participate in the Community Rating System			✓	HC11
Comment: *This action has been reframed and will be replaced by HC11*				
8. Conduct hazard loss estimation studies; incorporate cost-benefit methodology as a factor in prioritizing projects	✓			
Comment: *This action was completed as part of this hazard mitigation plan update*				
9. Develop a GIS-based multi-hazard website			✓	HC21
Comment: *This action has been reframed and will be replaced by HC21*				
10. Organize public awareness and preparedness program, including mitigation techniques and retrofit training			✓	HC21
Comment: *This action has been reframed and will be replaced by HC21*				
11. Develop Dam Evacuation Maps	✓			
Comment: *The State Dam Inventory System has been completed and meets the criteria for this action (DLNR, 2020)*				
12. Adopt tsunami design provisions and tsunami design zone maps for buildings (to be released in September 2016) for new and for evaluating existing buildings.		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
13. Implement State Drought Plan; improve water resources		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
14. Perform a comprehensive screening evaluation of private sector candidate building types for possible hurricane refuge use			✓	HC27
Comment: *This action has been reframed and will be replaced by HC27*				
15. Emergency shelter evaluation: all-hazard assessment of potentially capable hurricane refuges in the private sector inventory			✓	HC27
Comment: *This action has been reframed and will be replaced by HC27*				
16. Harden public schools for emergency shelters			✓	HC27
Comment: *This action has been reframed and will be replaced by HC27*				

Action Item from Previous Plan	Completed	Removed; No Longer Feasible	Carried Over to Plan Update	
			Check if Yes	Action # in Update
17. Update the HAZUS model to incorporate data on state and county bridges	✓			
Comment: *This action was completed as part of this hazard mitigation plan update*				
18. Study hardening requirements for Hilo and Kawaihae Harbors		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
19. Study hardening requirements for fuel storage		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
20. Investigate effectiveness of vog mitigation techniques			✓	HC28
Comment: *This action has been reframed and will be replaced by HC28*				
21. Adapt HAZUS for hurricane analysis	✓			
Comment: *This action was completed as part of this hazard mitigation plan update*				
22. Testing of the seismic and wind performance of single wall construction		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
23. Explore incentives for existing homeowners and businesses to retrofit their structures			✓	HC18
Comment: *This action has been reframed and will be replaced by HC27*				
24. Identify landslide and coastal erosion hazard areas and mitigation actions		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
25. Study hardening requirements for electrical system		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
26. Explore with utilities, feasibility of underground power lines		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				

23.2 RECOMMENDED MITIGATION ACTIONS

The working group reviewed the catalogs of hazard mitigation alternatives and selected actions to be included in a hazard mitigation action plan. The selection of actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table 23-2 lists the recommended hazard mitigation actions that make up the action plan. The actions as listed in the table are not presented in order of priority or precedence. Priorities are assigned individually to each action as described in Section 23.4. The timeframe indicated in the table is defined as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

Table 23-2. Hazard Mitigation Action Plan Matrix

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC1—Microwave Network Upgrade. This project involves the hardening of the County's radio communications system through replacement of the following systems: microwave system, direct current power system, photovoltaic energy systems, tower refurbishment and the acquisition of cell-on-wheels capability.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1, 4, 8, 11	Civil Defense		High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, depends on funding
Action HC2—Public Safety Building Flood Mitigation and Electrical Upgrade. This project will eliminate flooding that endangers the entire electrical system at the Public Safety complex and causes damage in other areas. The electrical system will be upgraded to prevent failure.						
Hazards Mitigated: Flood						
Existing	1, 4, 8, 11	Police	Public Works	High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, depends on funding
Action HC3—IT Data Center. Install a SmartMod 12x45 with a 11x34 utility skit to support the data center that supports critical services for the County currently housed at the Civil Defense building (920 Ululani St., Hilo) and the IT Department building (25 Aupuni St., Hilo).						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New	1, 4, 8, 11	IT	Civil Defense	High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, depends on funding
Action HC4—Wailuku Bridge #1 and Waiānuenue Avenue Bridge Hardening. Wailuku Bridge #1 over Wailuku River on Wainaku Street is an essential part of the traffic network in the area as it serves as a detour or important alternate route for Highway 19. The existing 129-foot, 2 span concrete bridge was built in 1919 and is not in compliance with today's engineering design standards, specifically in regard to resisting seismic forces.						
Hazards Mitigated: Earthquake, Tsunami						
Existing	1, 4, 8, 11	Public Works		High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, depends on funding
Action HC5—Generators for Wastewater Treatment Facilities. Install eight stationary generators to service the Hilo Wastewater Treatment Plant (WWTP); Kula'imano WWTP; Pāpa'ikou WWTP; Wailuku Sewer Pump Station (SPS); Pauka'a SPS; Wailoa SPS; Onekahakaha SPS; and Kōlea SPS during severe weather events. These facilities experience significant power outages. The installation of generators will mitigate outages during these events.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
Existing	1, 4, 8, 11	Department of Environmental Management		High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, depends on funding

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC6—Emergency Power Transfer Switching Capability for Critical Water Infrastructure. The hardening of the Parker #1, Parker #2, Lālāmilo B, Lālāmilo C, Honoka‘a, Makapala, Wai‘aha, Kahaluu, Queen Lili‘uokalani Trust, Pi‘ihonua #1, Pi‘ihonua #3A and ‘Ōla‘a #3 potable water producing facilities through the purchase and installation of transfer switches and supporting infrastructure (generator tap boxes, junction boxes, conduit, wire, supports, etc.) will allow the County of Hawai‘i Department of Water Supply to better protect the health and welfare of the public. *Hazards Mitigated:* Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
Existing	1, 4, 8, 11	Department of Water Supply		High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short Term, depends on funding
Action HC7—Waikoloa Reservoir No. 1—Dam Failure Retrofit. The project requires the improvements to address the stability of the embankments as well as the waterproofing of the reservoir itself. The embankments are being improved by widening the base of the embankment and increasing the overall strength supporting the reservoir walls. An underdrain at the toe of the embankment is also being installed to direct groundwater away from the embankment to minimize the chances of liquefaction. Also, waterproofing the reservoir will be accomplished by installing a synthetic liner, which eliminates the possibility of leaks through the numerous cracks in the concrete panels lining the interior of the reservoir. *Hazards Mitigated:* Dam Failure, Earthquake						
Existing	1, 4, 8, 11	Department of Water Supply		High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short Term, depends on funding
Action HC8—ArcGIS Data Management, Collection and Tracking. Create an information/data management system to provide actionable information to the planning process during an incident and to capture data for impact statistics and hazard analysis post-incident. *Hazards Mitigated:* Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1, 4, 8, 11	Civil Defense		High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short Term, depends on funding
Action HC9—Volcanic Risk Home Buyout Program. Develop and institute a home buyout program that targets eligible properties impacted by lava flows from volcanic eruptions. This program may be expanded to include homes exposed to other hazards as needs present themselves during the performance period of this plan. *Hazards Mitigated:* Volcano						
Existing	2, 3, 7, 11	Planning	Office of Housing and Community Development	High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short Term, depends on funding
Action HC10—Maintain NFIP Compliance. Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements: • Enforce the flood damage prevention ordinance. • Participate in floodplain identification and mapping updates. • Provide public assistance/information on floodplain requirements and impacts. *Hazards Mitigated:* Flooding, Coastal Flood, Tropical Cyclone, Dam Failure						
New and Existing	3, 4, 6, 7, 8, 9, 11	Public Works		Low	Local Funding, FEMA's Building Resilient Infrastructure and Communities program	Ongoing
Action HC11—Maintain CRS Participation. Continue to maintain and enhance (where feasible) the County's classification under the CRS program. *Hazards Mitigated:* Flooding, Coastal Flood, Tropical Cyclone, Dam Failure						
New and Existing	3, 4, 6, 7, 8, 9, 11	Public Works		Low	Local Funding	Ongoing

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC12—Flood Hazard Needs Assessments. Perform needs assessment and riverine flood studies to identify flood risk and flood mitigation projects in areas of need, including but not limited to; Puna, North Kona, South Kohala and Hāmākua.						
Hazards Mitigated: Flooding, Landslide, Coastal Flood, Tropical Cyclone						
New and Existing	2, 3, 8, 11	Public Works	civil Defense	High	FEMA HMA (Advance Assistance), FMA, Local Funding	Short-Term
Action HC13—Wailoa River Bridge Retrofit. Coordinate with the state to upgrade/retrofit Singing Bridge to address chronic coastal flooding and impacts from tsunami. Tsunami project—criticality of the DPW bridge to get retrofitted to prevent isolated populations.						
Hazards Mitigated: Chronic Flooding, Earthquake, Tsunami						
Existing	4, 7, 8, 11	Hawai‘i State DOT	Hawai‘i County	High	State DOT Funding, National DOT Funding	Long term
Action HC14—Training and Exercise. Augment the County’s annual emergency operations training and exercise program with relevant hazard scenario data and models (Hazus) that were developed in support of the risk assessment for this hazard mitigation planning effort.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1, 3, 7, 10	Civil Defense		Low	Local Funding, EMPG, HSGP	Ongoing
Action HC15—Critical Infrastructure (roads and bridges) needs assessment. Conduct a vulnerability/needs assessment of identified critical roads and bridges that results in the identification of retrofitting projects and identifies critical routes in support of evacuation planning.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
Existing	2, 3, 4, 8, 11	Public Works	Civil Defense	High	FEMA HMA (Advance Assistance), Local Funding	Short-Term
Action HC16—Audible Notification Needs Assessment. Conduct a needs assessment that identifies gaps in coverage in the County’s audible warning (sirens) system as well as existing systems that need to be replaced and/or updated.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1, 2, 7, 8, 11	Civil Defense		High	EMPG, HSGP, Local Funding	Short-Term
Action HC17—Rain Gauge Network. Purchase and install rain and stream flow gauges in the Hāmākua Coast to support landslide and flood risk identification and notification.						
Hazards Mitigated: Flood, Landslide, Coastal Flood, Tropical Cyclone						
New and Existing	1, 2, 3, 7, 8, 11	Civil Defense	NOAA	High	NWS Grants, NOAA Coastal Resilience Grants, HMGP (5% Initiative)	Long Term
Action HC18—Earthquake/Tropical Cyclone Retrofit Incentive Program. Conduct a study to determine the feasibility for the County to deploy an incentive-based program that would encourage private property owners to retrofit their properties against the impacts of earthquakes and tropical cyclones. Key to this study will be a vulnerability analysis that attempts to identify the general building stock within the County that is most vulnerable to these hazards.						
Hazards Mitigated: Earthquake, Volcanic Eruption						
Existing	2, 3, 4, 11	Civil Defense	Finance Department	Medium	FEMA HMA (Advance Assistance, Local Funding	Long Term
Action HC19—Vulnerable Property Protection. Where appropriate, support retrofitting, purchase or relocation of structures located in hazard areas, prioritizing those that have experienced repetitive losses and/or are located in high- or medium-risk hazard areas.						
Hazards Mitigated: Flooding, Coastal Flood, Tropical Cyclone, Dam Failure, Wildfire, Volcano						
Existing	4, 7, 11	Planning	Public Works	High	FEMA HMA, CDBG (DR and MIT), Local Funding	Long-Term

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC20——Plan Integration. Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including capital improvement programs, the general plan, recovery plans and strategic plans.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	3, 6, 8, 10, 11	Planning	Mayor's Office, Public Works	Low	Local Funding	Ongoing
Action HC21—Risk Communication. Leveraging existing County public outreach programs, utilize the best available data and science to communicate the risk from all hazards assessed by this plan to the public to promote prevention, preparedness, response, recovery and mitigation actions at the local scale.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	3, 7, 11	Civil Defense	Mayor's Office, County Public Information Officer	Low	Local Funding	Ongoing
Action HC22—Damage Assessment Protocol and Capacity Building. Develop protocol for collecting and storing data necessary to develop damage assessments. Research use of drone technology and IT solutions to take footage and convert into assessments.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	3, 7, 11	Civil Defense	Public Works	Low	Local Funding	Short Term
Action HC23—Codes and Policies for Sea Level Rise: Update county codes and policies to require that all coastal development consider and incorporate measures to address sea level rise.						
Hazards Mitigated: Climate Change/Sea Level Rise, Flooding, High Surf/Storm Surge/Coastal Flood, Tropical Cyclone						
New and Existing	3, 5, 6, 11	Planning	Public Works	Medium	Local Funding, FEMA's Building Resilient Infrastructure and Communities program	Short term
Action HC24—Fire Protection: Establish fire breaks around communities and along roadways.						
Hazards Mitigated: Fire, Volcano						
New and existing	5, 8, 11, 12,	Fire	Public Works	Medium	Local Funds, AFG, FEMA HMA Programs	Short Term, depends on funding
Action HC25—Shoreline setback for Coastal Erosion: Update county shoreline setback policies to include coastal erosion in order to better regulate development in the high-risk areas						
Hazards Mitigated: Flooding, Coastal Flood, Tropical Cyclone						
New and Existing	3, 6, 11	Planning	Public Works	Low	Local Funds	Short Term
Action HC26—Reduce development in high-risk hazard areas: Update and overlay hazard zones (as defined in Section 6.2.1) and develop conditions for land use and design within high risk zones and within or adjacent to urban growth areas outside of high-risk areas.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	2, 3, 5, 6, 8, 9, 10, 11	Planning	Mayor's Office	Low	Local Funds	Short term
Action HC27—Evacuation and Sheltering Assessment and Protocol: Perform an assessment of facilities utilized as shelters and identify mitigation needs as well as develop evacuation and sheltering protocol, policies, and procedures.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	3, 7	Civil Defense	DPR	Medium	Local Funds	Short Term

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC28—Volcanic Gas Monitoring: Provide training and develop monitoring plan to support gas/particulate monitoring system						
Hazards Mitigated: Volcano						
New and Existing	1, 7, 10, 11	Civil Defense	Fire	Low	Local Funds	Short Term
Action HC29—Emerging Hazards: This plan update was being completed during the COVID-19 pandemic, illustrating the need for the plan to be dynamic and have the flexibility to adapt to emerging hazards that fall outside of the traditional natural hazards targeted in the Disaster Mitigation Act. This action is an open-ended call for the County to adapt this plan as needed through the plan maintenance period to address new and emerging hazards of concern as they affect the Hawaiʻi County planning area.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	Civil Defense	County Government	High	FEMA HMA, Local Funding	Short Term
Action HC30—Disaster Distribution System: Develop internal protocol, policies and procedure for logistics, management and resource support during disasters, and develop agreement with state, federal and private partners to implement the plan.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1, 7, 8, 10, 11	Civil Defense	County Government	Medium	Local Funds, EMPG, HSGP	Short term
Action HC31—Mass Gathering Plan: Develop a plan that includes policies, procedures and protocols for conducting mass gathering events with an emphasis on terrorism.						
Hazards Mitigated: Terrorism						
New and Existing	2, 7, 8, 10, 11	Civil Defense	County Government	Medium	Local Funds, EMPG, HSGP	Short Term

a. Short-term = Completion within 5 years; Long-term = Completion within 10 years; Ongoing= Continuing new or existing program with no completion date

23.3 BENEFIT-COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed actions were weighed against estimated costs as part of the action prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some actions may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each action was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these actions.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the action; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The action could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
- **Low**—The action could be funded under the existing budget. The action is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Action will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Action will have a long-term impact on the reduction of risk exposure for life and property, or action will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the action are difficult to quantify in the short term.

Using this approach, actions with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, financial assistance may be available through the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For actions not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

23.4 ACTION PLAN PRIORITIZATION

Two priorities were identified for each action: a priority for implementation and a priority for the pursuit of grant funding. Table 23-3 lists the priority of each action. A qualitative benefit-cost review was performed for each of these actions to support the identification of the priority for implementation. The priorities are defined as follows:

- **Implementation Priority**
  - **High Priority**—An action that meets multiple objectives, has benefits that exceed costs, and has a secured source of funding. Action can be completed in the short term (1 to 5 years). A "high" priority cannot be given unless the action has a secured source of funding.
  - **Medium Priority**—An action that meets multiple objectives, has benefits that exceed costs, and is eligible for funding though no funding has yet been secured for it. Action can be completed in the short term (1 to 5 years), once funding is secured. Through the plan maintenance protocol identified for this plan, medium-priority actions can be changed to high-priority actions once funding is secured.
  - **Low Priority**—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no secured source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions are generally "wish-list" actions. They may be eligible for grant funding from programs that have not yet been identified.

- **Grant Pursuit Priority**
  - **High Priority—**An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium implementation priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.
  - **Medium Priority**—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low implementation priority; local funding options are unavailable.
  - **Low Priority—**An action that has not been identified as meeting any grant eligibility requirements or is a project that already has a secured source of funding

Table 23-3. Prioritization of Mitigation Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
HC1	4	High	High	Yes	Yes	No	Medium	High
HC2	4	High	High	Yes	Yes	No	Medium	High
HC3	4	High	High	Yes	Yes	No	Medium	High
HC4	4	High	High	Yes	Yes	No	Medium	High
HC5	4	High	High	Yes	Yes	No	Medium	High
HC6	4	High	High	Yes	Yes	No	Medium	High
HC7	4	High	High	Yes	Yes	No	Medium	High
HC8	4	High	High	Yes	Yes	No	Medium	High
HC9	4	High	High	Yes	Yes	No	Medium	High
HC10	7	Medium	Low	Yes	Yes	Yes	High	Medium
HC11	7	Medium	Low	Yes	No	Yes	High	Low
HC12	4	High	High	Yes	Yes	No	Medium	High
HC13	4	High	High	Yes	No	Yes	High	Low
HC14	4	Medium	Low	Yes	No	Yes	High	Low
HC15	5	High	High	Yes	Yes	No	Medium	High
HC16	5	High	High	Yes	No	No	Medium	Low
HC17	6	High	High	Yes	Yes	No	Medium	High
HC18	4	Medium	Medium	Yes	Yes	Yes	High	High
HC19	3	High	High	Yes	Yes	No	Medium	Medium
HC20	5	Medium	Low	Yes	No	Yes	High	Low
HC21	3	Medium	Low	Yes	No	Yes	High	Low
HC22	3	Medium	Low	Yes	No	Yes	High	Low
HC23	4	Medium	Medium	Yes	No	Yes	High	Low
HC24	4	High	Medium	Yes	Yes	Yes	High	High
HC25	3	Medium	Low	Yes	No	Yes	High	Low
HC26	8	Medium	Low	Yes	No	Yes	High	Low
HC27	2	Medium	Medium	Yes	No	Yes	High	Low
HC28	4	Medium	Low	Yes	No	Yes	High	Low
HC29	11	High	High	Yes	Yes	No	Medium	High
HC30	5	Medium	Medium	Yes	No	Yes	Medium	Low
HC31	5	Medium	Medium	Yes	No	Yes	Medium	Low

23.5 CLASSIFICATION OF MITIGATION ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 23-4 shows these classifications.

Table 23-4. Analysis of Mitigation Actions

Hazard	Actions That Address the Hazard, by Mitigation Type[a]						
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Community Capacity Building
Climate Change/ Sea Level Rise	8, 10, 11, 12, 20, 23, 26	3, 11, 15, 19	11, 21, 27	10, 11, 20, 26	1, 5, 11, 14, 16, 22, 30	11	11, 15, 16, 22
Dam Failure	8, 10, 11, 20, 236	3, 11, 15, 19	11, 21, 27	10, 11, 20, 26	1, 5, 11, 14, 16, 22, 30	7, 11	11, 15, 16, 22
Drought	8, 20, 26	3, 15	21, 27	20, 26	1, 5, 14, 16, 22, 30		15, 16, 22
Earthquake	8, 18, 20, 26	3, 4, 13, 15	21, 27	20, 26	1, 5, 14, 16, 22, 30	7	15, 16, 22
Flood	8, 10, 11, 12.20, 26	2, 3, 11, 13, 15, 19	11, 21, 27	10, 11, 20, 26	1, 5, 11, 14, 16, 17, 22, 30	11, 13	11, 12, 15, 16, 22
High Surf/Storm Surge/Coastal Flood	8, 10, 11, 12, 20, 25, 26	3, 11, 15, 19	11, 21, 27	20, 25, 26	1, 5, 11, 14, 16, 22, 30	11, 13	11, 15, 16, 22
High Windstorms	8, 20, 26	3, 15	21, 27	20, 26	1, 5, 14, 16, 22, 30		15, 16, 22
Landslide	8, 20, 25, 26	3, 15, 19	21, 27	20, 26	1, 5, 14, 16, 17, 22, 30		15, 16, 22
Tropical Cyclone	8, 10, 11.20, 26	3, 11, 15	11, 21, 27	10, 11, 20, 26	1, 5, 11, 14, 16, 17, 22, 30	11, 13	11, 15, 16, 22
Tsunami	8, 10, 11, 20, 26	3, 13, 15, 19	21, 27	20, 26	1, 5, 14, 16, 22	4, 13	15, 16, 22
Volcanic Eruption	8, 20, 26	3, 9, 15, 19	21, 27	9, 20, 26	1, 5, 14, 16, 22, 28, 30		15, 16, 22
Wildfire	8, 20, 26	3, 15, 19, 24	21, 27	20, 26	1, 5, 14, 16, 22, 30		15, 16, 22

Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.

- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

24. PLAN ADOPTION AND IMPLEMENTATION

The action plan presents a range of action items for reducing loss from hazard events. The County has prioritized actions and can begin to implement the highest-priority actions over the next five years. The effectiveness of the hazard mitigation plan depends on its effective implementation and incorporation of the outlined action items into existing County plans, policies, and programs. Some action items do not need to be implemented through regulation but can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. Hawaiʻi County Civil Defense will have lead responsibility for overseeing the plan implementation and maintenance strategy.

24.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. This plan was submitted for a pre-adoption review to Hawaiʻi State Civil Defense and FEMA Region IX prior to adoption. Once pre-adoption approval was provided, the County formally adopted the plan. A copy of the FEMA approval letter and the resolution adopting this plan can be found in Appendix G.

24.2 PLAN MAINTENANCE STRATEGY

Plan maintenance is the formal process for achieving the following:

- Ensuring that the hazard mitigation plan remains an active and relevant document and that the County maintains its eligibility for applicable funding sources
- Monitoring and evaluating the plan annually and producing an updated plan every five years
- Integrating public participation throughout the plan maintenance and implementation process
- Incorporating the mitigation strategies outlined in this plan into existing planning mechanisms and programs, such as any relevant comprehensive land-use planning process, capital improvement planning process, and building code enforcement and implementation.

To achieve these ends, a hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A method and schedule for monitoring, evaluating and updating the mitigation plan within a 5-year cycle
- An approach for how the community will continue public participation in the plan maintenance process.
- A process by which local governments will incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate

Table 24-1 summarizes the plan maintenance strategy. The sections below further describe each element.

Table 24-1. Plan Maintenance Matrix

Plan Element	Approach	Timeline
Plan Monitoring	• Track the implementation of actions over the performance period of the plan	Continuous over the 5-year performance period of the plan
Plan Evaluation	• Review the status of previous actions • Assess changes in risk • Evaluate success of integration	Upon initiation of hazard mitigation plan update, comprehensive general plan update, or major disaster
Integration into Other Planning Mechanisms	• Create a linkage between the hazard mitigation plan and the County's general plan and similar plans identified in the core capability assessment	Continuous over the 5-year performance period of the plan
Grant Monitoring and Coordination	• As grant opportunities present themselves, consider options to pursue grants to fund actions identified in this plan	As grants become available
Plan Update	• Reconvene, at a minimum, every 5 years to guide a comprehensive update of the plan.	Every 5 years or upon comprehensive update to General Plan or major disaster; funding and organizing for plan update will begin in FY 2021/2022
Continuing Public Participation	• Maintain the hazard mitigation website over the course of the plan • Bring the plan to the County Council meeting for review once a year • Receive comments through the website. • Maintain the comments over the course of the plan.	Continuous over the 5-year performance period of the plan

24.2.1 Plan Monitoring

Hawai‘i County Civil Defense will be the lead agency responsible for monitoring the plan, and will monitor plan implementation by tracking the status of all recommended mitigation actions in the action plan. Staff or departments with primary responsibility are identified in in Table 24-1.

24.2.2 Plan Evaluation

The plan will be evaluated by how successfully the implementation of identified actions has helped to achieve the goals and objectives identified in this plan. This will be assessed by a review of the changes in risk that occur over the performance period and by the degree to which mitigation goals and objectives are incorporated into existing plans, policies and programs.

24.2.3 Incorporation into Other Planning Mechanisms

Integrating relevant information from this hazard mitigation plan into other plans and programs where opportunities arise will be the ongoing responsibility of the County. By adopting a general plan and zoning ordinances, the County has planned for the impact of natural hazards, and these documents are integral parts of this hazard mitigation plan. The hazard mitigation planning process provided an opportunity to review and expand on policies contained within these documents, based on the best science and technology available at the time this plan was prepared. The County should use its general plan and the hazard mitigation plan as complementary documents to achieve the ultimate goal of reducing risk exposure to citizens of the planning area. A comprehensive update to a general plan may trigger an update to the hazard mitigation plan.

The County has committed to creating a linkage between the hazard mitigation plan and its general plan and similar plans identified in the core capability assessment. The action plan includes a high-priority mitigation action to create such a linkage. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Capital improvement programs

- Climate action/adaptation plans
- Community design guidelines
- Community Development Block Grant-Disaster Recovery action plans
- Community wildfire protection plans
- Comprehensive flood hazard management plans
- Debris management plans
- Emergency response plans
- Municipal codes
- Post disaster action/Recovery plans
- Public information/education plans.
- Recovery plans
- Resiliency plans
- Stormwater management programs
- Training and exercise of emergency response plans
- Water system vulnerability assessments
- Water-efficient landscape design guidelines

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated via the update process.

24.2.4 Grant Monitoring and Coordination

Hawai‘i County Civil Defense will identify grant funding opportunities. Once these opportunities are identified, staff will review the hazard mitigation plan and pursue a strategy to capture that grant funding. Hawai‘i County Civil Defense will assume lead responsibility for planning and facilitating grant opportunity meetings. Review of the hazard mitigation plan at these meetings can include the following:

- Discussion of any hazard events that occurred during the prior year and their impact on the planning area
- Impact of potential grant opportunities on the implementation of mitigation actions
- Re-evaluation of the action plans to determine if the timeline for identified actions need to be amended (such as changing a long-term action to a short-term action because of funding availability)
- Recommendations for new actions
- Impact of any other planning programs or initiatives that involve hazard mitigation.

24.2.5 Plan Update

Federal regulations require that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act (44 CFR Section 201.6.d(3)). This plan’s format allows the County to review and update sections when new data become available. New data can be easily incorporated, resulting in a plan that will remain current and relevant. The County intends to update the plan on a five-year cycle from the date of plan approval. This cycle may be accelerated to less than five years based on the following triggers:

- A presidential disaster declaration that impacts the planning area
- A hazard event that causes loss of life
- A 20-year plan update of a participating jurisdiction’s general plan

It will not be the intent of the update process to develop a complete new hazard mitigation plan. Based on needs identified by the planning team, the update will, at a minimum, include the following elements:

- The update process will be convened through a new working group.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- Action plans will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or County policies identified under other planning mechanisms (such as the general plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The County will adopt the updated plan.

Because plan updates can require a year or more to complete, Hawai‘i County Civil Defense will initiate efforts to update the plan before it expires. Hawai‘i County Civil Defense will consider applying for funding to update the plan in the Fiscal Year 2022/2023 grant cycle or will identify an alternate source of funding for the plan update in order to begin the update process in the spring of 2023.

24.2.6 Continuing Public Participation

The public outreach strategy used during development of the current update will provide a framework for public engagement through the plan maintenance process. It can be adapted for ongoing public outreach as determined to be feasible by the County. A working group similar to the one involved in developing this hazard mitigation plan update will be put in place to provide stakeholder input on plan maintenance activities.

The public will continue to be apprised of hazard mitigation activities through the website and reports on successful hazard mitigation actions provided to the media. Hawai‘i County Civil Defense will keep the website maintained, including monitoring the email address where members of the public can submit comments to the working group. This site will house the final plan and will be a one-stop shop for information regarding the plan and its implementation. Copies of the plan also will be distributed to the libraries in the planning area.

Upon initiation of the next plan update process, a new public involvement strategy will be initiated, with guidance from the new working group. This strategy will be based on the needs and capabilities of the County at the time of the update. At a minimum, it will include the use of local media outlets.

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County of Hawai‘i Multi-Hazard Mitigation Plan

Appendix A. Public Outreach Materials

HAZARD MITIGATION SURVEY

Hawai'i County Hazard Mitigation Plan Survey

Hawai’i County Civil Defense and local stakeholders are working together to update the Hawai’i County Hazard Mitigation Plan (HMP). During the course of this update, local leaders and the community are working together to identify risks, assess capabilities, and formulate a strategy to reduce disaster vulnerability.

We want to understand your awareness and knowledge about the natural hazards that affect our communities. We also want to incorporate your recommendations to help residents prepare for hazard events and prevent unnecessary impacts. The following questions will help us look at community demographics, measure how much local citizens already know about disaster-related issues and will help us identify areas where we need to improve. The information you provide will help us organize activities and prioritize projects to reduce the risk of injury or damage to property from future hazard events.

The survey consists of about 26 questions and provides an opportunity to comment. It should take less than 10 minutes to complete the survey and it is anonymous.

Mahalo for taking the time to participate in the 2020 Hawai’i County Hazard Mitigation Plan Survey!

Hawai'i County Hazard Mitigation Plan Survey

1. Where do you live?

- ◯ Puna
- ◯ South Hilo
- ◯ North Hilo
- ◯ Hamakua
- ◯ North Kohala
- ◯ South Kohala
- ◯ North Kona
- ◯ South Kona
- ◯ Ka'u
- ◯ I don't live in Hawai'i County

2. Where do you work?

- [ ] Puna
- [ ] South Hilo
- [ ] North Hilo
- [ ] Hamakua
- [ ] North Kohala
- [ ] South Kohala
- [ ] North Kona
- [ ] South Kona
- [ ] Ka'u
- [ ] I don't work

3. Where do you frequent (places you stay regularly, but don't work or have a permanent residence)

- [ ] Puna
- [ ] South Hilo
- [ ] North Hilo
- [ ] Hamakua
- [ ] North Kohala
- [ ] South Kohala
- [ ] North Kona
- [ ] South Kona
- [ ] Ka'u
- [ ] I don't frequent other areas of Hawai'i County

4. How many persons live in your household?

5. How many generations live in your household?

6. Please indicate the primary language spoken in your household.

- English
- Hawaiian
- Spanish
- Tagalog
- Ilocano
- Other Asian and Pacific Island Languages
- American Sign Language
- Other (please specify)

7. Which of the following natural hazard events have you, your place of employment, your school, or anyone in your household experienced withing the last 10 years in Hawai'i County? (Check all that apply)

- [ ] Volcanic Eruption
- [ ] Drought
- [ ] Earthquake
- [ ] Flood
- [ ] Landslide
- [ ] High Wind Storms
- [ ] Hurricane
- [ ] Storm surge/High Surf/Chronic Coastal Flood
- [ ] Climate Change/Sea Level Rise
- [ ] Tsunami
- [ ] Wildfire

8. How concerned are you about the following natural hazards in Hawai'i County?

	Not concerned	Somewhat concerned	Concerned	Very concerned	Extremely concerned
Volcanic Eruption	◯	◯	◯	◯	◯
Dam Failure	◯	◯	◯	◯	◯
Drought	◯	◯	◯	◯	◯
Earthquake	◯	◯	◯	◯	◯
Flood	◯	◯	◯	◯	◯
Landslide	◯	◯	◯	◯	◯
High Wind Storms	◯	◯	◯	◯	◯
Hurricane	◯	◯	◯	◯	◯
Storm Surge/High Surf/Chronic Coastal Flood	◯	◯	◯	◯	◯
Climate Change/Sea Level Rise	◯	◯	◯	◯	◯
Tsunami	◯	◯	◯	◯	◯
Wildfire	◯	◯	◯	◯	◯

9. Do you own or rent your place of residence?

◯ Own

◯ Rent

◯ Other (please specify)

10. How long have you lived at your current residence?

◯ Less than a year

◯ 1-5 years

◯ 6-10 years

◯ 11-20 years

◯ More than 20 years

◯ I don't live in Hawai'i County

11. When you moved into your home, which disasters did you consider could have an impact on your home?

- [ ] Volcanic Eruption
- [ ] Earthquake
- [ ] Drought
- [ ] Flood
- [ ] Landslide
- [ ] High Wind / Hurricane
- [ ] Tsunami
- [ ] Coastal Erosion
- [ ] Wildfire
- [ ] Invasive Species
- [ ] I didn't consider any disasters

12. To the best of your knowledge, is your home located within any of the following natural hazard areas? (please choose all that apply)

- [ ] FEMA designated Floodplain or Coastal Flood Zone
- [ ] Coastal Erosion Zone
- [ ] Earthquake Hazard Zone
- [ ] Landslide/Rockfall Hazard Zone
- [ ] Tsunami Evacuation Zone
- [ ] Wildfire Risk Area
- [ ] Lava Inundation Zone
- [ ] Lava Zone 1
- [ ] Lava Zone 2
- [ ] Lava Zone 3
- [ ] None of the above

13. Was the presence of a natural hazard risk zone (lava zone,flood zone, tsunami zone) disclosed to you by a real estate agent,seller,or landlord before you purchased or moved into your home?

- ( ) Yes
- ( ) No

If "Yes", did your real estate agent or landlord explain the implications of living in a hazard risk zone? Did you understand the information provided?

14. Do you have insurance that will provide coverage for losses from hazards not usually covered by homeowners' insurance policies (i.e. floods, landslides, wildfires, earthquakes)? Please choose all that apply.

- [ ] No, I have not purchased specialty insurance coverage
- [ ] Flood Insurance
- [ ] Earthquake Insurance
- [ ] Wildfire Insurance
- [ ] Lava Insurance
- [ ] I am not sure
- [ ] Other (please specify)

15. Have you ever had problems securing homeowners or renters insurance due to risks from hazards?

- ( ) Yes
- ( ) No

If "Yes", what hazard was the cause of the difficulty?

16. Which of the following incentives would motivate you to take additional steps to better protect your home from natural disaster? (select all that apply)

- [ ] Insurance premium discounts
- [ ] Mortgage discounts
- [ ] Low interest rate loans
- [ ] Grant funding for retrofits
- [ ] "Rebate" program
- [ ] None
- [ ] I rent my home
- [ ] Other (please specify)

17. Which of the following obstacles prevent you from strengthening your home from the next disaster? (select all that apply)

- [ ] It costs too much.
- [ ] I can't find a contractor to do the work.
- [ ] I don't really know what to do or how to do it.
- [ ] The odds of being impacted are too remote to justify the cost.
- [ ] I'm too busy. I'll prepare if there's any warning.
- [ ] There isn't a way to stop the hazard and damage.
- [ ] I don't care.

18. Hawai'i County recommends households have at least 14 days of food, water, and vital supplies (e.g. medications) on hand in the event of a disaster. How many days of food, water, and vital supplies does your household have on hand in the event of a disaster?

19. Which of the following steps has your household undertaken to prepare for a disaster? (select all that apply)

- [ ] Received first aid/CPR training
- [ ] Made a fire escape plan
- [ ] Established a "defensible space" (area free from vegetation and combustible materials) around your home
- [ ] Used fire resistive landscaping (plants that do not catch fire easily)
- [ ] Designated a meeting place
- [ ] Developed a personal preparation plan
- [ ] Learned how to turn off utilities, such as power, gas,and water
- [ ] Anchored service utilities to your home (water heater, wood stove, etc.)
- [ ] Stored sand bags
- [ ] Community Emergency Response Training (CERT)
- [ ] Prepared a disaster supply/emergency survival kit
- [ ] Installed smoke detectors on each level of the house
- [ ] Stored food and water
- [ ] Stored flashlights and batteries
- [ ] Stored a battery-operated or crank radio
- [ ] Purchased and leaned how to program a NOAA Weather Radio
- [ ] Stored a fire extiguisher
- [ ] Stored medical supplies (first aid kit, medications)
- [ ] Purchased natural hazard insurance (Flood, Earthquake, Wildfire)
- [ ] Subscribed to Emergency Civil Defense Alerts
- [ ] No preparation or disaster plan
- [ ] Other (please specify)

20. How prepared is your household to get along without electricity or propane for one to five days?

- ( ) Not at all prepared
- ( ) Somewhat prepared
- ( ) Very prepared

21. Where would you expect to find information to help you be prepared? (select all that apply)

- [ ] Television
- [ ] Internet
- [ ] Social Media
- [ ] Newspaper/magazine
- [ ] Public government meetings
- [ ] Schools/academic institutions
- [ ] Hawai'i County Civil Defense website
- [ ] Police/Fire/EMS
- [ ] Other (please specify)

22. How prepared is your household for a hazard event?

- ○ Not at all prepared
- ○ Somewhat prepared
- ○ Adequately prepared
- ○ Well prepared
- ○ Very well prepared

23. How would you expect to be notified in case of an immediate threat caused by a hazard? (select all that apply)

- [ ] Television
- [ ] Radio
- [ ] Facebook
- [ ] Twitter
- [ ] Nextdoor
- [ ] Civil Defense alert
- [ ] Police/Fire/EMS
- [ ] Audible notification system
- [ ] Other (please specify)

24. For which hazards should information be more readily available? Select all that apply.

- [ ] Volcanic Eruption
- [ ] Dam Failure
- [ ] Drought
- [ ] Earthquake
- [ ] Flood
- [ ] Landslide
- [ ] High Wind Storms
- [ ] Hurricane
- [ ] Storm Surge/High Surf/Chronic Coastal Flood
- [ ] Climate Change/Sea Level Rise
- [ ] Tsunami
- [ ] Wildfire
- [ ] Other (please specify)

25. Do you support policies and/or regulations that prohibit or restrict development in identified hazard zones?

- ( ) Yes
- ( ) No
- ( ) Not sure

Comments

26. What types of projects do you believe the County, State, or Federal agencies should be doing in order to reduce damage and disruption from hazard events within Hawai'i County? Please rank each option as a low, medium or high priority.

	Low	Medium	High
Retrofit (add safety improvements) and strengthen essential facilities such as police and fire stations, schools and hospitals.	( )	( )	( )

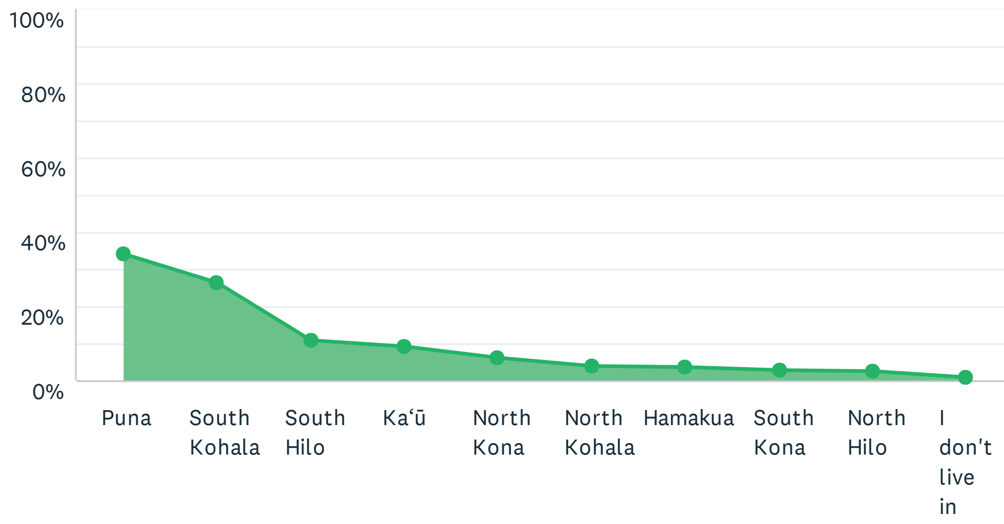
	Low	Medium	High
Retrofit (add safety improvements to) infrastructure such as harbors, roads, bridges, drainage facilities, water supply systems, wastewater systems and power supply facilities.	◯	◯	◯
Provide money for large projects such as dams, flood walls, drainage improvements, bank and coastal stabilization projects.	◯	◯	◯
Strengthen laws and regulations to include higher regulatory standards in hazard areas, such as floodplains and lava zones.	◯	◯	◯
Purchase properties that are in danger to natural hazards and maintain them as open space or parks.	◯	◯	◯
Assist vulnerable property owners with finding funding for reducing the risk from hazards.	◯	◯	◯
Provide better public information about risk and the exposure hazards within the area.	◯	◯	◯
Begin projects that restore that natural environment's ability to absorb he impacts from natural hazards such as rain gardens.	◯	◯	◯
Begin projects that lessen the potential impacts from climate change.	◯	◯	◯

	Low	Medium	High
Begin buyout programs where homes or properties located in designated "high hazard" or areas that are repeatedly damaged are purchased from their owners.	◯	◯	◯

SURVEY RESULTS

Q1 Where do you live?

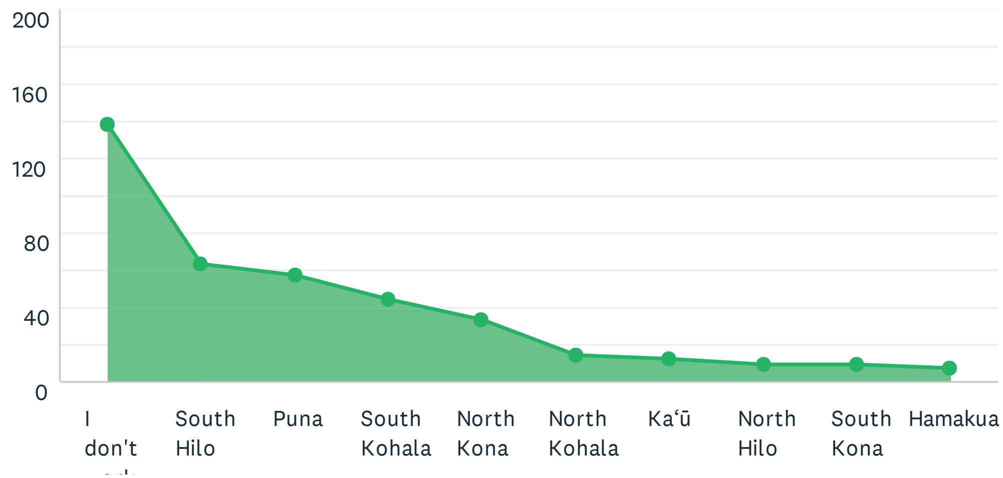
Answered: 361 Skipped: 2



ANSWER CHOICES	RESPONSES	
Puna	34%	123
South Kohala	26%	95
South Hilo	11%	39
Ka‘ū	9%	33
North Kona	6%	22
North Kohala	4%	14
Hamakua	4%	13
South Kona	3%	10
North Hilo	2%	9
I don't live in Hawai‘i County	1%	3
TOTAL		361

Q2 Where do you work?

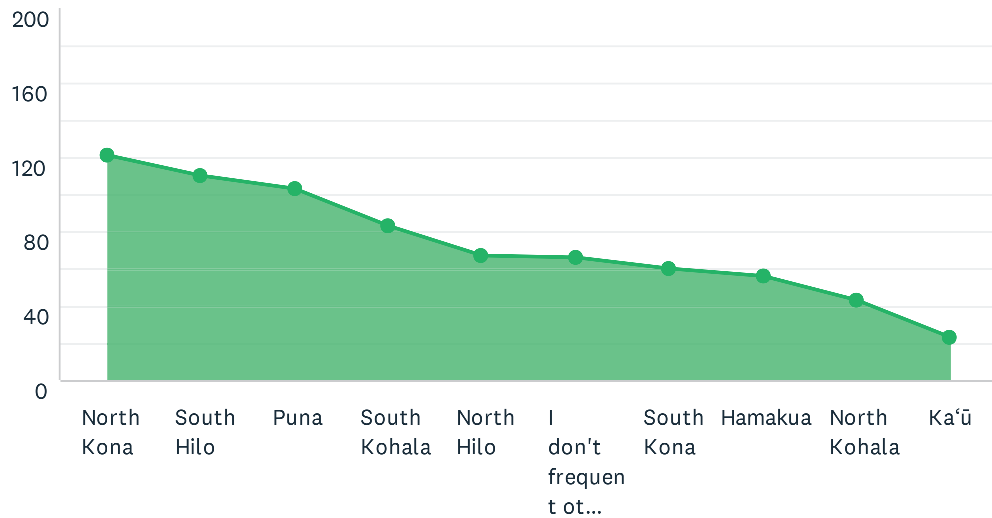
Answered: 355   Skipped: 8



ANSWER CHOICES	RESPONSES	
I don't work	38.87%	138
South Hilo	17.75%	63
Puna	16.06%	57
South Kohala	12.39%	44
North Kona	9.30%	33
North Kohala	3.94%	14
Kaʻū	3.38%	12
North Hilo	2.54%	9
South Kona	2.54%	9
Hamakua	1.97%	7
Total Respondents: 355		

Q3 Where do you frequent (places you stay regularly, but don't work or have a permanent residence)

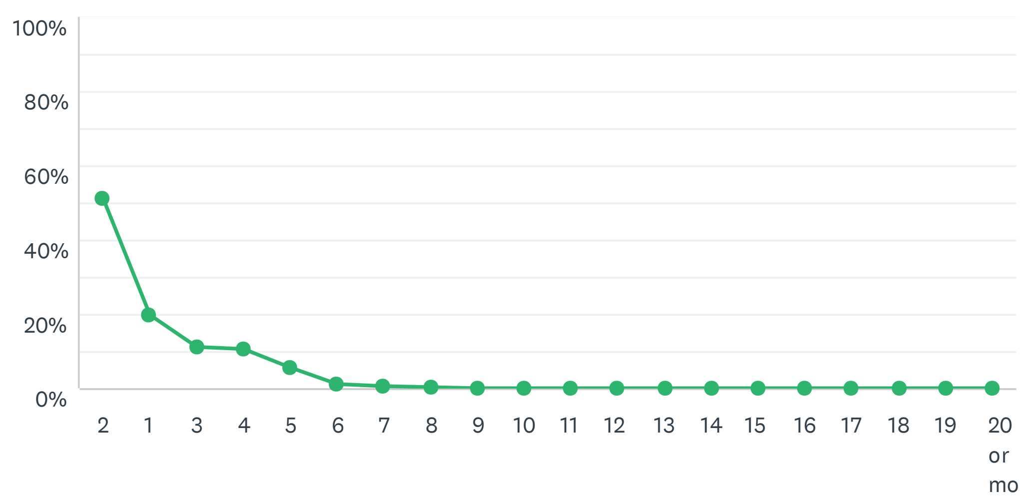
Answered: 355 Skipped: 8



ANSWER CHOICES	RESPONSES	
North Kona	34.08%	121
South Hilo	30.99%	110
Puna	29.01%	103
South Kohala	23.38%	83
North Hilo	18.87%	67
I don't frequent other areas of Hawaiʻi County	18.59%	66
South Kona	16.90%	60
Hamakua	15.77%	56
North Kohala	12.11%	43
Kaʻū	6.48%	23
Total Respondents: 355		

Q4 How many persons live in your household?

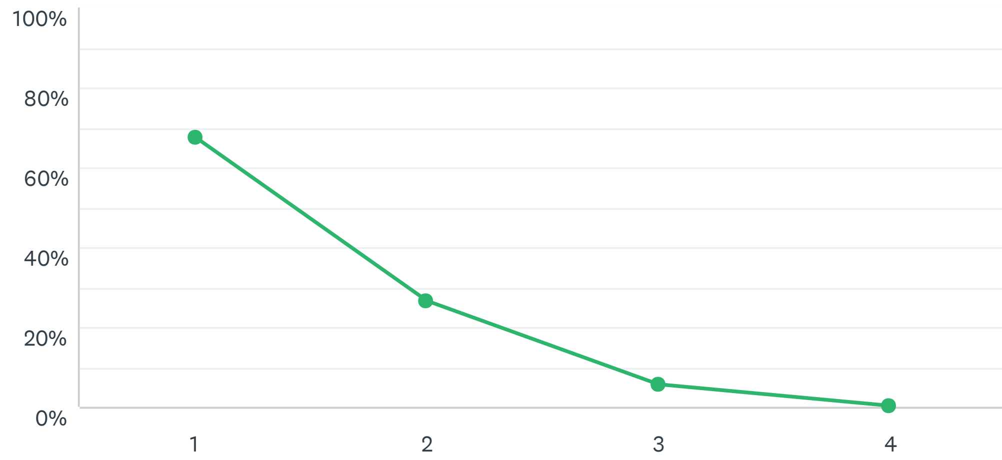
Answered: 360 Skipped: 3



ANSWER CHOICES	RESPONSES	
2	51%	184
1	20%	71
3	11%	40
4	11%	38
5	6%	20
6	1%	4
7	1%	2
8	0%	1
9	0%	0
10	0%	0
11	0%	0
12	0%	0
13	0%	0
14	0%	0
15	0%	0
16	0%	0
17	0%	0
18	0%	0
19	0%	0
20 or more	0%	0
TOTAL		360

Q5 How many generations live in your household?

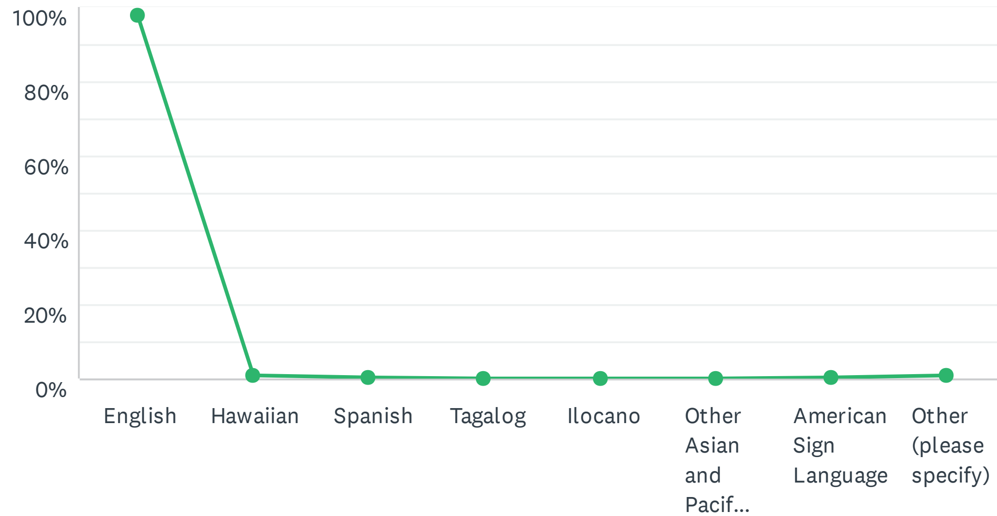
Answered: 354 Skipped: 9



ANSWER CHOICES	RESPONSES	
1	68%	239
2	27%	94
3	6%	20
4	0%	1
TOTAL		354

Q6 Please indicate the primary language spoken in your household.

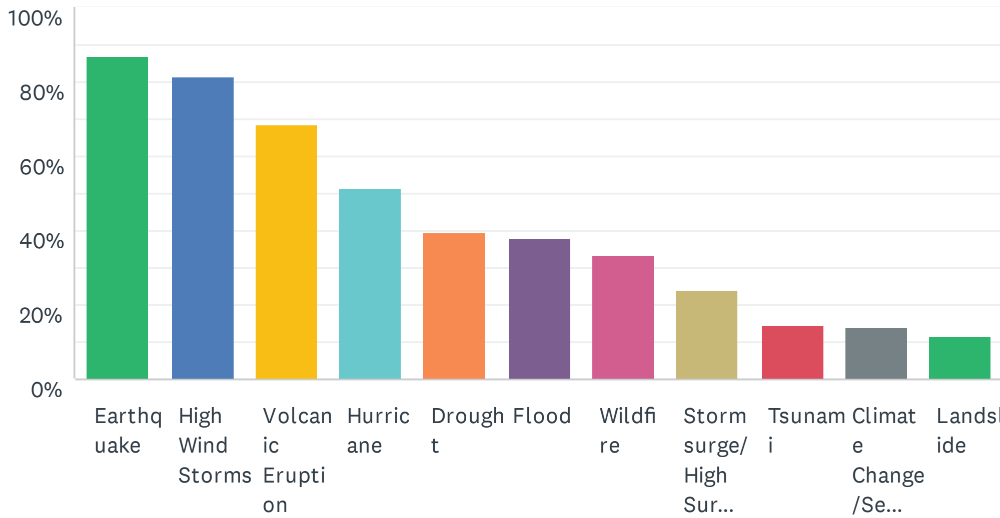
Answered: 360 Skipped: 3



ANSWER CHOICES	RESPONSES	
English	97.78%	352
Hawaiian	0.83%	3
Spanish	0.28%	1
Tagalog	0.00%	0
Ilocano	0.00%	0
Other Asian and Pacific Island Languages	0.00%	0
American Sign Language	0.28%	1
Other (please specify)	0.83%	3
TOTAL		360

Q7 Which of the following natural hazard events have you, your place of employment, your school, or anyone in your household experienced withing the last 10 years in Hawai'i County? (Check all that apply)

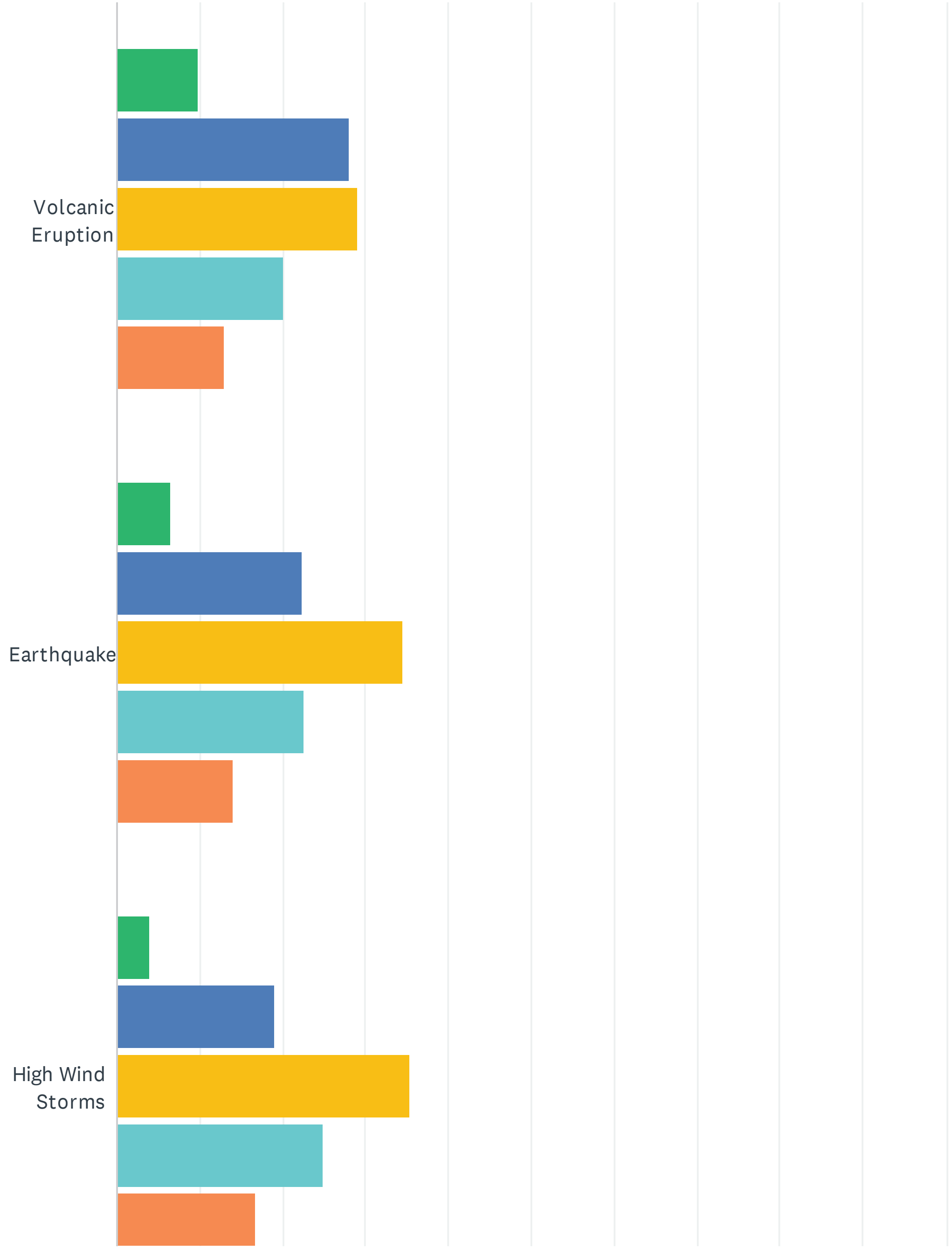
Answered: 353 Skipped: 10

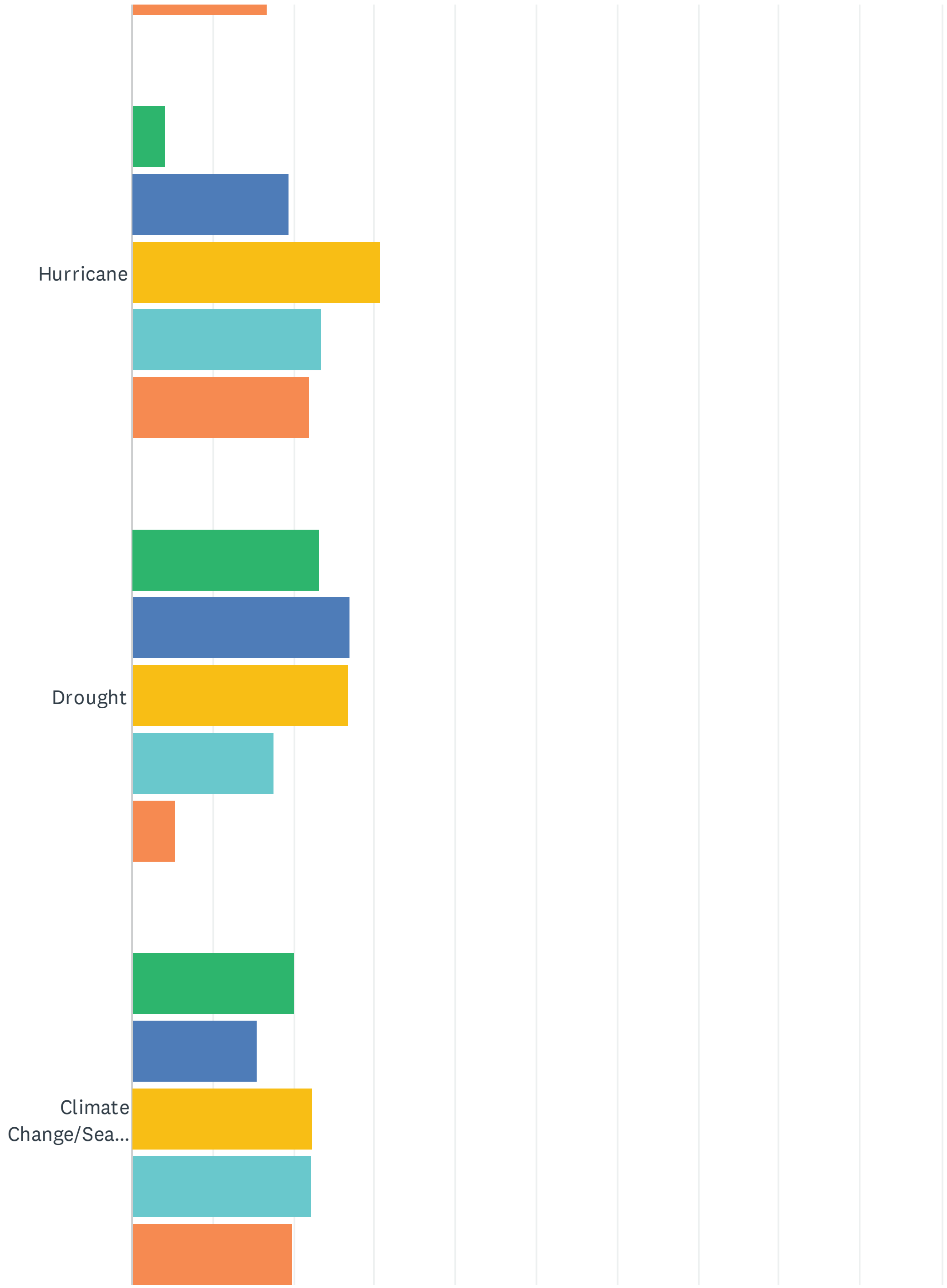


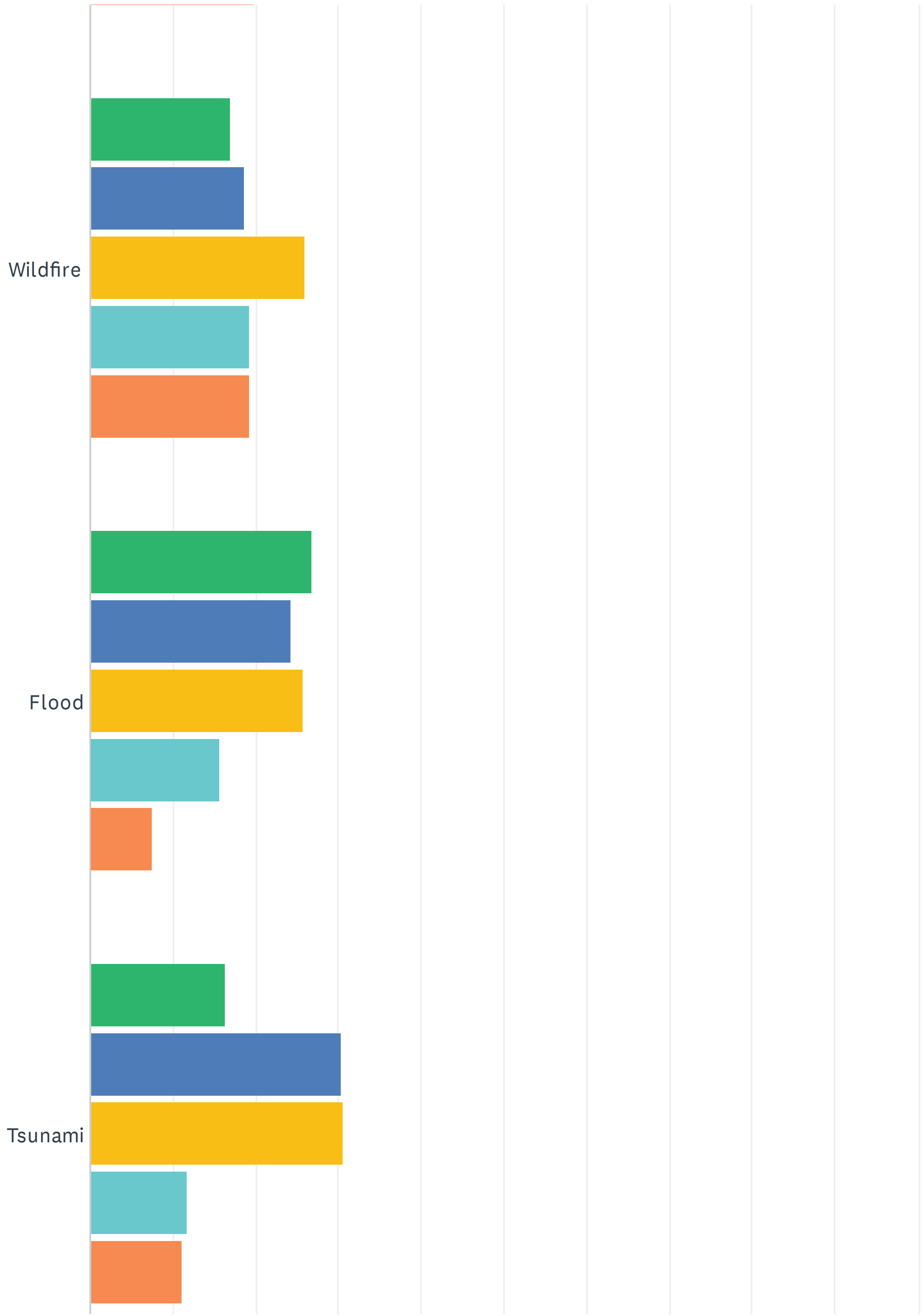
ANSWER CHOICES	RESPONSES	
Earthquake	87%	307
High Wind Storms	81%	287
Volcanic Eruption	69%	242
Hurricane	52%	182
Drought	40%	140
Flood	38%	135
Wildfire	33%	118
Storm surge/High Surf/Chronic Coastal Flood	24%	84
Tsunami	14%	51
Climate Change/Sea Level Rise	14%	50
Landslide	12%	41
Total Respondents: 353		

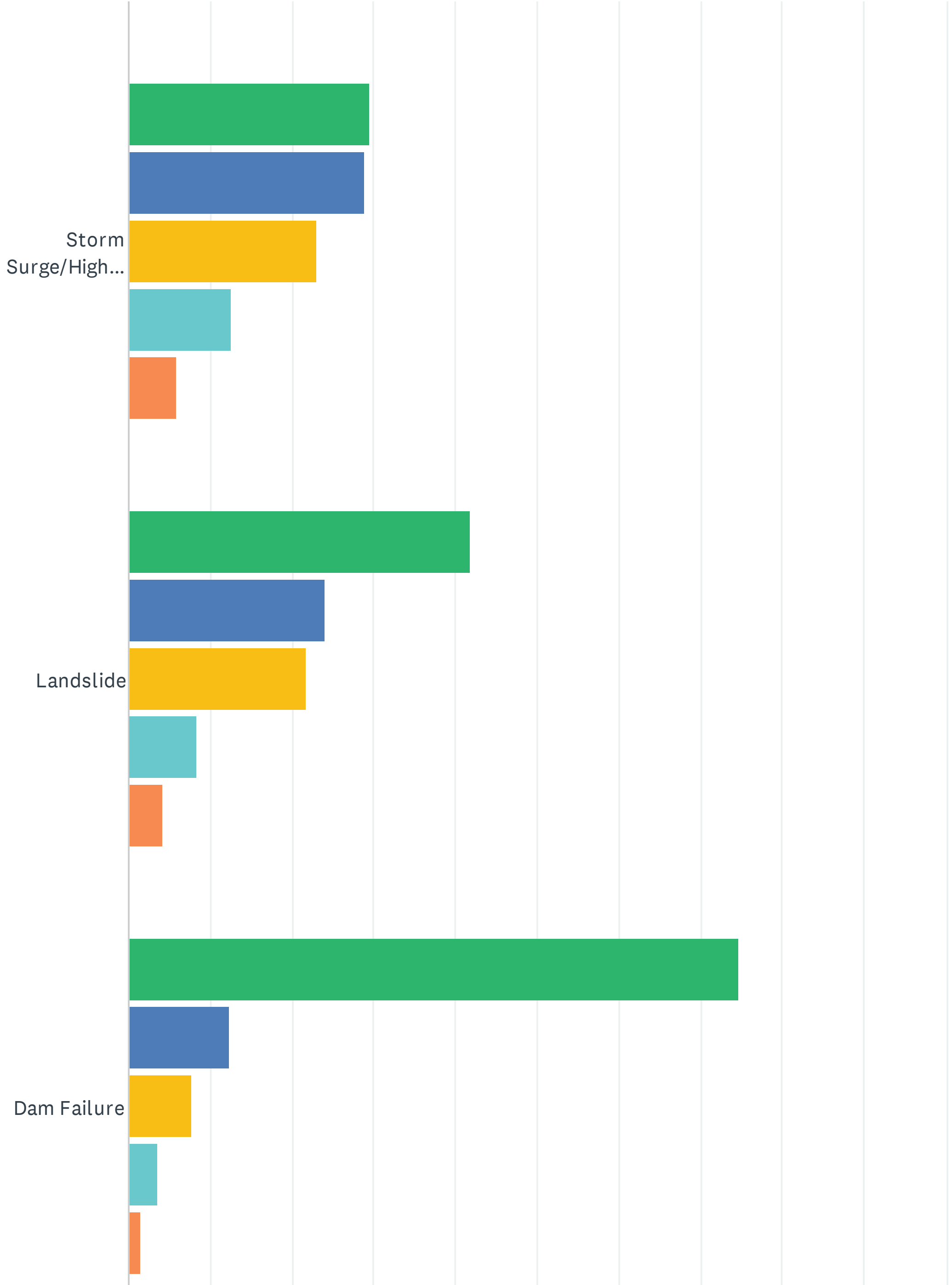
Q8 How concerned are you about the following natural hazards in Hawai'i County?

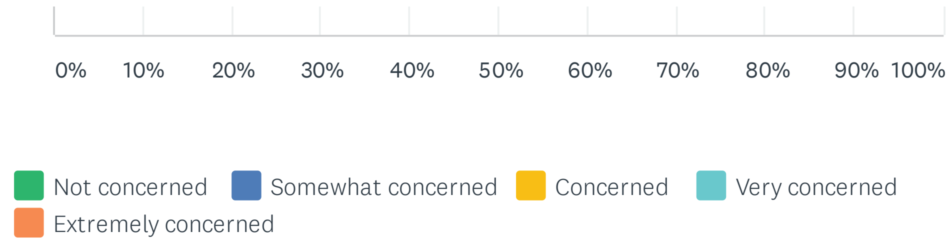
Answered: 361   Skipped: 2




Hurricane
Drought
Climate Change/Sea...


Wildfire
Flood
Tsunami

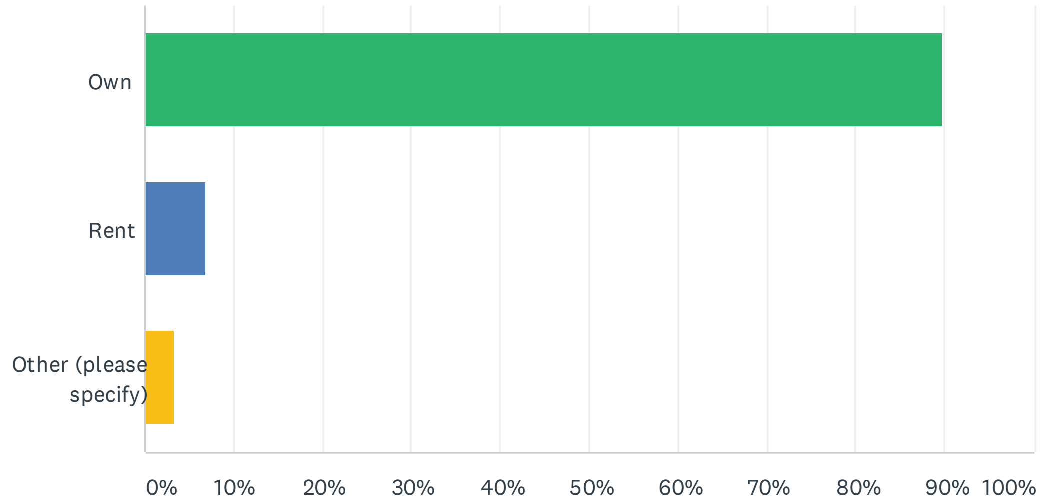

Storm Surge/High...
Landslide
Dam Failure



	NOT CONCERNED	SOMEWHAT CONCERNED	CONCERNED	VERY CONCERNED	EXTREMELY CONCERNED	TOTAL
Volcanic Eruption	10% 35	28% 100	29% 104	20% 72	13% 46	357
Earthquake	6% 23	22% 80	34% 123	23% 81	14% 50	357
High Wind Storms	4% 14	19% 68	35% 126	25% 89	17% 60	357
Hurricane	4% 15	19% 68	31% 108	23% 82	22% 77	350
Drought	23% 81	27% 94	27% 93	18% 61	5% 19	348
Climate Change/Sea Level Rise	20% 70	16% 54	22% 78	22% 77	20% 69	348
Wildfire	17% 59	19% 65	26% 90	19% 67	19% 67	348
Flood	27% 92	24% 83	26% 88	16% 54	8% 26	343
Tsunami	16% 56	30% 104	31% 105	12% 40	11% 38	343
Storm Surge/High Surf/Chronic Coastal Flood	30% 101	29% 99	23% 79	13% 43	6% 20	342
Landslide	42% 141	24% 81	22% 73	8% 28	4% 14	337
Dam Failure	75% 249	12% 41	8% 26	4% 12	2% 5	333

Q9 Do you own or rent your place of residence?

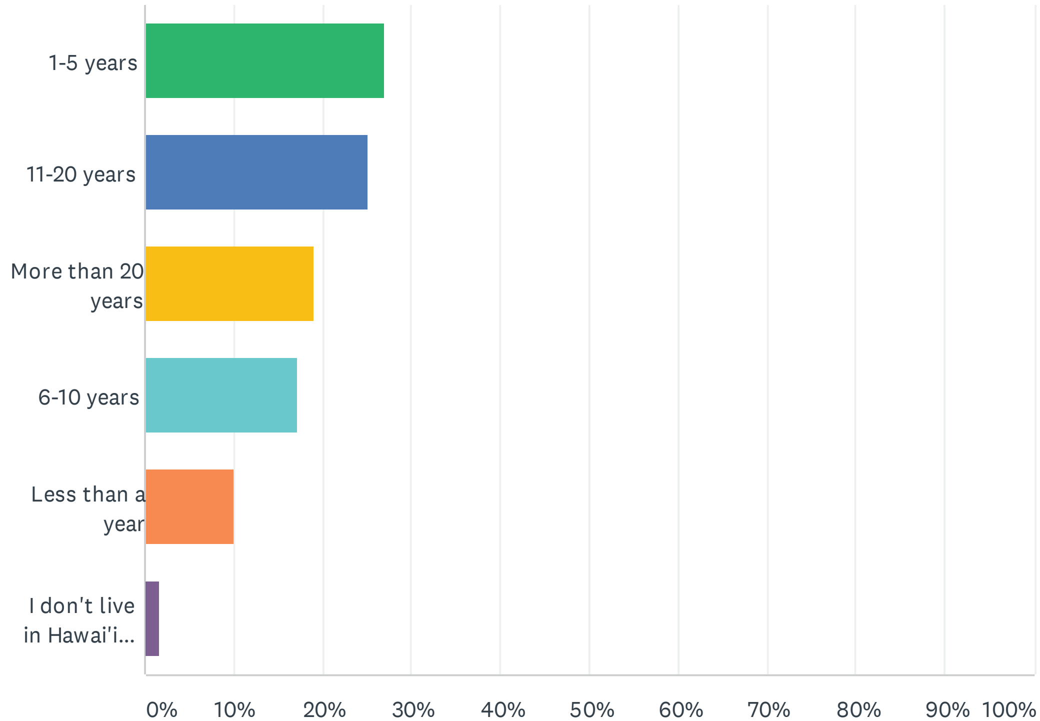
Answered: 362   Skipped: 1



ANSWER CHOICES	RESPONSES	
Own	90%	325
Rent	7%	25
Other (please specify)	3%	12
TOTAL		362

Q10 How long have you lived at your current residence?

Answered: 362   Skipped: 1

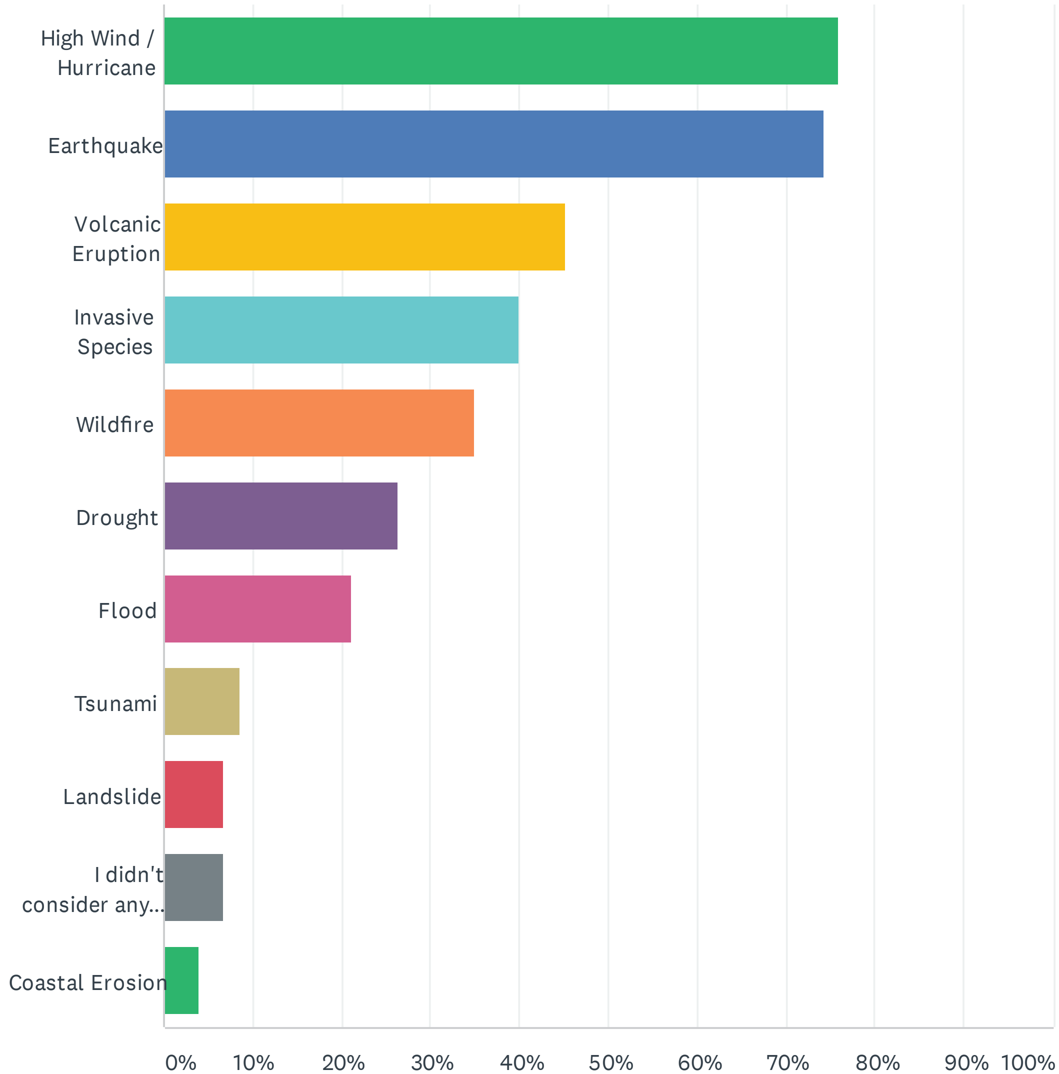


ANSWER CHOICES	RESPONSES	
1-5 years	27%	98
11-20 years	25%	91
More than 20 years	19%	69
6-10 years	17%	62
Less than a year	10%	36
I don't live in Hawai'i County	2%	6
TOTAL		362

Q11 When you moved into your home, which disasters did you consider could have an impact on your home?

Hawaiʻi County Hazard Mitigation Plan Survey

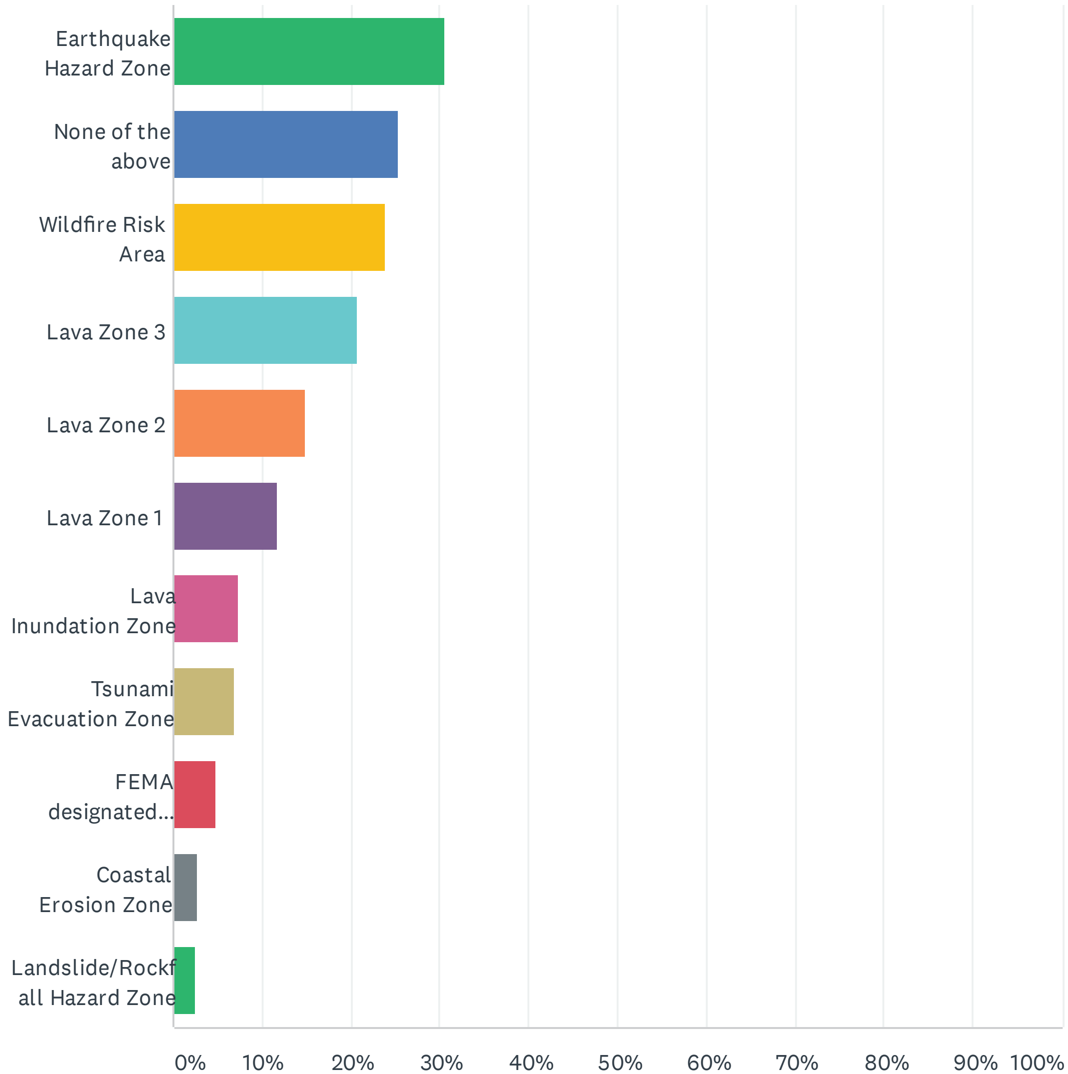
Answered: 361 Skipped: 2



ANSWER CHOICES	RESPONSES	
High Wind / Hurricane	76%	274
Earthquake	74%	268
Volcanic Eruption	45%	163
Invasive Species	40%	144
Wildfire	35%	126
Drought	26%	95
Flood	21%	76
Tsunami	9%	31
Landslide	7%	24
I didn't consider any disasters	7%	24
Coastal Erosion	4%	14
Total Respondents: 361		

Q12 To the best of your knowledge, is your home located within any of the following natural hazard areas? (please choose all that apply)

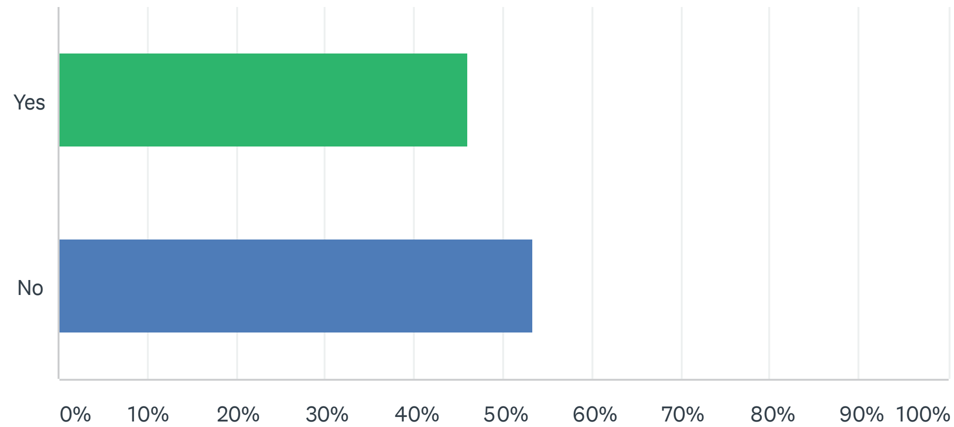
Answered: 357 Skipped: 6


Earthquake Hazard Zone
None of the above
Wildfire Risk Area
Lava Zone 3
Lava Zone 2
Lava Zone 1
Lava Inundation Zone
Tsunami Evacuation Zone
FEMA designated...
Coastal Erosion Zone
Landslide/Rockfall Hazard Zone
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ANSWER CHOICES	RESPONSES	
Earthquake Hazard Zone	31%	109
None of the above	25%	90
Wildfire Risk Area	24%	85
Lava Zone 3	21%	74
Lava Zone 2	15%	53
Lava Zone 1	12%	42
Lava Inundation Zone	7%	26
Tsunami Evacuation Zone	7%	25
FEMA designated Floodplain or Coastal Flood Zone	5%	17
Coastal Erosion Zone	3%	10
Landslide/Rockfall Hazard Zone	3%	9
Total Respondents: 357		

Q13 Was the presence of a natural hazard risk zone (lava zone,flood zone, tsunami zone) disclosed to you by a real estate agent,seller,or landlord before you purchased or moved into your home?

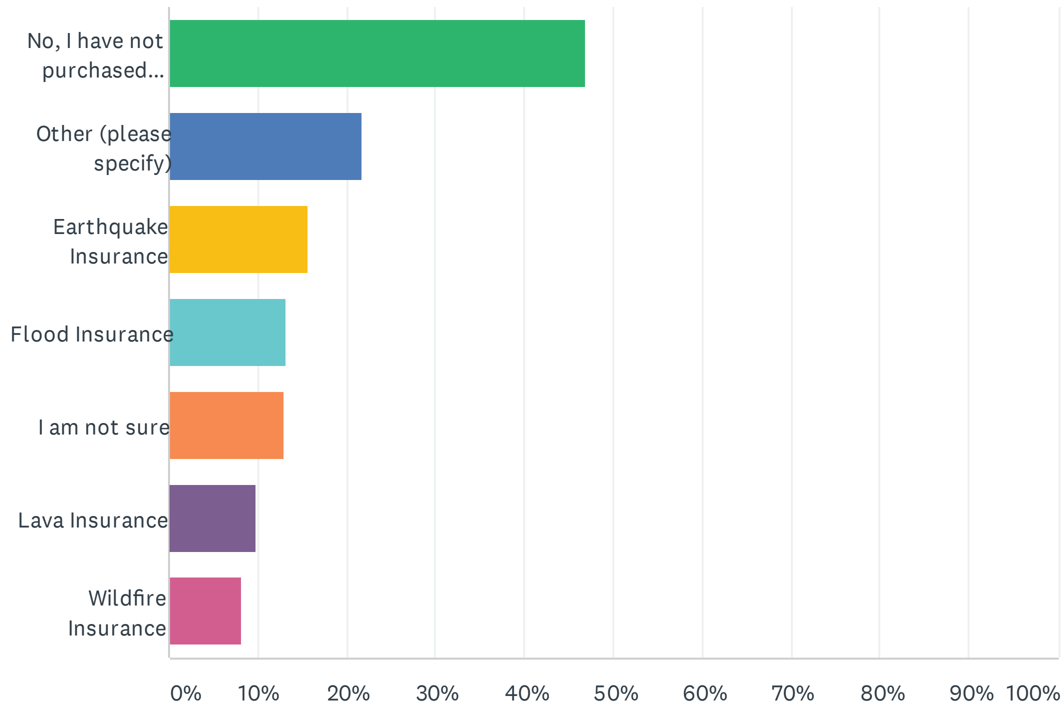
Answered: 360 Skipped: 3



ANSWER CHOICES	RESPONSES	
Yes	46%	166
No	53%	192
TOTAL		360

Q14 Do you have insurance that will provide coverage for losses from hazards not usually covered by homeowners' insurance policies (i.e. floods, landslides, wildfires, earthquakes)? Please choose all that apply.

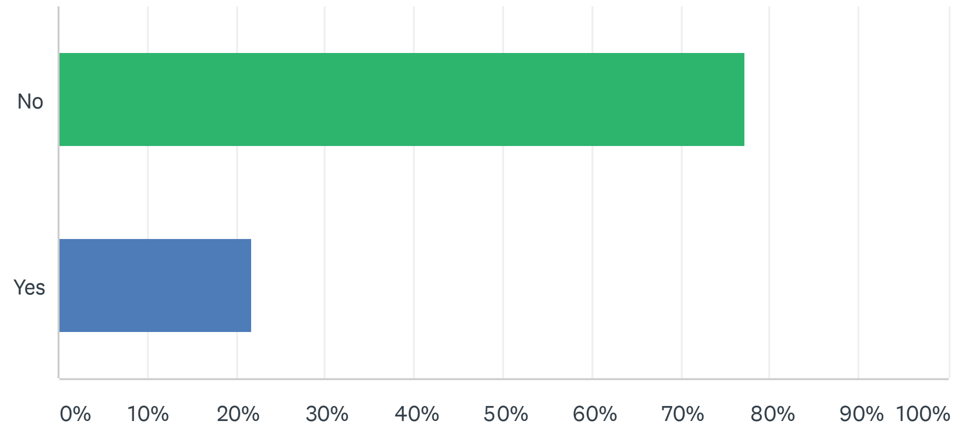
Answered: 357 Skipped: 6



ANSWER CHOICES	RESPONSES	
No, I have not purchased specialty insurance coverage	47%	167
Other (please specify)	22%	78
Earthquake Insurance	16%	56
Flood Insurance	13%	47
I am not sure	13%	46
Lava Insurance	10%	35
Wildfire Insurance	8%	29
Total Respondents: 357		

Q15 Have you ever had problems securing homeowners or renters insurance due to risks from hazards?

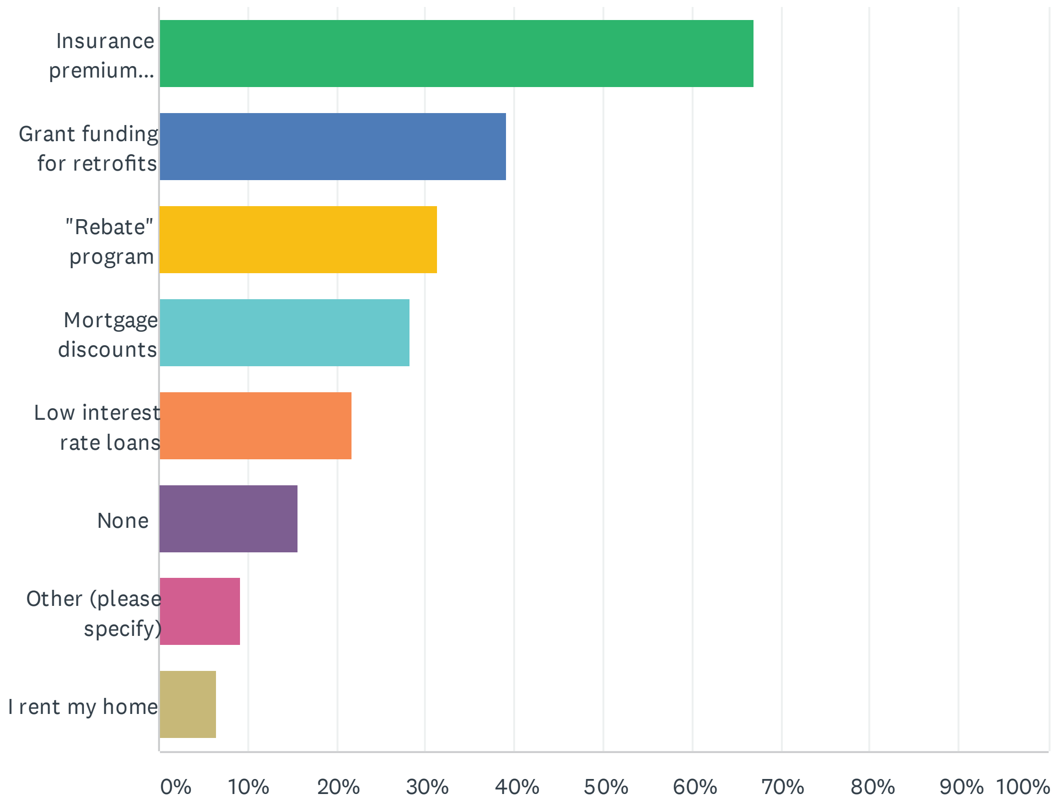
Answered: 350   Skipped: 13



ANSWER CHOICES	RESPONSES	
No	77%	270
Yes	22%	76
TOTAL		350

Q16 Which of the following incentives would motivate you to take additional steps to better protect your home from natural disaster? (select all that apply)

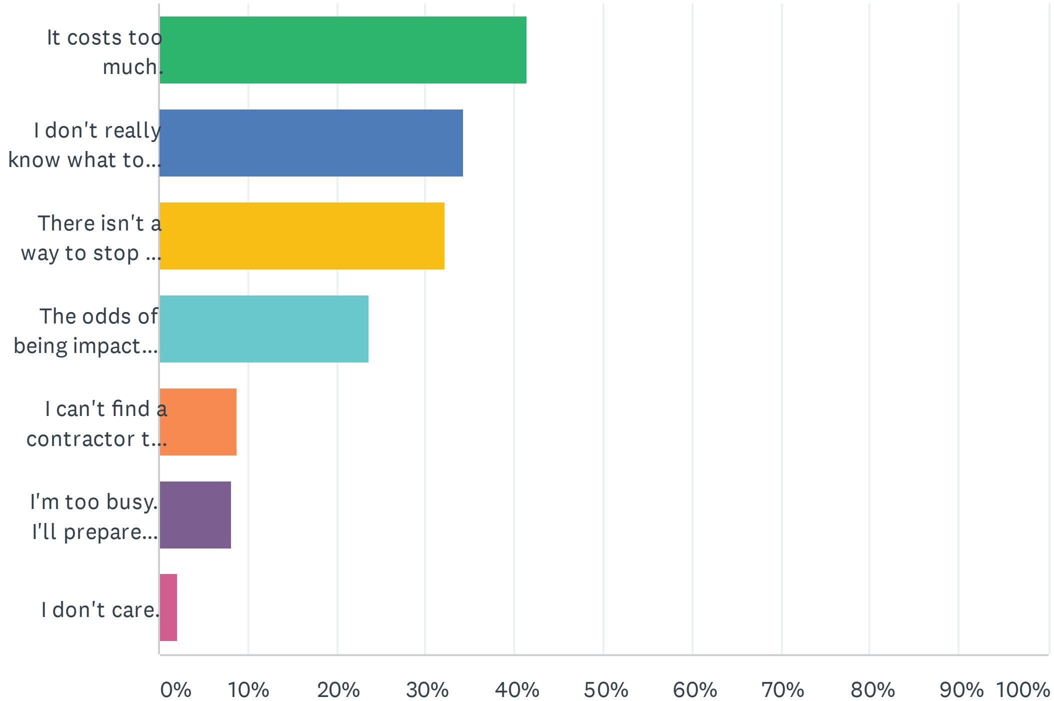
Answered: 357   Skipped: 6



ANSWER CHOICES	RESPONSES	
Insurance premium discounts	67%	239
Grant funding for retrofits	39%	140
"Rebate" program	31%	112
Mortgage discounts	28%	101
Low interest rate loans	22%	78
None	16%	56
Other (please specify)	9%	33
I rent my home	6%	23
Total Respondents: 357		

Q17 Which of the following obstacles prevent you from strengthening your home from the next disaster? (select all that apply)

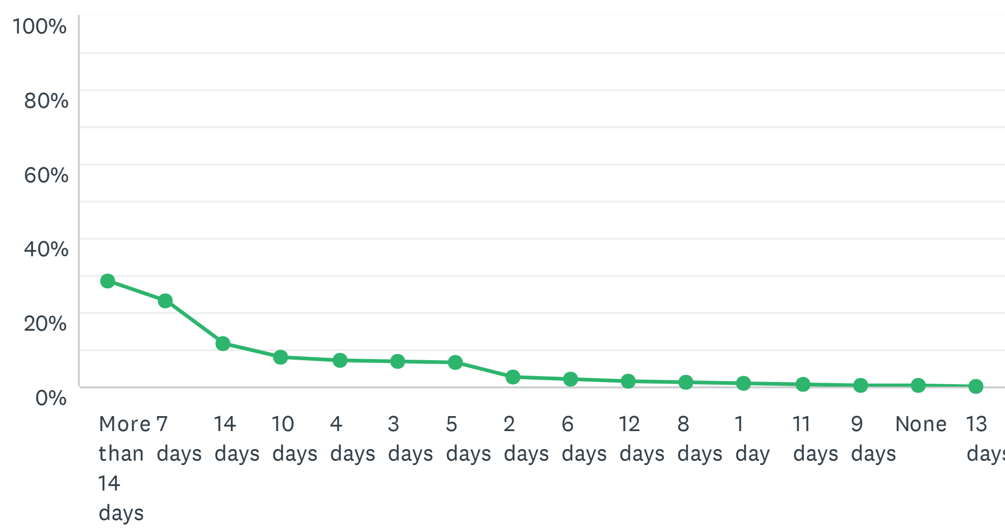
Answered: 329 Skipped: 34



ANSWER CHOICES	RESPONSES	
It costs too much.	41%	136
I don't really know what to do or how to do it.	34%	113
There isn't a way to stop the hazard and damage.	32%	106
The odds of being impacted are too remote to justify the cost.	24%	78
I can't find a contractor to do the work.	9%	29
I'm too busy. I'll prepare if there's any warning.	8%	27
I don't care.	2%	7
Total Respondents: 329		

Q18 Hawai'i County recommends households have at least 14 days of food, water, and vital supplies (e.g. medications) on hand in the event of a disaster. How many days of food, water, and vital supplies does your household have on hand in the event of a disaster?

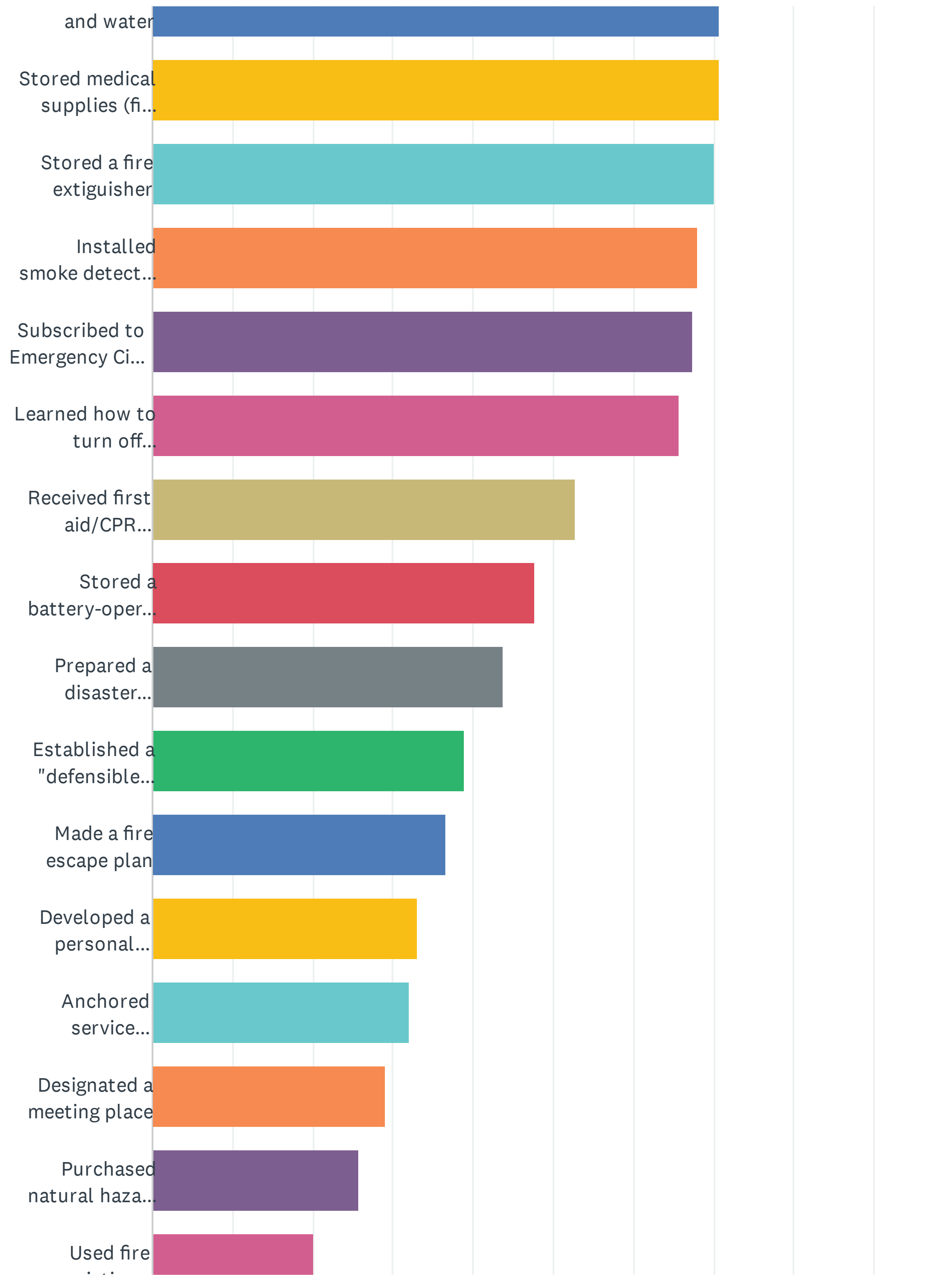
Answered: 356 Skipped: 7

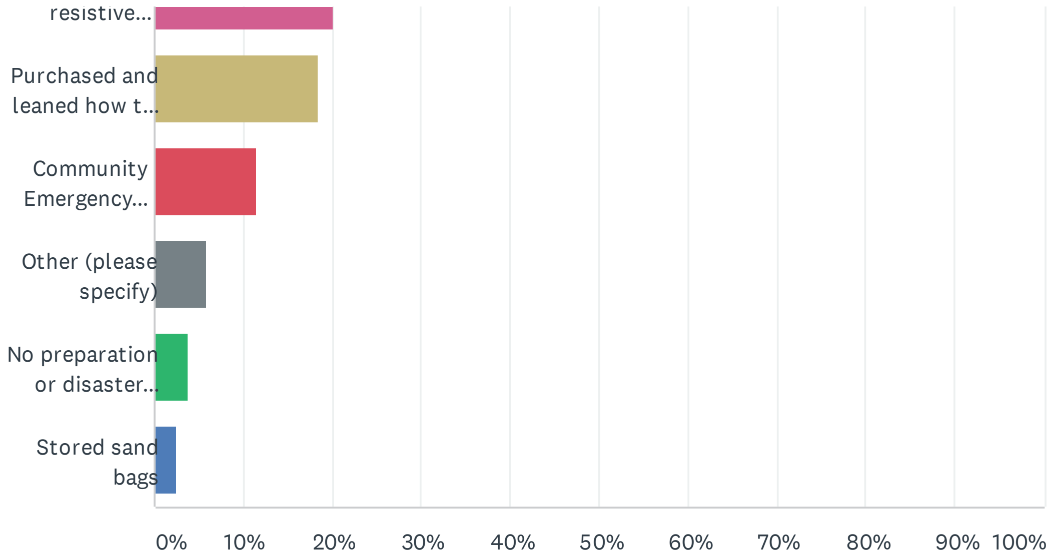


ANSWER CHOICES	RESPONSES	
More than 14 days	28%	101
7 days	23%	82
14 days	12%	41
10 days	8%	28
4 days	7%	25
3 days	7%	24
5 days	6%	23
2 days	3%	9
6 days	2%	7
12 days	1%	5
8 days	1%	4
1 day	1%	3
11 days	1%	2
9 days	0%	1
None	0%	1
13 days	0%	0
TOTAL		356

Q19 Which of the following steps has your household undertaken to prepare for a disaster? (select all that apply)

Answered: 355 Skipped: 8

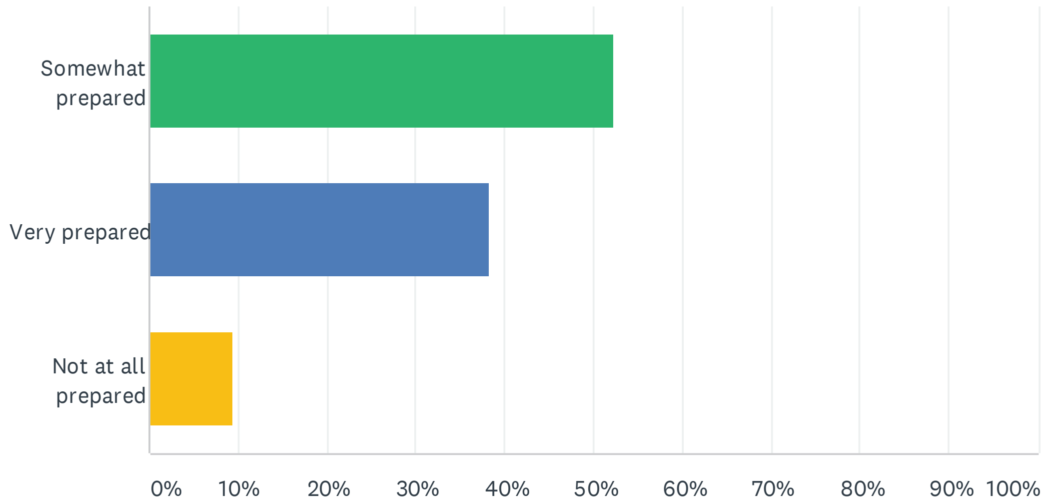

and water
Stored medical supplies (fi...
Stored a fire extiguisher
Installed smoke detect...
Subscribed to Emergency Ci...
Learned how to turn off...
Received first aid/CPR...
Stored a battery-oper...
Prepared a disaster...
Established a "defensible...
Made a fire escape plan
Developed a personal...
Anchored service...
Designated a meeting place
Purchased natural haza...
Used fire


resistive...
Purchased and leaned how t...
Community Emergency...
Other (please specify)
No preparation or disaster...
Stored sand bags
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ANSWER CHOICES	RESPONSES	
Stored flashlights and batteries	81%	289
Stored food and water	71%	251
Stored medical supplies (first aid kit, medications)	71%	251
Stored a fire extiguisher	70%	249
Installed smoke detectors on each level of the house	68%	241
Subscribed to Emergency Civil Defense Alerts	67%	239
Learned how to turn off utilities, such as power, gas,and water	66%	233
Received first aid/CPR training	53%	187
Stored a battery-operated or crank radio	48%	169
Prepared a disaster supply/emergency survival kit	44%	155
Established a "defensible space" (area free from vegetation and combustible materials) around your home	39%	138
Made a fire escape plan	37%	130
Developed a personal preparation plan	33%	117
Anchored service utilities to your home (water heater, wood stove, etc.)	32%	114
Designated a meeting place	29%	103
Purchased natural hazard insurance (Flood, Earthquake, Wildfire)	26%	91
Used fire resistive landscaping (plants that do not catch fire easily)	20%	71
Purchased and leaned how to program a NOAA Weather Radio	18%	65
Community Emergency Response Training (CERT)	12%	41
Other (please specify)	6%	21
No preparation or disaster plan	4%	13
Stored sand bags	3%	9
Total Respondents: 355		

Q20 How prepared is your household to get along without electricity or propane for one to five days?

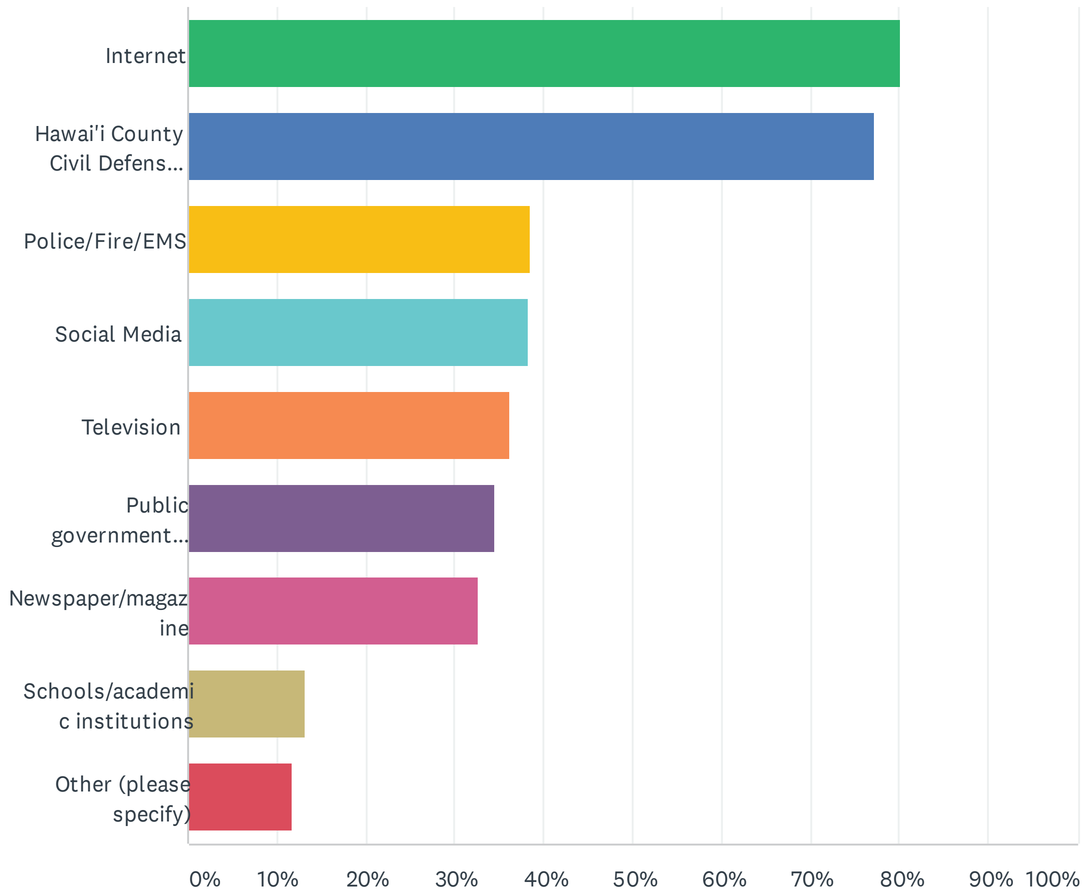
Answered: 360 Skipped: 3



ANSWER CHOICES	RESPONSES	
Somewhat prepared	52%	188
Very prepared	38%	138
Not at all prepared	9%	34
TOTAL		360

Q21 Where would you expect to find information to help you be prepared? (select all that apply)

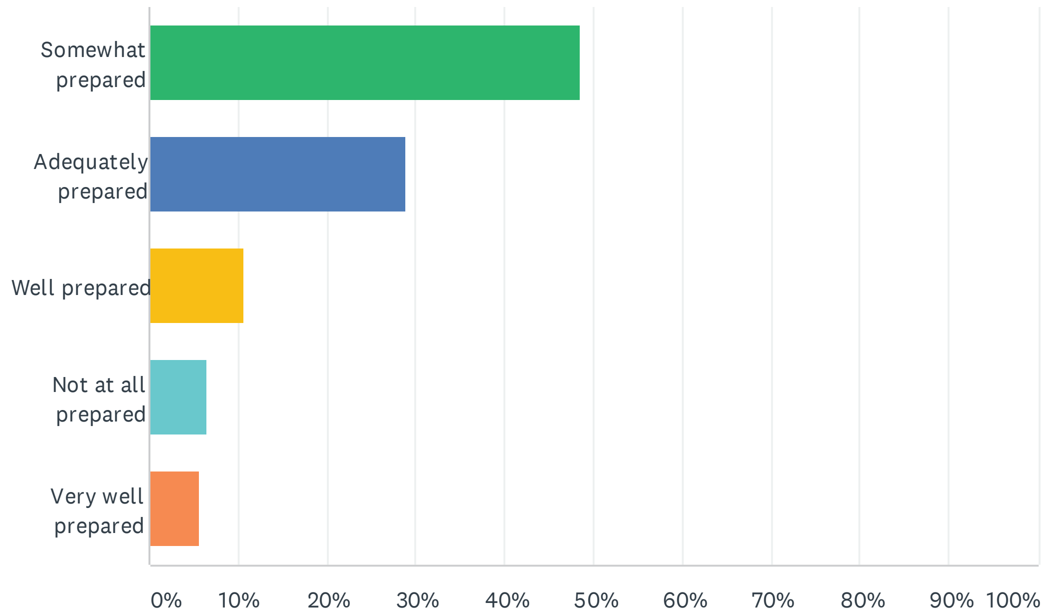
Answered: 356 Skipped: 7


Internet
Hawai'i County Civil Defens...
Police/Fire/EMS
Social Media
Television
Public government...
Newspaper/magazine
Schools/academic institutions
Other (please specify)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ANSWER CHOICES	RESPONSES	
Internet	80%	285
Hawai'i County Civil Defense website	77%	275
Police/Fire/EMS	38%	137
Social Media	38%	136
Television	36%	129
Public government meetings	35%	123
Newspaper/magazine	33%	116
Schools/academic institutions	13%	47
Other (please specify)	12%	42
Total Respondents: 356		

Q22 How prepared is your household for a hazard event?

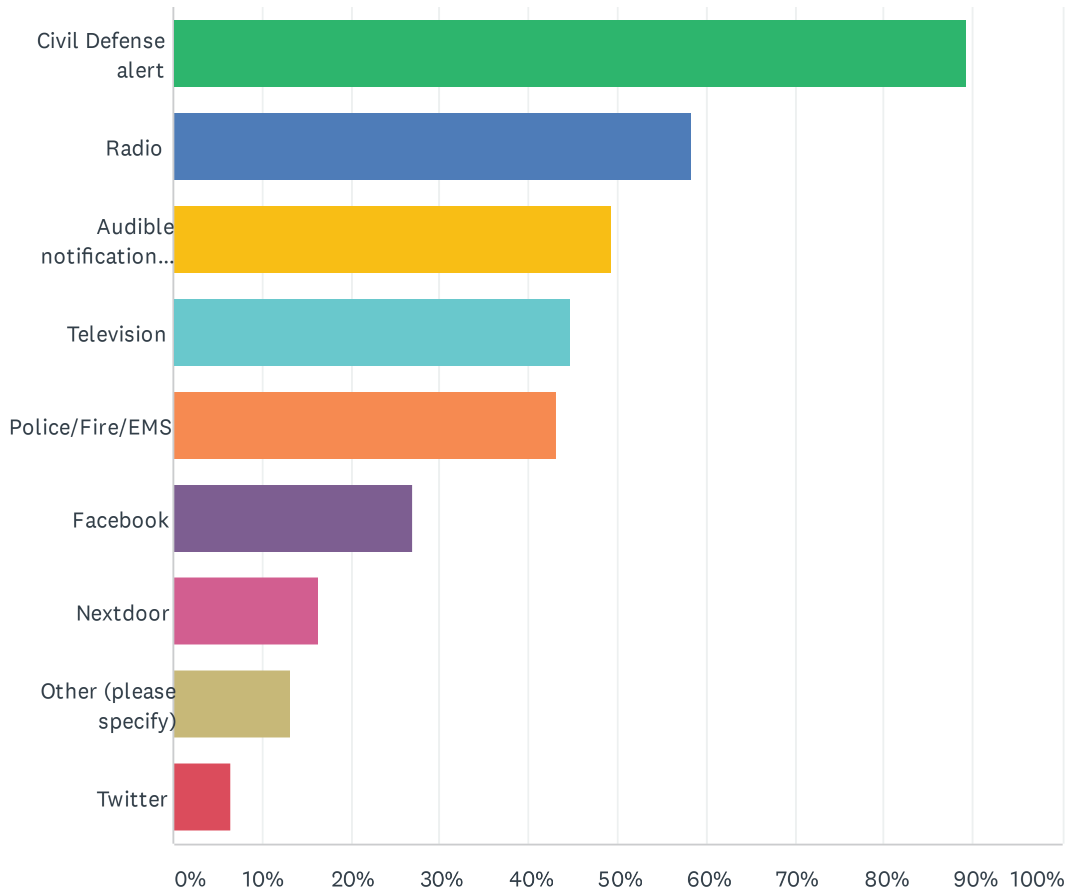
Answered: 357 Skipped: 6



ANSWER CHOICES	RESPONSES	
Somewhat prepared	48%	173
Adequately prepared	29%	103
Well prepared	11%	38
Not at all prepared	6%	23
Very well prepared	6%	20
TOTAL		357

Q23 How would you expect to be notified in case of an immediate threat caused by a hazard? (select all that apply)

Answered: 355 Skipped: 8

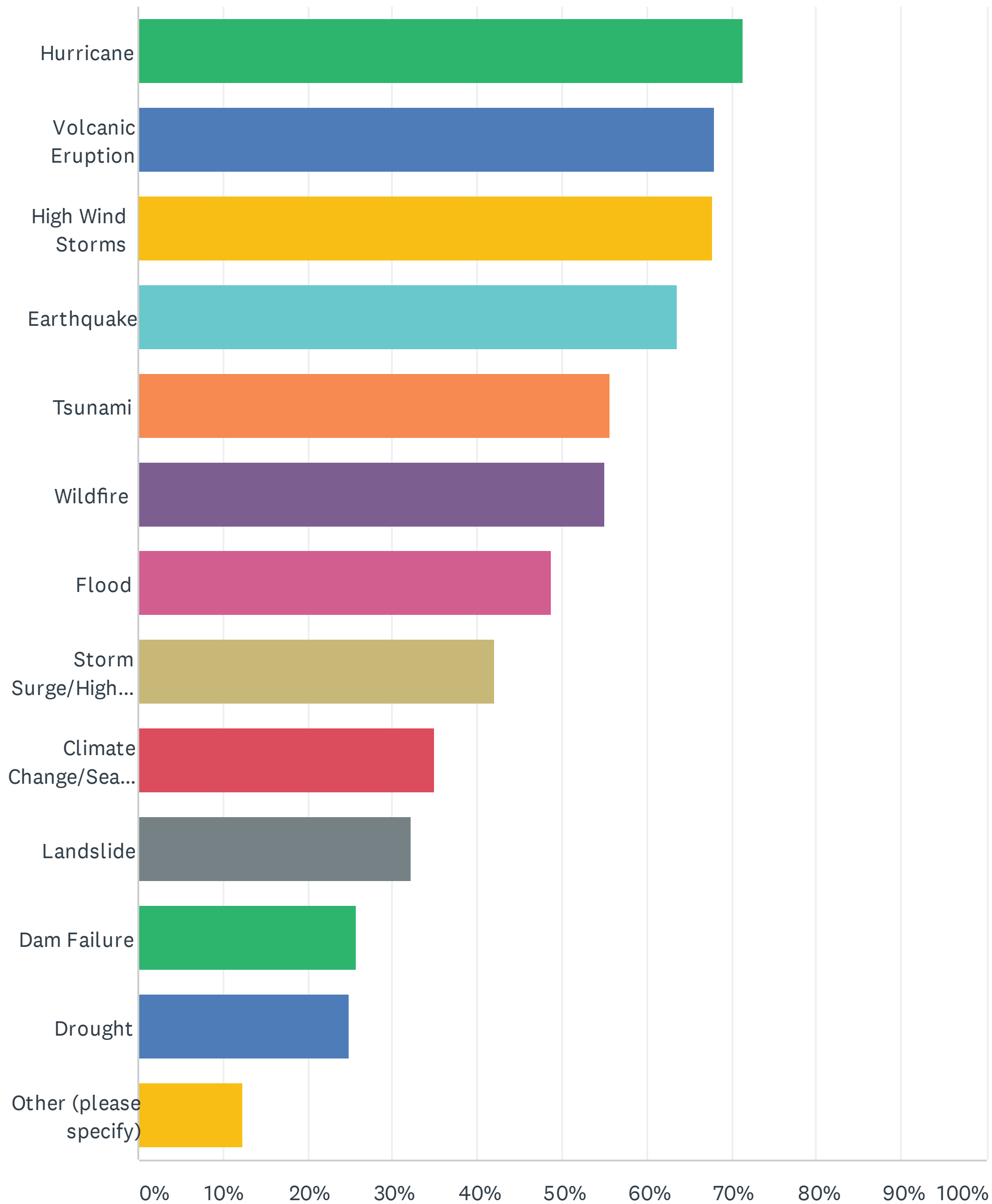

Civil Defense alert
Radio
Audible notification...
Television
Police/Fire/EMS
Facebook
Nextdoor
Other (please specify)
Twitter
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ANSWER CHOICES	RESPONSES	
Civil Defense alert	89%	317
Radio	58%	207
Audible notification system	49%	175
Television	45%	159
Police/Fire/EMS	43%	153
Facebook	27%	96
Nextdoor	16%	58
Other (please specify)	13%	47
Twitter	6%	23
Total Respondents: 355		

Q24 For which hazards should information be more readily available? Select all that apply.

Answered: 338 Skipped: 25

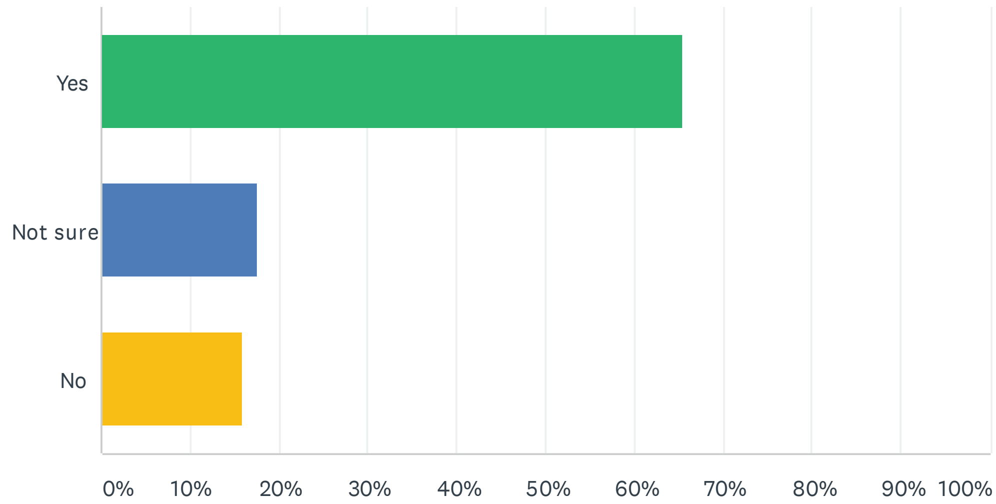
Hawai‘i County Hazard Mitigation Plan Survey



ANSWER CHOICES	RESPONSES	
Hurricane	71%	241
Volcanic Eruption	68%	230
High Wind Storms	68%	229
Earthquake	64%	215
Tsunami	56%	188
Wildfire	55%	186
Flood	49%	165
Storm Surge/High Surf/Chronic Coastal Flood	42%	142
Climate Change/Sea Level Rise	35%	118
Landslide	32%	109
Dam Failure	26%	87
Drought	25%	84
Other (please specify)	12%	42
Total Respondents: 338		

Q25 Do you support policies and/or regulations that prohibit or restrict development in identified hazard zones?

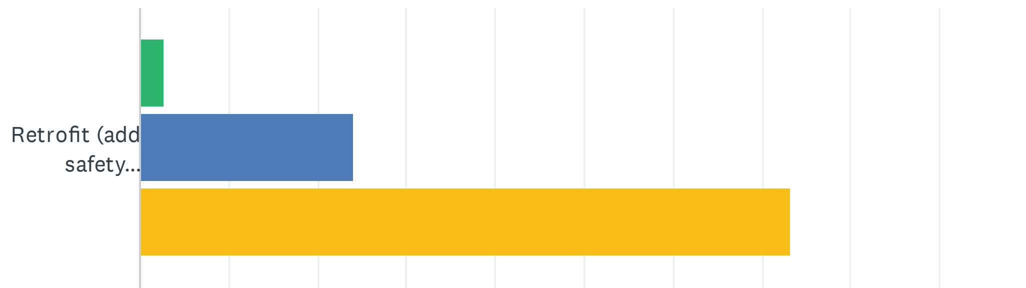
Answered: 359 Skipped: 4

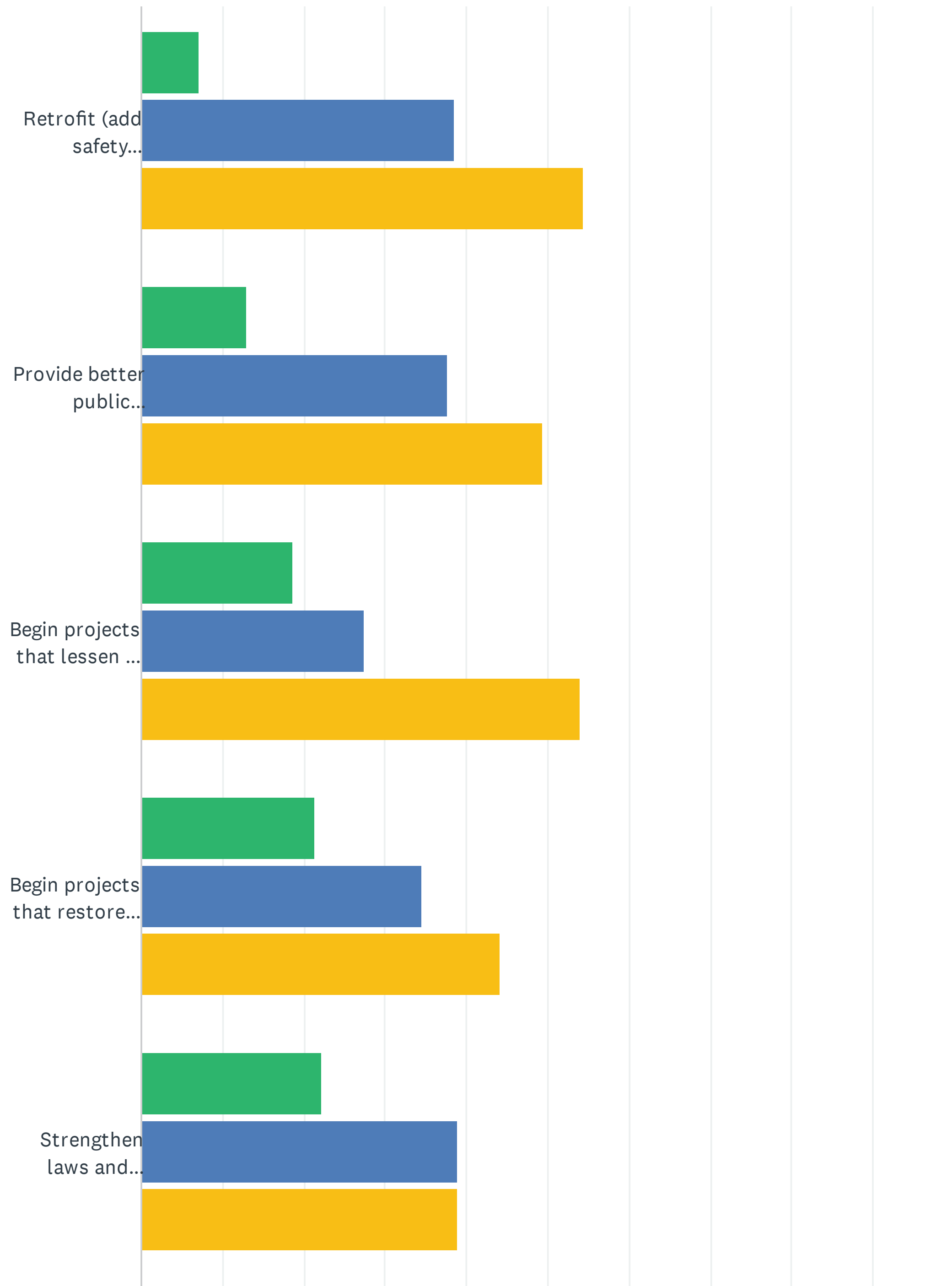


ANSWER CHOICES	RESPONSES	
Yes	65%	235
Not sure	18%	63
No	16%	57
TOTAL		359

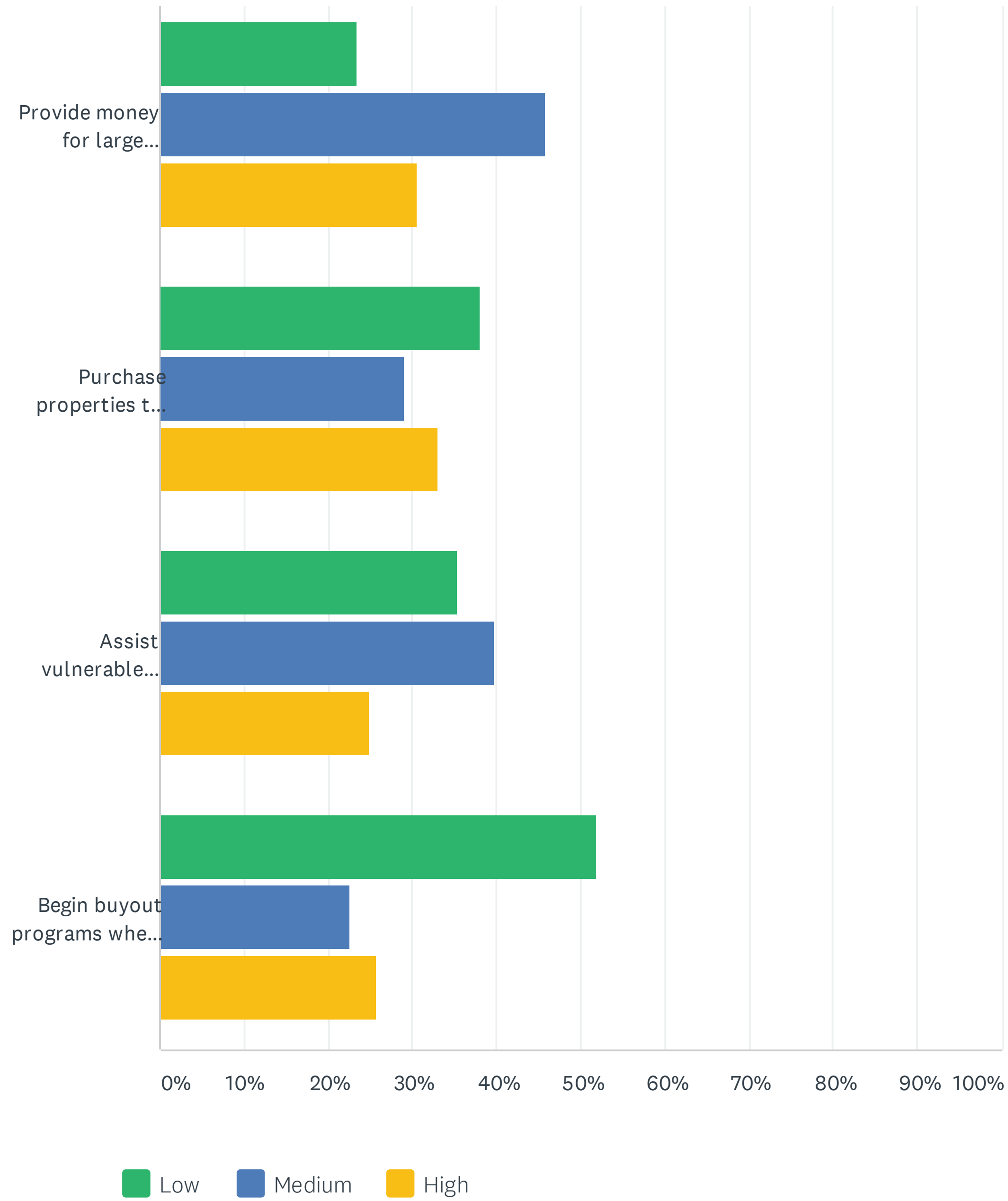
Q26 What types of projects do you believe the County, State, or Federal agencies should be doing in order to reduce damage and disruption from hazard events within Hawai'i County? Please rank each option as a low, medium or high priority.

Answered: 361 Skipped: 2




Retrofit (add safety...
Provide better public...
Begin projects that lessen ...
Begin projects that restore...
Strengthen laws and...

Hawaiʻi County Hazard Mitigation Plan Survey



	LOW	MEDIUM	HIGH	TOTAL	WEIGHTED AVERAGE
Retrofit (add safety improvements to) infrastructure such as harbors, roads, bridges, drainage facilities, water supply systems, wastewater systems and power supply facilities.	3% 10	24% 86	73% 262	358	2.70
Retrofit (add safety improvements) and strengthen essential facilities such as police and fire stations, schools and hospitals.	7% 25	38% 137	54% 194	356	2.47
Provide better public information about risk and the exposure hazards within the area.	13% 46	38% 133	49% 175	354	2.36
Begin projects that lessen the potential impacts from climate change.	19% 66	27% 97	54% 191	354	2.35
Begin projects that restore that natural environment's ability to absorb he impacts from natural hazards such as rain gardens.	21% 76	35% 123	44% 157	356	2.23
Strengthen laws and regulations to include higher regulatory standards in hazard areas, such as floodplains and lava zones.	22% 79	39% 138	39% 138	355	2.17
Provide money for large projects such as dams, flood walls, drainage improvements, bank and coastal stabilization projects.	24% 83	46% 162	31% 108	353	2.07
Purchase properties that are in danger to natural hazards and maintain them as open space or parks.	38% 134	29% 102	33% 116	352	1.95
Assist vulnerable property owners with finding funding for reducing the risk from hazards.	35% 125	40% 140	25% 88	353	1.90
Begin buyout programs where homes or properties located in designated "high hazard" or areas that are repeatedly damaged are purchased from their owners.	52% 182	23% 79	26% 90	351	1.74

MEETING AGENDAS AND NOTES

Meeting 1, October 29, 2019

County of Hawaiʻi
Meeting Agenda

Purpose of Meeting:	Hawaii County Multi Hazard Mitigation Plan Working Group
Location of Meeting:	Civil Defense Emergency Operations Center
Date of Meeting:	10.29.2019

Attendees:

Cindy Rolli (Tt)	Michael Yee (CoH)	David Yamamoto (CoH)	Roxcie Waltjen (CoH)	Harry Takiue (HDOT)
April Surprenant (CoH)	Deanna Sako (CoH)	Riley Saito (CoH)	Darren Rosario (CoH)	Patti Pinto (CERT)
Robert Perreira (CoH)	Barry Periatt (CoH)	Blaine Oyama (Spectrum)	Alison Miskiman (CoH)	Maurice Messina (CoH)
Robyn Matsumoto (CoH)	Talmadge Magno (CoH)	Diane Ley (CoH)	David Kurohara (HELCO)	James Komata (CoH)
Bob Kamau (Spectrum)	Eric Honda (DOH)	Bryce Harada (CoH)	Paul Agamata (HIEMA)	Rob Flanner (Tt)
Daniel Chun (CoH)	Megan Brotherton (Tt)	Steven Bergfeld (DLNR)	Bethany Morrison (CoH)	Rob Lee (HDOT)
Bill Hanson (CoH)				

Agenda Summary:

Item No.	Description	Action item(s):
1	**Welcome and Introductions** • Group Introductions • Review Agenda	
2	**Project Overview** • Work plan ○ Premise of Disaster Mitigation Act law: No plan, no money. Pre-disaster funding program implemented. • Timeline ○ Plan must be adopted and approved by FEMA by August 1, 2020 • Important milestones ○ Public meeting locations and times TBD	
3	**The Working Group Role** • WG Purpose • Working Group Meetings - Monthly ○ 3rd Tuesday of every month from 2-4pm ○ Aupuni Center Conference Room for future meetings (open to the public). ○ Meeting facilitator is the Chair. ○ Public input will be testimony only on the previous agenda. Not discussion. Sign-in sheet at every meeting for public input. There will be no real-time response to public input. Ground Rules and organizational structure will keep the meeting orderly. Working Group is a recommending body, not a decision-making body. Public will have a very direct input on the risk assessment and the draft plan at the	• **Decision:** OneDrive folder will be extended to Working Group by April Surprenant via email

	scheduled Public Meetings. Press release will emphasize key times the public will be allowed to input. o Recommend designated spokesperson (Chair, Vice-chair, PIO) who will handle comments for the press. • WG Expectations o **Decision:** OneDrive folder will be extended to Working Group by April Surprenant via email o **Decision:** Barry will upload meeting notes to the website. • WG Organization o Talmadge Magno – Chair o April Surprenant – Co-chair • Confirm WG ground rules o **Consensus:** All in agreement to Working Group Guidelines o **Consensus:** Add to Guidelines - Total comment time for public input – 18 minutes (6 comments). o **Consensus:** Add to Guidelines - No recording devices o **Consensus:** Add to Guidelines - Working Group has the right to go into Executive Session which will be closed to public.	• **Decision:** Barry will upload meeting notes to the website. • **Consensus:** All in agreement to Working Group Guidelines • **Consensus:** Add to Guidelines - Total comment time for public input – 18 minutes (6 comments). • **Consensus:** Add to Guidelines - No recording devices • **Consensus:** Add to Guidelines - Working Group has the right to go into Executive Session which will be closed to public.
4	**Plan Review** • Review prior Hawaii County HMP 2015 o Hazards of concern for Hawaii County o Confirm Critical Facilities and lifelines definition o County's goals and objective o Framework and Structure (Example – State Plan) • Hazards of Concern o Full risk assessment must be done for natural hazards. For non-natural hazards (no concept of frequency; a profile will be developed, but not full risk assessment for non-natural hazards. o Non-natural hazard not eligible for HMGP grant funding. Other funding eligible under Homeland Security Grants, etc. o Hazard List will be prioritized eventually. o Deep dive into each list item will occur after risk assessment.	`

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Climate change will be addressed within each hazard.
List came from 2015 Plan and State of Hawaii Hazard Mitigation Plan.
Action: Tt to send three lists of all hazards of concern – 2015 Plan, State Plan, FEMA
Discussion on other potential non-natural hazards: EMP, solar, space weather, movement of magnetic polar points, invasive species (catalyst to agricultural repercussions), war (how is it addressed under state THIRA Threat Hazard Identification Risk Assessment), political unrest (Mauna Kea)
Consider crossover between response and mitigation.

Action: Tt to provide examples of non-natural hazards from other jurisdictions.
Just because a hazard is profiled, does not mean FEMA will give a mitigation grant for it.

HAZUS takes spatial extent of a hazard and intersects with an inventory based on three levels.

Dam failure, earthquake, flood, tsunami, tropical cyclones (wind damage only).
Point based for every attribute in the County.
LIDAR used for terrain model with asset inventory, damage functions.
HAZUS based on assumptions and available data to quantify risk.
Benefit cost analysis can be used as a tool by the county and stakeholders for future mitigation.

Action: Tt to send list of Critical Facilities and definitions to the working group for review and consensus
Working Group response needed: Is anything missing from the list?
Lifeline definition critical to aligning with FEMA's new program: Building Resilient Infrastructure in Communities (BRIC)

Critical Facilities will be categorized within seven lifeline categories. Aggregate data on locations will be part of plan, not forward facing.
Financial institutions, grocery stores also part of County critical facilities.

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Action: Tt to send three lists of all hazards of concern – 2015 Plan, State Plan, FEMA for review and consensus on the list of hazards
Action: Tt to provide examples of non-natural hazards from other jurisdictions.
Action: Tt to send list of Critical Facilities and definitions for review and consensus
Working Group response needed: Is anything missing from the list?

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5	**Public Involvement Strategy**
	• Press release announcing commencement of the plan update process
	• Update the HMP website with information on the plan update
	• Web page on Civil Defense website specific to Hazard Mitigation:
	  ○ Public comment section with parameters:
	    ▪ Register to comment
	    ▪ Comment only on plan and process
	    ▪ Intent is good feedback
	  ○ Minutes, agendas, drafts, fact sheet
	  ○ Website launch: November 15, 2019
	• Additional Outreach Capabilities (suggestions welcomed)
	  ○ Website
	  ○ Survey-Should we do one again?
	  ○ Press/media
	  ○ Social Media
	• Strategy for public engagement:
	  ○ Phase 1: Gauge public perception of risk
	  ○ Phase 2: Present draft plan and recommendations
	  ○ Take advantage of established events to set up a booth for public engagement.
	  ○ Best process for feedback is a completed survey.
	  ○ Equal opportunity to engage Hilo and Kona sides of the island.
	  ○ Effective outreach with other plans?
	    ▪ GP draft outreach was community-organized and hosted. Builds trust.
	    ▪ Website comments.
	    ▪ Facebook, mailing lists to inform community of website.
	  ○ Working group: Share survey via Facebook, Everbridge (opt-in system) – explore for feasibility.
	  ○ **Action:** Tt to design brief informative PowerPoint 3-4 slide deck to show at department meetings, classrooms, community events.
	    ▪ Promote Website
	    ▪ How to take Survey
	  ○ Must keep records of public comments. Memorialized in text.
	  ○ Survey design:
	    ▪ Questions that lead to useful information.
	    ▪ Targeted surveys yield better data – get these out at community events.
		• **Action:** Tt to design brief informative PowerPoint 3-4 slide deck to show at department meetings, classrooms, community events.
		  ○ Promote Website
		  ○ How to take Survey

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<td>▪ Pre-kickoff surveys can be used if questions are relevant to community perception of risk.
▪ Action: Patti Pinto will share previous surveys (Survey Monkey) with Working Group.
o Initial Public input should be disseminated via the press. PIO from Mayor's office (to be determined).
o Consensus: Add amendment to Guidelines - Working Group members will not talk to press.
o Decision: PIO should be part of the Working Group.
o Goals and objectives can be amended at any time, but survey should be initiated as soon as possible. The sooner the better. Survey results not necessary to set goals.
o Next Steps: CERT data, Survey examples, PIO press release, Website launch
o Decision: Keep survey short and concise. Use a bar to show progress. Format will make it more successful. Ten questions or less is best.
o Tt uses Survey Monkey as the platform of choice.
o Survey should be anonymous.
o Not focused on government agency.
o Possible survey title examples: "Get Safe Hawaii" "Community Risk Reduction"
o Create a sample survey and send to Working Group.
o Civil Defense is starting a new outreach program in November and will incorporate survey promotion.</td>
<td>• Consensus: Add amendment to Guidelines - Working Group members will not talk to press.

• Decision: PIO should be part of the Working Group.

• Decision: Keep survey short and concise. Use a bar to show progress. Format will make it more successful. Ten questions or less is best.</td>
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<td>6</td>
<td>Action Items and Next Steps
• Risk Assessment Document and Data Request
• Confirm Guiding Principle, Goals and Objectives</td>
<td>• Next Steps: CERT data, Survey examples, PIO press release, Website launch
• Action: Cindy to send out email to Working Group with meeting notes, slide deck and supporting documents from today's meeting, revised Guidelines
• Action: Working Group Members designate alternates and identify by email to Cindy by Monday, November 4</td>
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<td>Adjourn</td>
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COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: HMP Working Group
MEETING DATE: 10.29.19

Name	Title	Agency/Entity	Phone Number	Email
Dan Chun	Risk Mgmt	COH	805-422-9337	dchun@hawaiicounty.gov
David Kuribara	Liaison	HELCO	808-896-8776	david.kuribara@hawaiielectriclight.com
Blaine Oyama		Spectrum	808 430 5625	blaine.oyama@charter
Bob Kamau	Construction Sup	Spectrum	8089600189	bob.kamau@charter.com
Bethany Morrison	Planner	Planning	961-8138	Bethany.morrison@hawaiicounty.gov
Patti Pinto	CERT Coord.	CERT	430-1777	pintonan@gmail.com
Steve Bergfeld	Branch Manager	Div. Forestry & Wildlife	808 937-1969	steven.t.bergfeld@hawaii.gov
Maurice Messina	Dep. DIR.	P+R	808-961-8311	maurice.messina@hawaiicounty.gov
Rob Lee	Engineer	HDOT	808-933-8866	rob.lee@hawaii.gov
Barry Periatt	Administrative Off	HCCDA	808 935 0031	barry.periatt@hawaiicounty.gov
Paul Agamata		HIEMA	808 217 8829	paul.agamata@xceptions.com
David Yamamoto	Dir	DPW	961-8321	david.yamamoto@hawaiicounty.gov
ROBYN MATSUMOTO	ACTING DEPUTY CHIEF	DPW/BLDG	961-8366	robyn.matsumoto@hawaiicounty.gov

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: HMP Working Group Mtg.
MEETING DATE: 10-29-19

Name	Title	Agency/Municipality	Phone Number	E-mail
Bill Hanson	Admin Officer	HCCDA	937-2181	William.Hanson@HawaiiCounty.gov
Talmadge Magno	ADMIN.	HCCDA	935-0031	Talmadge.Magno@hawaiicounty.gov
Rob Flaner		TetraTech		
Megan Brotherton		TetraTech		
Cindy Rolli		TetraTech		
April Surprenant		Planning		

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: HMP Working Group
MEETING DATE: 10.29.19

Name	Title	Agency/Municipality	Phone Number	E-mail
ERIC HONDA	DEHPC	DOH	933 0917	eric.honda@doh.hawaii.gov

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: HMP Working Group
MEETING DATE: 10.29.19

Name	Title	Agency/Entity	Phone Number	Email
BRYCE HARADA	ENGINEER	DPW-ENG	(808) 961-8042	bryce.harada@hawaiicounty.gov

TETRA TECH

Hawaii County
Hazard Mitigation Plan - Update

Working Group Meeting #1

Tuesday, October 29, 2019

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TETRA TECH

Tetra Tech Project Team

Project Manager - Rob Flaner

Project Planner - Cindy Rolli

Lead Risk Assessor – Alison Miskiman

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TETRA TECH

Today's Discussion

- Why are you here?
- DMA and Hazard Mitigation Plans
- The 2020 Plan Update
- The Working Group and Guidelines
- Timeline
- Hazards of Concerns
- Critical Facilities and Lifelines
- Working Group Meetings
- Next Steps?

What is the Disaster Mitigation Act (DMA)?

Federal legislation that establishes a pre-disaster hazard mitigation program and requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP).

=

Federal $$$ for pre-disaster and post-disaster hazard mitigation projects in Hawaii County planning area

Benefits of Hazard Mitigation Plans

- Establish eligibility for grant funds ($$$ for projects)
- Improve understanding of risks and vulnerabilities
- Reduce negative impact of natural hazards – actions save lives, reduce displacement, and speed recovery
- Encourage sustainable actions – builds strong, resilient, and self-sufficient communities
- Foster collaboration between local jurisdictions and residents

Examples of Mitigation Strategies

- Seismic retrofit of buildings and bridges
- Redundancy of water systems and fuel systems
- Tree planting to reduce heat in urban cores
- Education programs to be better informed of risks
- Policies– building codes and zoning
- Incentives – grants or financial assistance for risk reduction at business and household level

TETRA TECH

2020 Plan Update

Phase 1	Organize Resources
Phase 2	Risk Assessment
Phase 3	Public Involvement Strategy
Phase 4	Identify Goals, Objectives and Actions
Phase 5	Plan Maintenance Strategy
Phase 6	Assemble the Plan
Phase 7	Plan Review and Adoption
Phase 8	Plan Implementation

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The Working Group

The Planning Workgroup	Will operate under a set of ground rules
	Will participate in the Public Involvement Strategy
	Will act as spokespersons for the process
	Will meet 5 to 7 times for a minimum of 2 hours per meeting
	Will oversee plan development

TETRA TECH

Project Milestones

10/29/19
Working Group Kick Off Meeting

01/05/20
Risk Assessment – Working Group Review

1/15/2020
Public Meeting – Risk Assessment Review (Kona and Hilo)

4/01/2020
Draft Plan – Working Group Review

5/15/2020
Public Meeting Draft Plan Review (Kona and Hilo)

Adopted Plan to FEMA
8/1/2020

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Public Outreach Strategy

- Press release announcing commencement of the plan update process
- Update the HMP website with information on the plan update
- Additional Outreach Capabilities (suggestions welcomed)
  - Upcoming Events?
  - Website (IT/Barry update – Nov 15th start date)
  - Survey
  - Press/media

Hazards of Concern

- Hazards of Concern
  - Flood
  - Volcano
  - Earthquake
  - Tsunami
  - Sea Level Rise
  - Drought
  - Wildfires
  - Landslides
  - Tropical Cyclones (High winds, storm surge)
  - Dam Failures
  - Non-Natural Hazards (Supply Chain, Mass Events, Cyber)
  - Pandemic Outbreaks
  - Climate Change

2015 HMP Review

TETRA TECH

What is HAZUS?

- HAZUS-MH is a powerful risk assessment methodology for analyzing potential losses from floods, hurricane winds and earthquakes
- HAZUS outputs include:
  - *Number, location, types, and occupancy of vulnerable buildings*
  - *Actual or assessed values of the vulnerable buildings*
  - *Critical facilities*
  - *An estimate of losses per hazard*
  - *Debris accumulation*

Critical Facilities

Critical Facilities: *Those structures from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided.*

Examples:

- Fire Stations
- Police Stations
- Schools
- Infrastructure: Water distribution, waste water, e

FEMA Lifeline Definition

Lifelines: *Provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security*

Seven Lifeline Categories:

- Safety and Security
- Health and Medical
- Communications
- Hazardous Materials
- Food, Water, Sheltering
- Energy (Power & Fuel)
- Transportation

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Working Group Meetings

Hawaii County Multi-Hazard Mitigation Plan Update 2020

Oct 2019

WG Agenda

- *Hazards of Concern*
- *Critical Facilities & Lifelines*
- *Public Outreach Strategy*

Nov 2019

WG Agenda

- *Goals and Objectives Confirmation*
- *Public Outreach Strategy*
- *Plan Structure*

Jan 2020

WG Agenda

- *Risk Assessment Review*
- *Mitigation Capabilities*
- *Public Outreach Strategy*

March 2020

WG Agenda

- *Draft Plan Review*
- *Public Outreach Strategy*

June 2020

WG Agenda

- *Final Draft Review*
- *Public Comment*

3rd Tuesday, 2-4 pm at Civil Defense

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Next Steps

1. Working Group will be finalized.
   – All future meetings will be open to the public and advertised as such.
2. Civil Defense will update website with plan update information
3. Goal and objectives setting – Working Group to review HMP 2015 and State HMP to confirm on Nov WG meeting
4. Complete risk assessment
5. Phase 1 public outreach

Questions ?

Hazards of Concern	Proposed 2020 County HMP
Volcanic Eruption	X
Dam Failure	X
Drought	X
Earthquake	X
Flood	X
Landslide	X
High Wind Storms	X
Hurricane	X
Storm surge/High Surf/Chronic Coastal Flood	X
Climate Change/Sea Level Rise	X
Tsunami	X
Wildfire	X
Hazardous Materials (non-natural hazard)	
Invasive Species (non-natural hazard)	X
Supply Chain (non-natural hazard)	X
Mass Events (non-natural hazard)	X
Cyber (non-natural hazard)	X
Pandemic Outbreaks (non-natural hazard)	X
Hail	
Lightning	
Erosion	
Extreme temperatures	
Subsidence	
Tornado	
Severe winter weather	

2015 County HMP	2018 State HMP
X	X
X	X
X	X
X	X
X	X
X	X
X	X
X (Tropical Cyclones)	X
X	X
X	X
X	X
X	X
	X
	X (Health Hazards)

Facility Type	Include as a Critical Facility in the 2020 HMP? (Yes/No)	Is this category considered a lifeline to the County? (Yes/No)
Safety and Security		
Civil Defense Emergency Operations Center	Yes	Yes
Fire stations (includes SAR/EMS)	Yes	Yes
Hospitals/Medical	Yes	Yes
Police stations	Yes	Yes
County Government	Yes	Yes
Department of Public Works base yards	Yes	Yes
Sirens	Yes	Yes
Transportation Lifeline		
Harbors	Yes	Yes
Airports	Yes	Yes
Bridges	Yes	Yes
Buses	Yes	Yes
Utility Lifeline		
Electrical Power	Yes	Yes
PGV Wells		
Electric substations/transfer stations	Yes	Yes
Fuel	Yes	Yes
Gas	Yes	Yes
Wastewater Facilities/Pumps	Yes	Yes
Communication (wired/cabled)	Yes	Yes
Water wells	Yes	Yes
Pump Station – Potable	Yes	Yes
Recovery Support Facility		
Debris clearing and disposal	Yes	Yes
Financial institutions	Yes	Yes
Socially Vulnerable Facility		
Schools	Only when used as high wind shelters.	Only when used as high wind shelter.
Nursing homes	Yes	Yes
Assisted Living Centers	Yes	Yes
Residential Care	Yes	Yes
Extended Care	Yes	Yes
Food, Water, Sheltering Lifeline		
Emergency shelters	Yes	Yes
Ice Distributor (survival supplies)	Yes	Yes
Grocery Store Supermarket	Yes	Yes
Correctional Facility/Jail/Prison	Yes	Yes
Community Center	Yes	Yes
Gym (potential shelter)	Yes	Yes

Fatality Management	Yes	Yes
Health Care Supply Chain	Yes	Yes
Temporary Power	No	Yes
Other Category - Assessed but not reported in critical facility tables - County just wanted a point analysis for		
Onsite Disposal Systems	No	No

Critical Facilities: Those structures from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided.
[DEFINITION]

FEMA Lifelines: Provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic securit. Categories: Safety and Security; Health and Medical; Communications; Hazardous Materials; Food, Water, Sheltering; Energy; and Transportation **[DEFINITION]**

County of Hawaiʻi
MHMP Working Group Consensus Memo

Purpose of Memo:	Hawaii County Multi Hazard Mitigation Plan Working Group Consensus
Subject:	Hazards of Concern/Critical Infrastructure
Date of Meeting:	10.29.2019
Working Group Member:	

Item No.	Description	Y/N and explanation if applicable
1	**10/29 Meeting Minutes** – Indicate update or edits needed	
2	**Working Group Guidelines** – Agree on revised content (Y/N)	
3	**Working Group Members** – additions/edit; add names, agencies, and email	
4	**Hazards of Concern** – • Agree with 2020 HMP List (Y/N) • Add any additional hazards of concern	`
5	**Critical Infrastructure –** • Agree with definitions and list (Y/N) • Provide additional critical infrastructure/lifelines not listed	
6	**Questions/Comments** • List any questions/comments related to the HMP process, plan, etc	

HAWAII COUNTY HAZARD MITIGATION PLAN UPDATE
Working Group Guidelines

PURPOSE

As the title suggests, the role of the Working Group is to guide the Planning Partnership (county participants) through the process that will result in a hazard mitigation plan (HMP) update that can be embraced both politically and by the constituency within the planning area. The Working Group will provide guidance and leadership, oversee the planning process, and act as the point of contact for all partners and the various interest groups in the planning area. The makeup of this committee was selected to provide the best possible cross section of views to enhance the planning effort and to help build support for hazard mitigation. The Working Group that has been selected for this process in included in Table 1.

CHAIR

Chair for the Working Group is Civil Defense **Administrator Talmadge Magno**. The role of the chair is to:
1) Lead meetings so that agendas are followed and meetings adjourn on- time
2) Allow all members to be heard during discussions
3) Moderate discussions between members with differing points of view
4) Be a sounding board for staff in the preparation of agendas and how to best involve the full Working Group in work plan tasks.

April Surprenant (Deputy Planning Director (Acting)) is serving as vice chairperson to take the chair's role when the chair is not available.

ATTENDANCE

Participation of all Working Group members in meetings is important and members should make every effort to attend each meeting. If Working Group members cannot attend, they should inform the Chair before the meeting is conducted. Each Working Group member should attempt to identify an alternate who will represent that member at any meeting for which attendance cannot be met.

ALTERNATES

In the event a regular Working Group member cannot attend a meeting, they may designate an alternate that can make a binding decision or vote on any issue at a meeting in which they preside as a Working Group representative.

QUORUM

A minimum attendance at each meeting often is needed to ensure that the different viewpoints of Working Group members are adequately represented. A quorum for this Working Group will be 9 members in attendance. This quorum can be met with an attendance augmented by designated alternates.

DECISION-MAKING

As the Working Group provides advice and guidance on the HMP update, it will strive for consensus on all decisions that need to be made, with special effort to hear and consider all opinions within the group. Consensus is defined as a recommendation that may not be ideal for each Committee member, but every member can live with it (using the consensus continuum as a gage). Strong minority opinions will be recorded in meeting summaries and the Working Group may choose to note such opinions in their final recommendations.

RECOMMENDATIONS

The Working Group's recommendations will be recorded in the meeting summaries and reflected in the HMP update as appropriate. The Working Group may also assist in the presentation of the HMP update to the elected bodies of participating organizations.

SPOKESPERSONS

Ideally, the Working Group will present a united recommendation after considering the different viewpoints of its members, recognizing that each member might have made a somewhat different recommendation as an individual. To consistently represent the Working Group's united recommendations to participating organizations, the public, and the media, the Chairperson will act as the Working Group spokesperson as well as the Public Information Office associated with the working group. In addition, each member should have a responsibility to represent the Working Group's recommendation when speaking on HMP-related issues as a Working Group member. Any differing personal or organizational viewpoints should be clearly distinguished from the Committee's work. The Working Group will not engage directly with the media.

STAFFING

The Planning Team for this project includes Talmadge Magno, Hawaii County Administrator for Civil Defense, and personnel from the contract consultant assistance provided by Tetra Tech, Inc. The Planning Team will schedule meetings, distribute agendas, prepare information/presentations for Working Group meetings, write meeting summaries, and generally seek to facilitate the Working Group's activities.

PUBLIC INVOLVEMENT

As they conduct work, members will seek to keep the public and the groups to which they are affiliated informed about the HMP update. Development of a public involvement strategy will be one of the first tasks undertaken by the Working Group.

Working Group meetings will be open to the public and agendas and minutes will be posted on a project web-page sponsored by Hawaii County. Opportunities for public comment during Working Group meetings will be at the discretion of the Chair. If the Chair has determined that public comment will be taken, comments will be limited to a time duration specified by the Chair (ie: 3 minutes per subject, per individual; a maximum of 6 public testimonies will be accepted in person. Comments will be allowed to be given at the beginning of the meetings and only related to the previous Working Group's meeting agenda. Other acceptable methods of public input will include written or emailed documents to staff or Working Group members and there will be no public comment during meetings, unless authorized by the Chair. Development of a public involvement strategy will be one of the first tasks undertaken by the Working Group. During any of the Working Group meetings; the Chair can designate required Executive Sessions which will be closed to the public.

COURTESY

Working Group members should treat each other with respect, listen to each other, work cooperatively, and allow all members to voice their opinions.

MEETINGS

Meetings generally will be held monthly either via conference call or at the Civil Defense building, unless a change of venue is requested by the Working Group. The Working Group also has the option to meet via teleconference as appropriate and to adjust the schedule due to holidays or other extenuating circumstances.

TABLE 1
HAWAII COUNTY - MULTI-HAZARD MITIGATION PLAN WORKING GORUP

Name	Organization	Contact Information (Email)	Alternate POC	Email
Talmadge Magno	Civil Defense (Chair)	Talmadge.magno@hawaiicounty.gov	April Surprenant (Vice Chair)	April.surprenant@hawaiicounty.gov
April Surprenant	Planning (Vice Chair)	April.surprenant@hawaiicounty.gov	Bethany Morrison	Bethany.morrison@hawaiicounty.gov
Robert Perreira	Fire	Robert.perreira@hawaiicounty.gov	Darren Rosario	Darren.Rosario@hawaiicounty.gov
Robyn Matsumoto	DPW - Building	Robyn.Matsumoto@hawaiicounty.gov		
Bob Kamau	Spectrum	Bob.kamau@charter.com	Blaine Oyama	blaine.oyama@charter.com
Daniel Chun	Risk Management	Daniel.Chun@hawaiicounty.gov		
Barry Periatt	Civil Defense	Barry.Periatt@hawaiicounty.gov	Bill Hanson	William.Hanson@hawaiicounty.gov
Eric Honda	DOH	Eric.honda@doh.hawaii.gov	Jason Dela Cruz	jason.delacruz@doh.hawaii.gov
David Yamamoto	Public Works	David.Yamamoto@hawaiicounty.gov	Allan Simeon	Allan.Simeon@hawaiicounty.gov
Bryce Harada	Public Works (Floodplain Manager)	Bryce.Harada@hawaiicounty.gov		
Steven Bergfeld	Div of Forestry and Wildlife	steven.t.bergfeld@hawaii.gov		
David Kurohara	Helco	david.kurohara@hawaiielectriclight.com		
Paul Agamata	HIEMA	pagamata@hawaii.edu		
Patti Pinto	CERT	hawaiicert@gmail.com	Pat Steffen	pasteffen99@gmail.com
Maurice Messina	P&R	Maurice.Messina@hawaiicounty.gov	James Komata	James.Komata@hawaiicounty.gov
Diane Ley	R&D	Diane.Ley@hawaiicounty.gov	Riley Saito	Riley.Saito@hawaiicounty.gov
Harry Takiue	HDOT	Harry.h.takiue@hawaii.gov	Rob Lee	Rob.lee@hawaii.gov

Meeting 2, December 17, 2019

County of Hawaiʻi
Meeting Summary

Purpose of Meeting:	Hawaii County Multi Hazard Mitigation Plan Working Group, Meeting #2
Location of Meeting:	Aupuni Center Conference Room, 101 Pauahi St., Hilo, HI 96720
Date/Time of Meeting:	Tuesday, December 17, 2019 2pm-4pm

Attendees:

	April Surprenant (CoH)	Talmadge Magno (CoH)	Barry Periatt (CoH)	Bill Hanson (CoH)
Robert Perreira (CoH)	Steven Bergfeld (DLNR)	Riley Saito (CoH)	Daniel Chun (CoH)	Diane Ley (CoH)
Eric Honda (DOH)	Paul Agamata (HIEMA)	Bethany Morrison (CoH)	Harry Takiue (HDOT)	Patti Pinto (CERT)
Bryce Harada (CoH)	Maurice Messina (CoH)	Rob Flanner (Tt) (phone)	Rob Lee (HDOT)	Megan Brotherton (Tt)
David Kurohara (HELCO)	Allan Simeon (CoH)	Sarah Freeman (CoH)	Cindy Rolli (Tt)	

Agenda and Meeting Summary:

Item No.	Description	Action item(s):
1	**Confirm Mission and Goals** Group discussion leading to adoption: ***Mission:*** *Identify and evaluate risks to life safety and property resulting from hazard events to determine viable actions that will reduce risk and create resilient communities.* ***Goals:*** *1. Utilize state-of-the-art methods and technologies as well as local knowledge to identify hazards, risks, and capabilities.* *2. Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly.* *3. Protect natural and cultural resources to the extent practicable that mitigate hazards.* *4. Promote actions that support land use planning and regulations designed to ensure long-term resiliency.* *5. Promote community risk reduction and preparedness through public education, training, and awareness.* *6. Improve capabilities to implement response protocols and continuity of operations and services.* *7. Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of hazards.*	Mission and Goals Adopted by the Working Group: Motion: April Surprenant Second: David Kurohara

2	**Adopt Hazards of Concern** Group discussion leading to adoption • *Volcanic Hazards (follow up with Talmadge to get vog data for modeling)* • *Dam Failure* • *Drought* • *Earthquake* • *Flood* • *Landslide* • *High Wind Storms* • *Hurricane* • *Storm surge/High Surf/Chronic Coastal Flood* • *Climate Change/Sea Level Rise* • *Tsunami* • *Wildfire* • *Invasive Species* • *Supply Chain (non-natural hazard)* • *Mass Events (non-natural hazard) (double check on the terminology)* • *Cyber (non-natural hazard)* • *Pandemic Outbreaks*	Hazards of Concern Adopted by the Working Group: Motion: Paul Agamata Second: Barry Periatt
3	**Hazard Scenarios** Group discussion; presented scenarios that will be modeled for the Risk Assessment (see PPT)	
4	**Public Outreach Strategy** a. Website https://www.hawaiicounty.gov/departments/civil-defense/multi-hazard-mitigation-plan-2020 b. Survey https://www.surveymonkey.com/r/HawaiiCountyHMP c. Public Meeting dates and meeting format (all 6-8 pm not including set up and breakdown) January 22 - Hilo, Aupuni Center January 23 - Kailua-Kona, West Hawaii Civil Center January 29 - Waimea, Waimea Community Center January 30 - Ocean View, Ocean View Community Center	CD to add link to survey on Everbridge to populate Facebook; other departments will add to their Facebook. Tt to send meeting notes, all follow up materials from meeting and upload to OneDrive including survey QR code. Tt to send invites to WG Members for assistance to man stations at Public Meetings. Tt to email Sarah.Freeman@hawaiicounty.gov - Food Basket; may want to add a station Tt to email Bethany.Morrison@hawaiicounty.gov - Community Action Committees may be able to support stations
5	**Next Working Group Meeting: January 21st – Risk Assessment Results**	

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: Hawaii County Multi-Hazard Mitigation Plan Working Group
MEETING DATE: December 17, 2019

Name	Title	Agency/Municipality	Phone Number	Email
Barry Periatt	Admin Off	Civil Defense	935-0031	barry.periatt@hawaiicounty.gov
David Kurohara	HELCO Liaison	HELCO	896-8176	david.kurohara@hawaiielectriclight.com
Bethany Morrison	Planner	Planning	961-8138	Bethany.morrison@hawaiicounty.gov
Steve Bergfeld	Branch Manager	DOFAW	974-4221	steven.t.bergfeld@hawaii.gov
Bill Hanson	Admin Officer	C.D.	935-0031	william.hanson@hawaiicounty.gov
April Surprenant	Deputy	Planning	961 8125	
BRYCE HARADA	FLOODPLAIN MANAGER	DPW	961-8042	bryce.harada@hawaiicounty.gov
ERIC HONDA	Act DHO	DOH	933 0913	
Allan Simeon	~~DPW~~	DPW	961-8321	allan.simeon@hawaiicounty.gov
Cindy Rolli	Planner	Tetra Tech	872 232 3389	cindy.rolli@tetratech.com

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: Hawaii County Multi-Hazard Mitigation Plan Working Group
MEETING DATE: December 17, 2019

Name	Title	Agency/Municipality	Phone Number	Email
Patti Pinto	CERT Coord.	Civil Defense	808-430-1777	hawaiicert@gmail.com
Daniel Chun	Risk Mgmt Officer	Finance	805-422-9337	dchun@hawaiicounty.gov
Talmadge Magno	CD Administrator	CD	808-935-0031	
Paul Ogamak	HIEMA	HIEMA	8084642200	
Sarah Freeman	Food Access Coordinator	R&D	961-8582	sarah.freeman@hawaiicounty.gov
Diane Ley	director	R&D	961-8368	diane.ley@hawaiicounty.gov
Riley Saito	Dep. Director	R&D	323-4704	Riley.Saito@hawaiicounty.gov
Rob Lee	HDOT Engineer	HDOT	938-9205	rob-lee@hawaii.gov
Harry Takiue	Acting DE	HDOT	933-8866	harry.h.takiue@hawaii.gov
Robert Perreira	Assistant Fire Chief	HFD	932-2907	robert.perreira@hawaiicounty.gov
Maurice Messina	Mayor's Office	Mayor's Office	961-9322	
Megan Brotherton	Admin	Tetra Tech		Megan.Brotherton@TetraTech.com

TETRA TECH

Hawaii County
Hazard Mitigation Plan - Update

Working Group Meeting #2

Tuesday, December 17, 2019

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Tetra Tech Project Team

Project Manager - Rob Flaner

Project Planner - Cindy Rolli

Risk Assessor – Carol Baumann

TETRA TECH

Today's Discussion

- Confirm Mission and Goals
- Hazard Scenarios
- Public Outreach Strategy
  - Website
  - Survey
  - Public Meeting dates and meeting format
- Next Working Group Meeting: January 21st – Risk Assessment Results
- Next Steps?

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Confirm Mission

County HMP 2015	County HMP 2020
Vision: The purposes of this multi-hazard mitigation plan are twofold: 1. to protect people and structures from harm and destruction; and 2. to minimize the costs and disruption of disaster response and recovery.	Combine and only have a Mission Statement: Identify and evaluate risks to life safety and property resulting from hazard events to determine viable actions that will reduce risk and create resilient communities.
Mission: This plan will focus on mitigation, i.e., strategies to reduce risks.	

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Identification of Goals

1. Supports the selection of projects/actions
2. Cover the 6 categories of mitigation
   - Preparedness
   - Response
   - Public outreach
   - Property protection
   - Natural Systems Protection
   - Local plans and Regulations
3. Meet HMP Plan requirements
4. Consistent with State HMP

TETRA TECH

Confirm Goals (slide 1 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Continually strive to improve the state of the art for the identification of hazard areas, prediction capabilities, and warning systems.	**Goal:** Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess State capabilities to reduce the impact of those hazards	Utilize state-of-the-art methods and technologies as well as local knowledge to identify hazards, risks, and capabilities.

Confirm Goals (slide 2 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Ensure that all emergency response critical facilities and communication systems remain operational during hazard events. **Goal:** Ensure that all lifeline infrastructures are able to withstand hazard events or have contingency plans to quickly recover after a disaster. **Goal:** Protect natural and cultural resources to the extent practicable that buffer hazards or have significant value.	**Goal:** Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes high risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.	Goal: Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly. Goal: Protect natural and cultural resources to the extent practicable that mitigate hazards.

Confirm Goals (slide 3 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Minimize losses by adopting mitigation regulations for future development and retrofit existing structures within hazard areas.	**Goal:** Promote actions designed to ensure long-term resiliency	Promote actions that support land use planning and regulations designed to ensure long-term resiliency.

Confirm Goals (slide 4 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Develop a level of awareness among the general public and businesses, particularly the visitor industry, that results in calm and efficient evacuations, self-sufficient survival skills, and willingness to abide by preventive or property protection requirements.	**Goal:** Promote public awareness of natural hazard risks and public action to reduce the long-term risks	Promote community risk reduction and preparedness through public education, training and awareness.

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Confirm Goals (slide 5 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Minimize post-disaster recovery disruption by planning and developing systems for efficient clean-up, documentation of damage and injury, and processing of appropriate aid to rebuild businesses and the economy.	**Goal:** Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.	Improve capabilities to implement response protocols and continuity of operations and services.

Confirm Goals (slide 6 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Provide adequate pre-and post-disaster emergency shelters to accommodate residents and visitors.		**Identify as an objective - not a stand alone goal**

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Confirm Goals (slide 7 of 7)

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
	Goal: Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards	Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of hazards.

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Hazards of Concern

- Volcanic Hazards (follow up with Talmadge to get vog data for modeling)
- Dam Failure
- Drought
- Earthquake
- Flood
- Landslide
- High Wind Storms
- Hurricane
- Storm surge/High Surf/Chronic Coastal Flood
- Climate Change/Sea Level Rise
- Tsunami
- Wildfire
- Invasive Species
- Supply Chain (non-natural hazard)
- Mass Events (non-natural hazard) (double check on the terminology)
- Cyber (non-natural hazard)
- Pandemic Outbreaks

Hazard	Scenarios
Volcanic	Lava zones; lava flow areas for various events
Dam Failure	Waikoloa Reservoir No. 1 (HA0040), Reservoir No. 2 (HA0122), Reservoir No. 3 (HA0136) inundation areas.
Earthquake	Kalapana 1975 M7.7, Kau M8.0, and Hawaii (South Kohala) M6.7 ShakeMaps; 100-year probabilistic.
Flood	Effective FEMA 100-year flood; Puna flood study; High risk flood areas
Landslide	Landslide susceptibility; Landslide and coastal erosion hazard areas
High Wind	Straight line wind hazard areas
Hurricane	2015 Hawaii Catastrophic Hurricane Plan category 4; SLOSH (Sea, Lake and Overland Surges from Hurricanes).
Chronic Coastal Flood	Chronic coast flooding: Hawaii Sea Level Rise Vulnerability and Adaptation Report SLR-XA 1.1ft
Climate Change/Sea Level Rise	Hawaii Sea Level Rise Vulnerability and Adaptation Report SLR-XA 3.2ft (future chronic coastal flooding) and 1%CFZ + 3.2ft SLR (event-based coastal flooding plus sea level rise).
Tsunami	2010 study inundation area
Wildfire	Communities at Risk from Wildfire

Public Outreach Strategy

Website / Social Media:
https://www.hawaiicounty.gov/departments/civil-defense/multi-hazard-mitigation-plan-2020

Survey:
https://www.surveymonkey.com/r/HawaiiCountyHMP

Public Meeting dates and meeting format

Public Outreach Strategy

- Press release announcing commencement of the plan update process
- Update the HMP website with information on the plan update
- Additional Outreach Capabilities (suggestions welcomed)
  - Upcoming Events?
  - Website
  - Survey
  - Press/media

Public Meeting Dates

Date	Location	Address	Time
January 22	Hilo, Aupuni Center Conference Room	101 Pauahi St., Hilo, HI 96720	5:45 pm - 8:30 pm
January 23	Kailua-Kona, West Hawaii Civil Center, Building G	74-Keohokalole Hwy, Kailua-Kona, HI 96740	5:30 pm – 8:30 pm
January 29	Waimea, Waimea Community Center	65-1260 Kawaihae Rd., Waimea, HI 96743	5:30 pm – 8:30 pm
January 30	Ocean View, Ocean View Community Center	92-8924 Lelani Circle, Ocean View, HI 96704	6:00 pm – 8:00 pm

Public Meeting Format

Room setup:

- Presentation area in front, seating down the middle of the auditorium
- Tables on either side of the room for each hazard station
- Maps, monitors, and/or other visual aids for each station
- Potential for local business display (ex. Home Depot participating in handing out small freebees or brochures)

Meeting flow:

- Start with 30-minute presentation to overview the hazards, then loop for those who arrive later
- Remainder of meeting will be public interaction at hazard stations, taking the survey, GIS stations. Each table/station will be manned by two people. One will ideally be an expert in the field, the other will record comments and take notes.

Next Working Group Meeting: January 21st

Risk Assessment Results

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Working Group Meetings

Hawaii County Multi-Hazard Mitigation Plan Update 2020

Oct 2019

WG Agenda

- *Hazards of Concern*
- *Critical Facilities & Lifelines*
- *Public Outreach Strategy*

Dec 2019

WG Agenda

- *Goals Confirmation*
- *Public Outreach Strategy*

Jan 2020

WG Agenda

- *Risk Assessment Review*
- *Public Outreach Strategy*

Feb 2020

WG Agenda

- *Objectives*
- *Public Outreach Strategy*

March 2020

WG Agenda

- *Mitigation Actions*
- *Public Comment*

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Questions ?

Hawaii County Multi-Hazard Mitigation Plan 2020

Mission and Goals – Working Group Meeting 12.17.19

Step 1: Review and confirm Mission Statement for the MHMP 2020 Update

County HMP 2015	County HMP 2020
Vision: The purposes of this multi-hazard mitigation plan are twofold: 1) to protect people and structures from harm and destruction; and 2) to minimize the costs and disruption of disaster response and recovery.	Combine and only have a Mission Statement: Identify risks to life and property resulting from hazards events to determine viable actions that will reduce risk and create resilient communities.
Mission: This plan will focus on mitigation, i.e., strategies to reduce risks.	

Step 2: Review and confirm goals that will be adopted for the 2020 MHMP update. County Goals need to be in alignment with the State HMP Goals. The table below captures the alignment between goals established between the two plans.

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
Goal: Continually strive to improve the state of the art for the identification of hazard areas, prediction capabilities, and warning systems.	**Goal:** Utilize state-of-the-art methods and technology and local knowledge to identify and analyze natural hazards and assess State capabilities to reduce the impact of those hazards.	
Goal: Ensure that all emergency response critical facilities and communication systems remain operational during hazard events. **Goal:** Ensure that all lifeline infrastructures are able to withstand hazard events or have contingency plans to quickly recover after a disaster. **Goal:** Protect natural and cultural resources to the extent practicable that buffer hazards or have significant value.	**Goal:** Reduce the long-term vulnerability of Hawaii's people, property and jurisdictions, including state-owned or operated buildings, infrastructure and critical facilities, to natural hazards while conserving the State's natural, historical, and cultural assets. This includes high risk properties such as repetitive loss (RL) and severe repetitive loss (SRL) properties.	
Goal: Minimize losses by adopting mitigation regulations for future development and retrofit	**Goal:** Promote actions designed to ensure long-term resiliency	

County HMP 2015 Goals	State HMP 2018 Goals	County HMP 2020 Goals
existing structures within hazard areas.		
Goal: Develop a level of awareness among the general public and businesses, particularly the visitor industry, that results in calm and efficient evacuations, self-sufficient survival skills, and willingness to abide by preventive or property protection requirements.	**Goal:** Promote public awareness of natural hazard risks and public action to reduce the long-term risks	
Goal: Minimize post-disaster recovery disruption by planning and developing systems for efficient clean-up, documentation of damage and injury, and processing of appropriate aid to rebuild businesses and the economy.	**Goal:** Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.	
Goal: Provide adequate pre-and post-disaster emergency shelters to accommodate residents and visitors.		
	Goal: Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards	

Hazards of Concern	Proposed 2020 County HMP
Volcanic Eruption	X
Dam Failure	X
Drought	X
Earthquake	X
Flood	X
Landslide	X
High Wind Storms	X
Hurricane	X
Storm surge/High Surf/Chronic Coastal Flood	X
Climate Change/Sea Level Rise	X
Tsunami	X
Wildfire	X
Invasive Species (non-natural hazard)	X
Supply Chain (non-natural hazard)	X
Mass Events (non-natural hazard)	X
Cyber (non-natural hazard)	X
Pandemic Outbreaks (non-natural hazard)	X

Meeting 3, January 21, 2020

County of Hawaiʻi
Meeting Summary

Purpose of Meeting:	Hawaii County Multi Hazard Mitigation Plan Working Group, Meeting #3
Location of Meeting:	Aupuni Center Conference Room, 101 Pauahi St., Hilo, HI 96720
Date/Time of Meeting:	Tuesday, January 21, 2020 2pm-4pm

Attendees:
24 in attendance. See accompanying sign-in sheet.

Planning Team in Attendance:
Rob Flaner
Cindy Rolli
Talmadge Magno
April Surprenant
Barry Periatt
Bill Hansen

Agenda and Meeting Summary:

Item No.	Description	Action item(s):
1	**Risk Assessment Results Review** See accompanying PPT slide deck.	
2	**Public Outreach Strategy** a. Survey 104 respondents to survey so far. Top subjects of interest are lava and hurricane. b. Public Meeting dates and meeting format Public meetings are held to gauge perception of risk. Devise strategies to address those risks. Open house format. We want input from the community. Data goes back to Working Group. Then data will be searched to add to risk hazard to delineate hazard awareness zone or identify strategy to do a study to identify risk area. PPT presentation preview for Public Meetings Direct public to stations with hazard maps first, then to GIS station to determine hazards at their residence location. Ask public to mark maps, take survey. PPT will cycle during the open house portion of the meeting.	

	PPT slide deck and hazard maps will be posted on CD website with today's meeting notes. Address hazards and risks even if they are not eligible for government funding. Supply chain interruption can happen for every hazard event. Address it as a stand-alone as well as part of other events. Isolation is a difficult hazard to profile but will be presented in a different way than other hazards. USGS, UH literature will be available to public to take. Include slide (next steps) for the last public meeting to review the draft plan.	
3	**Next Working Group Meeting:** February 18th	

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: Multi-Hazard Mitigation Plan Working Group
MEETING DATE: January 21, 2020

Name	Title	Agency/Municipality	Phone Number	Email
T MAGNO	CD ADMIN.	CD	935-0031	
J Black	CD Pto	CD	"	
Allan Simeon		DPW	961-8341	
David Yamamoto		"	"	
David Kurohara	~~HECO~~ Liaison	Hawaiian Electric	896-8176	
Barry Periatt	CD	CD	935-0031	
Tom Olson	CD 5	CD	935-0031	
Robyn Matsumoto	Acting ~~DPW~~ Building Chief	DPW		
Steve Bergfeld	Branch Manager DOFAW	DOFAW	974-4221	
April Surprenant	Deputy	COH Plng	961-8125	
Rob Lee	Engineer	HDOT	938-9205	
MEGAN BROTHERTON	ADMIN	TETRATECH		

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: Multi-Hazard Mitigation Plan Working Group
MEETING DATE: January 21, 2020

Name	Title	Agency/Municipality	Phone Number	Email
Kurt Inaba	Engineer	DWS	961-7238	kinaba@hawaiidws.org
Keith Okamoto	Manager	DWS	961-8050	kokamoto@hawaiidws.org
Bryce Harada	Engineer	DPW	961-8042	bryce.harada@hawaiicounty.gov
Eric Honda	DEHPC	DOH	933 0917	eric.honda@doh.hawaii.gov
Dan Chun	Risk Mgt	Finance	808 4339227	Daniel.Chun@hawaiicounty.gov
X Patti Pinto	CERT Coordinator	CD	808-430-1777	phawaiicert@gmail.com
X Sarah Freeman	Food Access Coordinator	R&D		sarah.freeman@hawaiicounty.gov
X Diane Ley	director	R&D	808-961-8368	diane.ley@hawaiicounty.gov
Kawika Uyehara	Deputy	DWS	961 8050	kuyehara@hawaiidws.org

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: Multi-Hazard Mitigation Plan Working Group
MEETING DATE: January 21, 2020

Name	Title	Agency/Municipality	Phone Number	Email
Judy Hayducsko	Civil Eng. IV	Dept Water Supply		
Maurice Messina	Chief of Staff	Mayor's Off.		
Bill Hanson	Admin Officer	HCCDA	935-0031	william.Hanson@hawaii[illegible]

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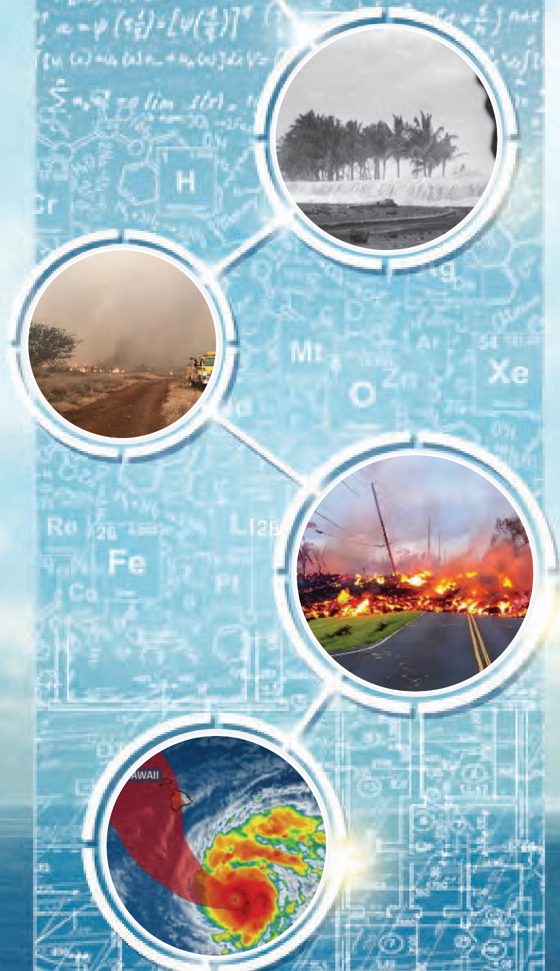
Hawaii County Hazard Mitigation Plan-Update

Phase 1 Public Meetings

Rob Flaner, CFM

Cindy Rolli, CFM



Tonight's Speakers

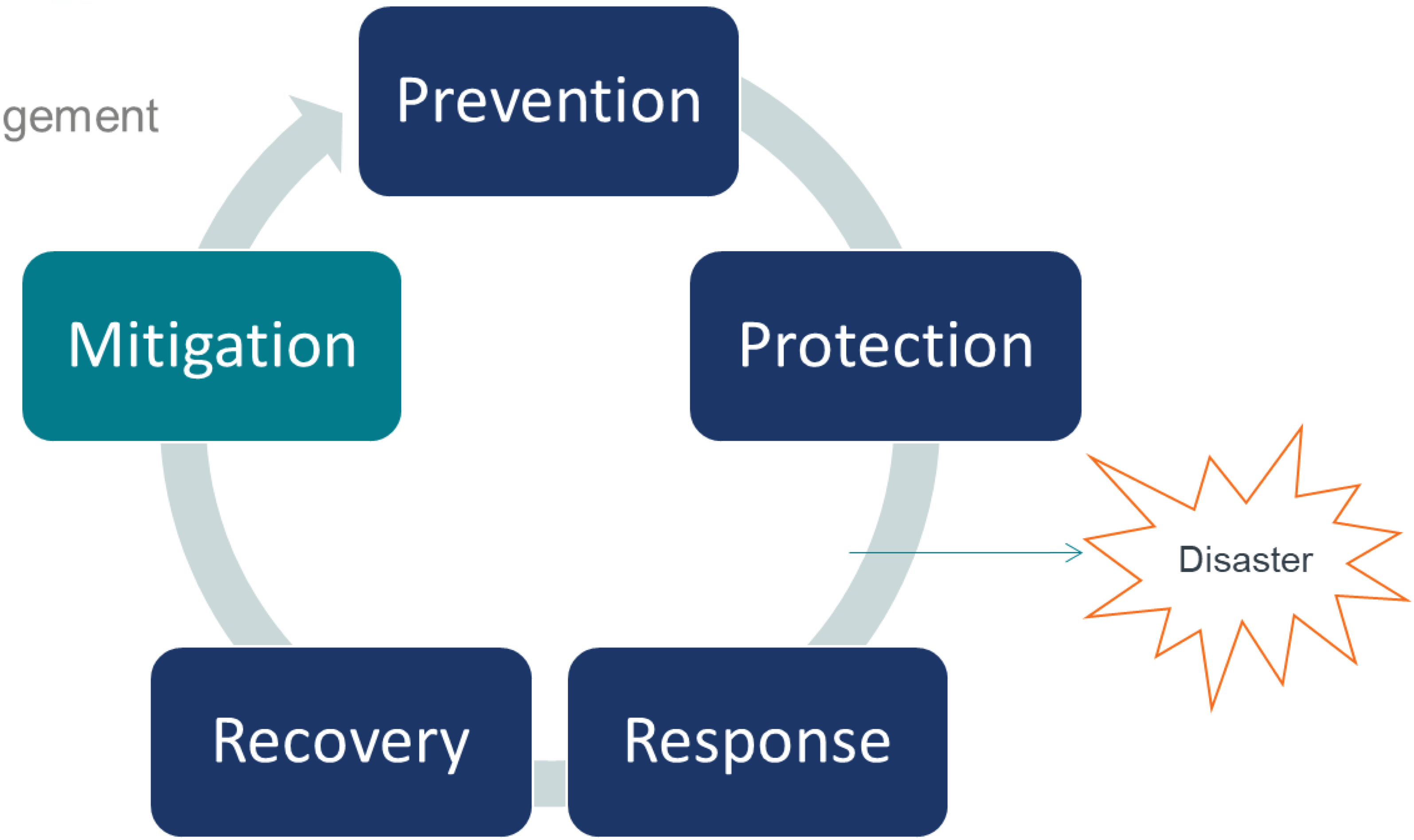
- Talmadge Magno – Civil Defense Administrator
  - 30 years with National Park Service providing; emergency management and law enforcement throughout western US and Hawai‘i.
  - Last 8 years of career served as Chief Ranger of Hawai‘i Volcanoes National Park
- Rob Flaner – Hazard Mitigation Program Manager, Tetra Tech, Inc.
  - Technical consultant to Hawaii County
  - Former Federal Emergency Management Agency (FEMA) contractor
  - Facilitated over 75 successful mitigation planning efforts since 2003
- Cindi Rolli – Lead Project Planner, Tetra Tech, Inc
  - Leading the planning process for this update
  - Also supporting the County's Recovery efforts

What are we going to talk about?

- Provide a brief overview of the drivers for planning
- Describe the Hawaii County planning process
- The Hazard Mitigation Working Group
- Vision and Goals for the plan
- The Risk Assessment
- Alternatives Analysis
- Next Steps
- Questions

What is Mitigation?

Five Phases of
Emergency Management



"Sustained action taken to reduce or eliminate long-term risk to life and property"

What is the Disaster Mitigation Act (DMA)?

Federal legislation that establishes a pre-disaster hazard mitigation program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP)

"No Plan, no money!"

Disaster Mitigation Act of 2000

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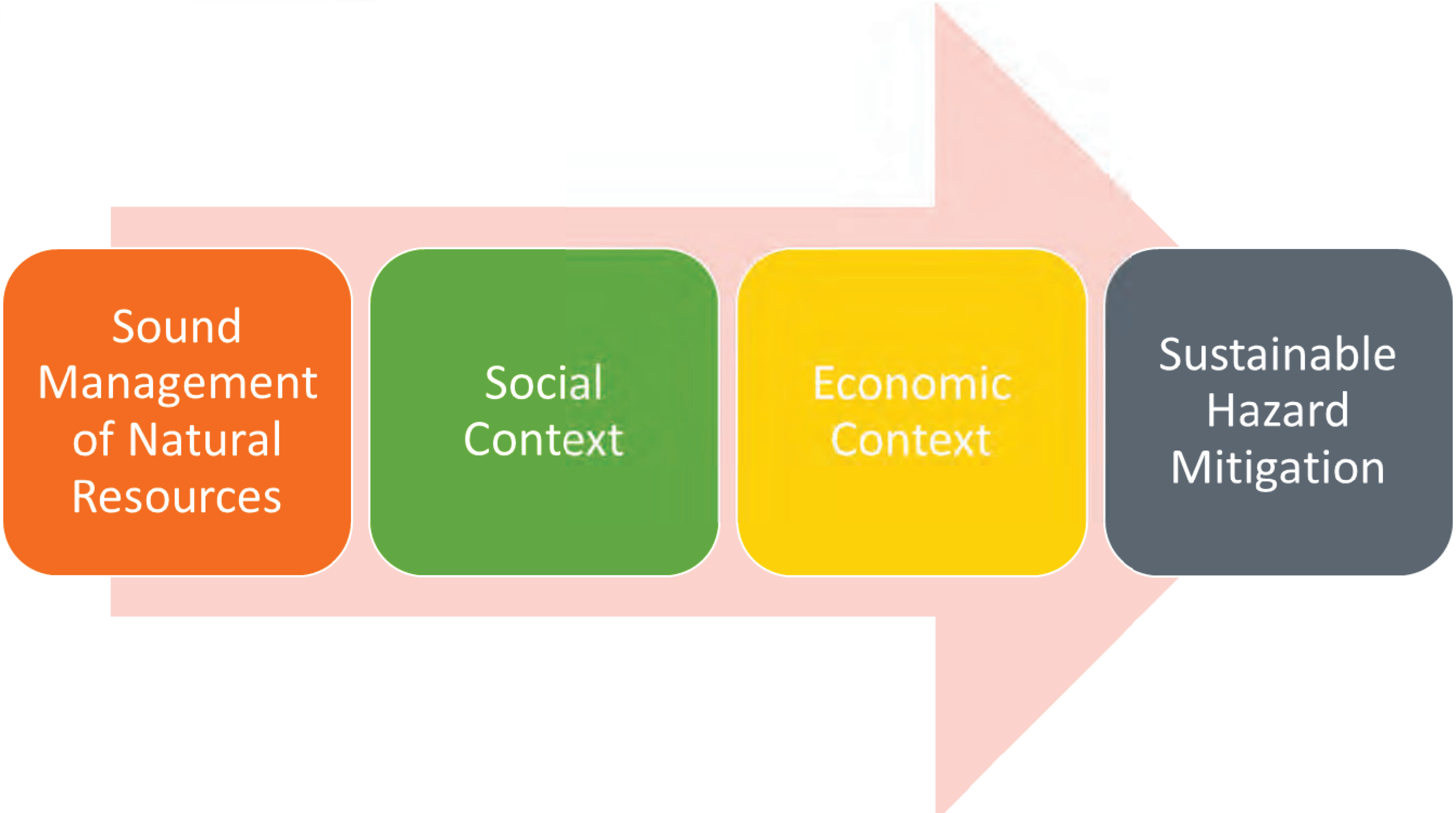

Why Plan?

- Establish/maintain eligibility for grant funds
- Preparedness: pro-active vs. reactive
- Sustainability
- Key element in emergency management
- Can set the course for response and recovery to impacts from natural disasters
- Requires commitment and support from both elected officials and their constituents

What is required in a DMA plan?

According to Section 201.6, 44CFR, an approved plan must:

- Engage the public through all phases of the plan's development
- Review and incorporate plans and programs that can support/enhance hazard mitigation
- Assess risk to natural hazards that impact a planning area
- Identify a plan maintenance strategy
- Identify and prioritize actions

This is a Plan Update

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- FEMA Requires Local Hazard Mitigation Plans to be updated every 5-years.
- The last Plan for Hawaii County was approved in 2015
  - Addressed 13 hazards of concern
  - Identifies 8 goals and 20 objectives
  - Identified and prioritized over 30 actions to address those hazards with the greatest impact
- This plan update will:
  - Revisit the risk assessment
  - Reengage the public
  - Confirm vision, goals and objectives
  - Review core capabilities
  - Reconcile past actions
  - Identify and prioritize new actions

The County's Objectives for this Plan Update Process

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- Promote the wise use of resources and increase coordination among Hawaii County programs and stakeholders
- Leverage the County's on-going recovery efforts from the Kilauea volcano eruption
- Identify natural hazard risks and vulnerabilities for the people, property and economy of Hawaii County
- Develop specific strategies to reduce disaster risk and improve resilience

The Plan Update Work Plan

- 7 phase scope of work
- Follow the 10-Step Planning script from FEMA's Community Rating System (CRS Program).
- Centers on a comprehensive risk assessment and active public engagement strategy

The HMP Working Group

- A 24 member Working Group is overseeing the plan update
- Multi-disciplined representation
- Stakeholders (business, academia, government)
- Emergency Management
- Has met 2 times since October 2019
- Meets 3rd Tuesday of every month from 2-4pm at the Aupuni Center Conference Room
- All meetings are open to the public

The Plan's Mission Statement

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Identify risks to life and property resulting from hazards events to determine viable actions that will reduce the risk and enable resilient communities.

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1. Utilize state-of-the-art methods and technologies as well as local knowledge to identify hazards, risks, and capabilities.
2. Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly.
3. Protect natural and cultural resources to the extent practicable that mitigate hazards.
4. Promote actions that support land use planning and regulations designed to ensure long-term resiliency.
5. Promote community risk reduction and preparedness through public education, training, and awareness.
6. Improve capabilities to implement response protocols and continuity of operations and services.
7. Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of hazards.

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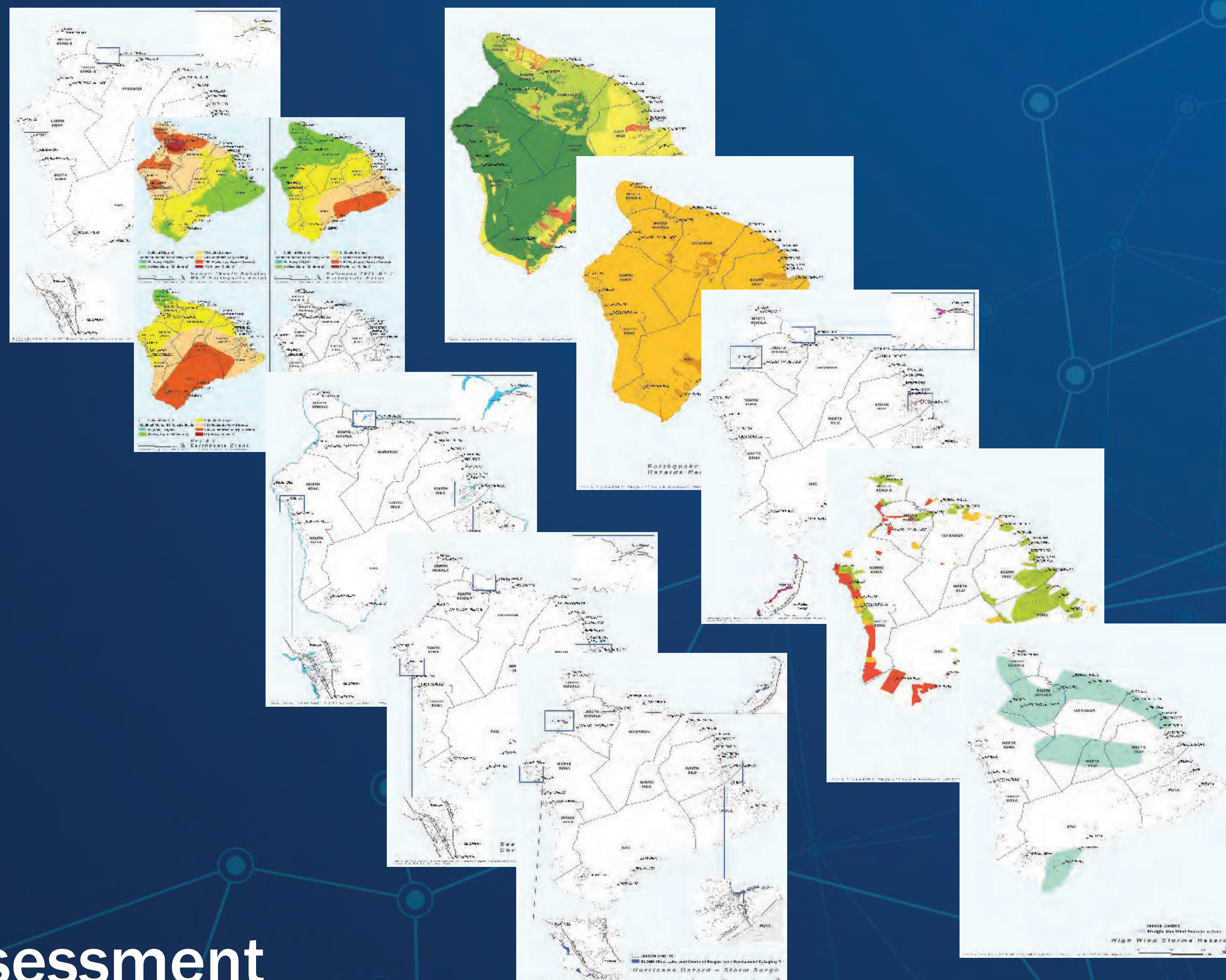


The Risk Assessment

What is Risk?

Risk is defined as a function of :

☑Hazard

- *Source of potential danger or adverse condition*

☑Exposure

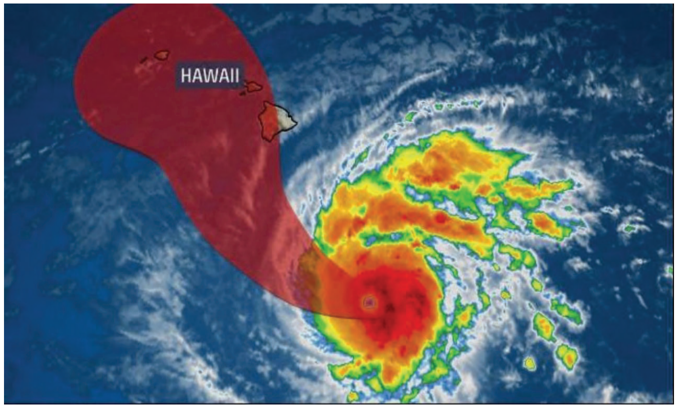
- *Manmade or natural features that are exposed to the hazard*

☑Vulnerability

- *Damage susceptibility of the exposed features*

☑Capability

- *Regulatory Capability*
- *Technical Capability*
- *Financial Capability*



Risk Reduction

- ☞ ***Manipulate the Hazard***
  -
- ☞ ***Reduce Exposure***
  -
- ☞ ***Reduce Vulnerability***
  -
- ☞ ***Increase capability***
  -

Development of the Hawaii County Risk Assessment

5

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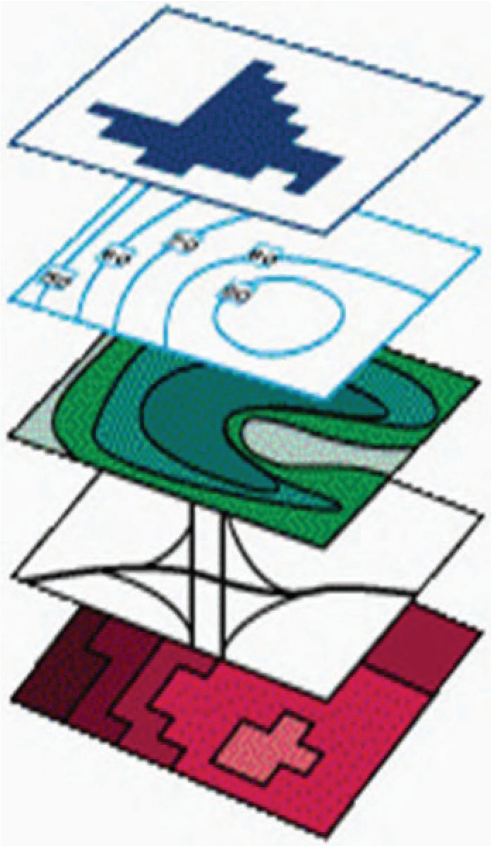

1. **Hazard Locators (Soils, floodplains, landslides)**
2. **Inventories (Buildings, roads, critical areas)**
3. **Exposure (Direct and Indirect)**
4. **Disaster Scenario (Vulnerability Assessments)**
5. **Suggest Risk Reduction Measures**

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What is Hazus?

- HAZUS-MH is a powerful risk assessment methodology for analyzing potential losses from floods, hurricane winds and earthquakes.

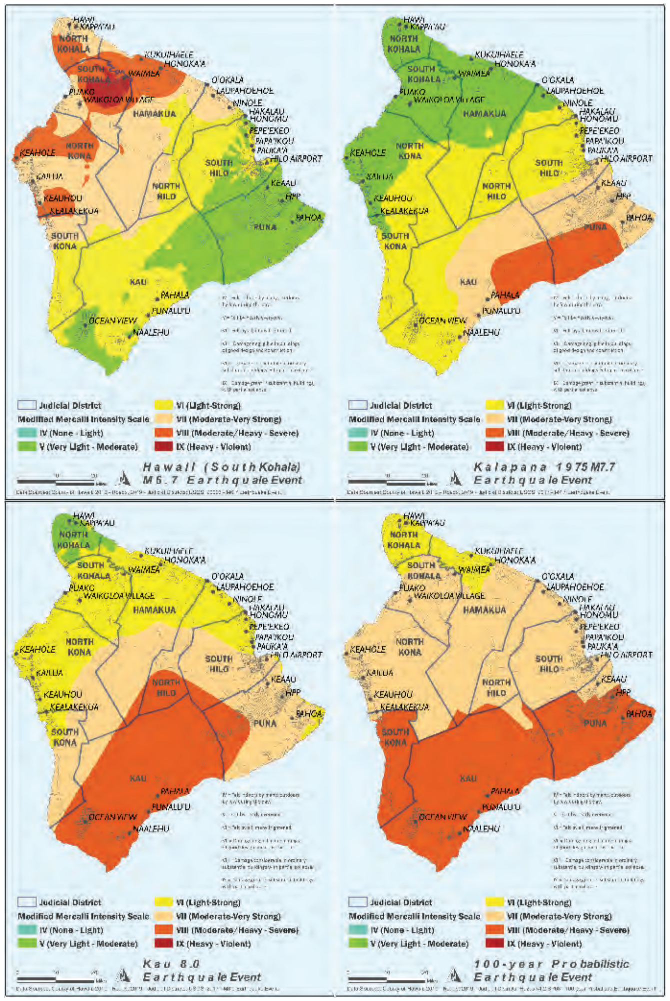
- HAZUS outputs include:
  - *Number, location, types, and occupancy of vulnerable buildings*
  - *Actual or assessed values of the vulnerable buildings*
  - *Critical facilities*
  - *An estimate of losses per hazard*
  - *Debris accumulation*

The Hawaii County Risk Assessment

- The foundation of the plan is a comprehensive risk assessment of 10 natural hazards of concern
  - ✓Assess hazard
    - Past events
    - Areas most affected
    - Frequency
    - Severity
    - Warning time for response
  - ✓Determine Exposure
  - ✓Assess Vulnerability
    - Loss Estimation

The Hazards of Concern

- **Natural Hazards**
  - Volcanic Hazards
  - Dam Failure
  - Drought
  - Earthquake
  - Flood
  - Landslide
  - High Wind Storms
  - Hurricane
  - Storm surge/High Surf/Chronic Coastal Flood
  - Climate Change/Sea Level Rise
  - Tsunami
  - Wildfire
  - Invasive Species
- **Non-Natural Hazards**
  - Supply Chain
  - Mass Gathering Events
  - Cyber



Hazard Scenarios

Hazard	Scenarios
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Dam Failure	Waikoloa Reservoir No. 1 (HA0040), Reservoir No. 2 (HA0122), Reservoir No. 3 (HA0136) inundation areas.
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Tsunami	2010 study inundation area
Wildfire	Communities at Risk from Wildfire

Preliminary Results

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	Exposure						Damage				
Hazard	Number of Structures Exposed	% of Total Structures	Structure RCV Exposed	% of Total Structure RCV	Content RCV Exposed	% of Total Content RCV	Structure Loss	% of Total Structure RCV	Content Loss	% of Total Content RCV	Direct Economic Loss (include structure, contents, inventory capital-related income, wage, and rental income losses, and relocation expenses)
Volcano - Lava Zone 1	974	1.2%	$176,208,235	0.5%	$90,926,904	0.4%					
Volcano - Lava Zone 2	6,555	7.9%	$1,165,659,926	3.5%	$629,128,584	2.5%					
Volcano - Historic Lava Flows	3,115	3.8%	$659,395,772	2.0%	$336,004,492	1.4%					
NEHRP Soils - D & E	2,502	3.0%	$2,029,830,629	6.1%	$2,221,022,969	9.0%					
Earthquake - Kalapana M7.7											**$2,677,830,163**
Earthquake - Kau M8.0											**$3,183,699,401**
Earthquake - Hawaii (South Kohala) M6.7											**$3,461,433,741**
Earthquake - 100-yr Probabilistic											**$6,721,388,993**
Landslide Susceptibility - High (Classes 7 - 10)	19,340	23.4%	$6,652,124,337	19.9%	$5,131,127,605	20.8%					
Flood - FEMA 100-yr	2,813	3.4%	$5,923,557,684	17.7%	$5,581,486,736	22.6%	**$50,839,332**	**0.2%**	**$41,686,178**	**0.2%**	
Flood - Chronic Coastal (SLR-XA 1.1 ft)	11	0.0%	$90,736,503	0.3%	$46,553,320	0.2%					
SLR - Event-based Coastal Flood Plus SLR (1%CFZ + 3.2ft SLR)	2,543	3.1%	$6,126,641,646	18.3%	$5,747,245,409	23.3%					
SLR - Future Chronic Coastal Flood (SLR-XA 3.2ft)	40	0.0%	$100,723,818	0.3%	$52,535,755	0.2%					
Tsunami - Tsunami Inundation Area	2,573	3.1%	$1,768,001,486	5.3%	$1,308,737,347	5.3%					
Hurricane - Category 4 Scenario Wind							**$7,440,752,904**	**22.2%**	**$3,764,241,595**	**15.2%**	
Hurricane - Category 4 Storm Surge Inundation Area	647	0.8%	$748,405,776	2.2%	$604,514,408	2.4%					
High Wind Storm - Straight Line Wind Awareness Area	16,987	20.5%	$5,892,680,075	17.6%	$3,509,221,044	14.2%					
Wildfire - Communities at Risk Level High	22,322	27.0%	$8,431,259,276	25.2%	$5,756,153,540	23.3%					
Wildfire - Communities at Risk Level Medium	7,003	8.5%	$2,735,670,214	8.2%	$1,550,290,168	6.3%					

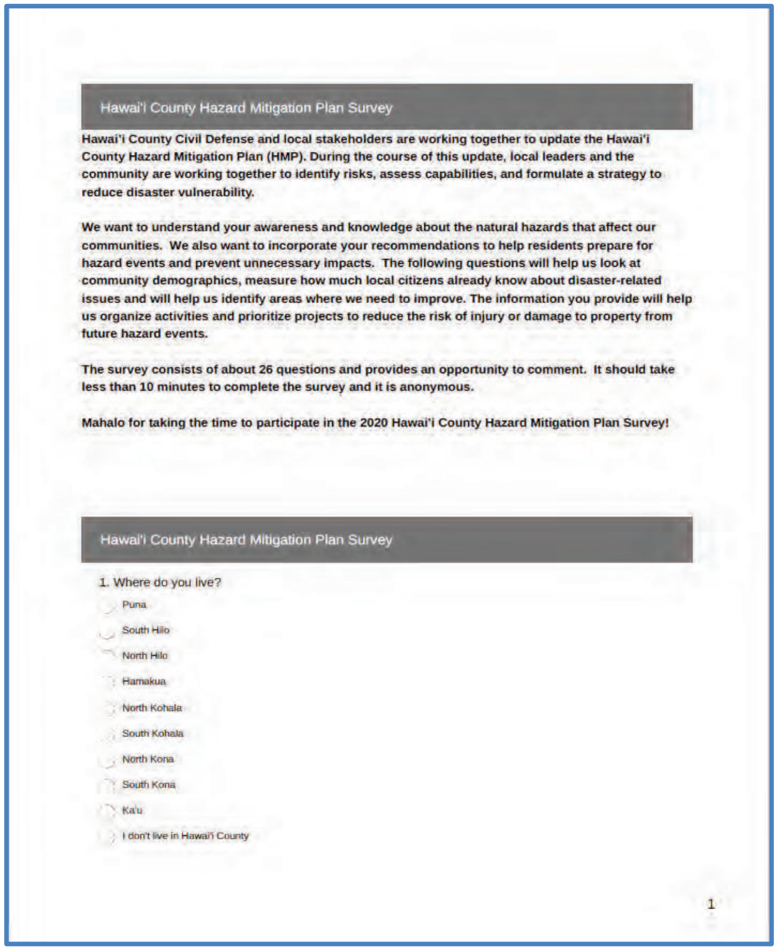
Citizens Role in this Open House

- ✓
- ✓
- ✓ ***Complete a Survey***
- ✓

Hazard Mitigation Plan Public Survey

Please complete the Public Survey:

https://www.surveymonkey.com/r/HawaiiCountyHMP



Hawai'i County Hazard Mitigation Plan Survey

Hawai'i County Civil Defense and local stakeholders are working together to update the Hawai'i County Hazard Mitigation Plan (HMP). During the course of this update, local leaders and the community are working together to identify risks, assess capabilities, and formulate a strategy to reduce disaster vulnerability.

We want to understand your awareness and knowledge about the natural hazards that affect our communities. We also want to incorporate your recommendations to help residents prepare for hazard events and prevent unnecessary impacts. The following questions will help us look at community demographics, measure how much local citizens already know about disaster-related issues and will help us identify areas where we need to improve. The information you provide will help us organize activities and prioritize projects to reduce the risk of injury or damage to property from future hazard events.

The survey consists of about 26 questions and provides an opportunity to comment. It should take less than 10 minutes to complete the survey and it is anonymous.

Mahalo for taking the time to participate in the 2020 Hawai'i County Hazard Mitigation Plan Survey!

Hawai'i County Hazard Mitigation Plan Survey

1. Where do you live?

- Puna
- South Hilo
- North Hilo
- Hamakua
- North Kohala
- South Kohala
- North Kona
- South Kona
- Ka'u
- I don't live in Hawai'i County

1

For More Information

Please visit the County website at:

https://www.hawaiicounty.gov/departments/civil-defense

This site includes:

- FAQs
- Working Group
    - meeting Agendas/minutes
- The draft Plan
- Prior Plan

Next Steps

- Confirm Objectives
- Review Core Capabilities
- Identify alternatives
- Identify/Prioritize Actions
- Assemble the Plan
- ***Phase 2 public outreach***
- Submit the Plan
- Adopt the Plan

Questions?

Meeting 4, February 18, 2020

County of Hawaiʻi
Meeting Agenda

Purpose of Meeting:	Hawaii County Multi Hazard Mitigation Plan Working Group
Location of Meeting:	Aupuni Center 2-4 PM
Date of Meeting:	02.18.2020

Attendees:
17 in attendance. See accompanying sign-in sheet.

Planning Team in Attendance:
April Surprenant
Barry Periatt
Rob Flaner
Cindy Rolli

Agenda Summary:

Item No.	Description	Action item(s):
1	Results from Public Outreach Survey and Public Meetings • Overview of PPT presentation • Potential project for future hazard mitigation surveys: Get more surveys from people "off the street" for a broader range of preparedness responses	
2	Group Facilitation Exercise: Define objectives for HMP Plan • Identify the objectives that meets the most goals o Select 10-16 objectives • Objectives are a measurable component of the plan	• Identify potential gaps in goals • Reword objectives to make them measurable • Planning Team will meet to review and combine list of selected objectives • Working Group meeting in March will look at actions based on objectives list
3	**Next Working Group Meeting:** March 17th	

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: MHMP Working Group Meeting #4
MEETING DATE: 2-18-20

Name	Title	Agency/Municipality	Phone Number	Email
Barry Periatt		HCCDA	935-0031	
Dan Chun		Risk Mgmt	961-8068	
April Surprenant		Plng	961 8125	
Patti Pinto		CERT	430-1777	
Kawika Uyehara		DWS	961 8050	
Pat Steffen		CERT	213-1786	
Keith Okamoto		DWS	961-8050	
Bethany Morrison		Planning	961-8138	
[illegible]		HIEMA	217-8629	
[illegible]		DPW	961-8324	
Diane Ley		RED	961-8368	
Bob Kaman		SPECTRUM	960-0189	

COUNTY OF HAWAII
SIGN-IN SHEET
MEETING NAME: MHMP Working Group Meeting #4
MEETING DATE: 2.18.20

Name	Title	Agency/Municipality	Phone Number	Email
[illegible]		Hawaiian Electric	896-8176	
Robyn Matsumoto		DPW | BLDG	961-8466	
MEGAN BROTHERTON		TETRA TECH		
Cindy Rolli		Tetra Tech	872-232-3389	

Hawaiʻi County Multi-Hazard Mitigation Plan - Objectives Exercise

Objectives are:

- **Short- or long-term aims that, when combined, form a strategy or a course of action to meet a goal.**
- **More specific than goals, but less specific than actions (projects).**

Once objectives have been established, the MHMP Working Group will use them to define and prioritize actions. We will strive to identify stand-alone objectives that meet multiple goals, supporting the linear concept of purpose statement, goals, objectives and actions that all directly support each other.

The sample objectives below are adapted from mitigation plans in other jurisdictions, other best practice objectives and an identified objective from the December Working Group Meeting. You will notice that many of these objectives overlap, use similar terms, and cover similar topics.

Please select objectives by associating one or more goals with the desired objective. If you don't associate any goals with an objective, that indicates that you don't recommend that objective. You will also have the opportunity to suggest different objectives at the end of the exercise.

HAWAIʻI COUNTY HMP 2020 GOALS:

1. **Utilize state-of-the-art methods and technologies as well as local knowledge to identify hazards, risks, and capabilities.**
2. **Ensure that all critical facilities and infrastructure withstand hazard incidents and have contingency plans to restore services quickly.**
3. **Protect natural and cultural resources to the extent practicable that mitigate hazards.**
4. **Promote actions that support land use planning and regulations designed to ensure long-term resiliency.**
5. **Promote community risk reduction and preparedness through public education, training and awareness.**
6. **Improve capabilities to implement response protocols and continuity of operations and services.**
7. **Strengthen partnerships and leverage existing resources and capabilities to identify, assess, and reduce the impact of hazards.**

NOTES AND REMINDERS:

You may want to print off the goals, so that you can refer to them while completing the exercise. It will likely be easier to refer to a hard copy.

Please remember that this is simply a prioritization exercise. We will discuss the results of this exercise at the next Working Group meeting.

* 1. In order to track participation, please provide your name:

2. Please choose the plan goals that each objective meets:

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-1. Provide adequate pre-and post-disaster emergency shelters to accommodate residents and visitors.	☐	☐	☐	☐	☐	☐	☐
O-2. Improve understanding of the locations, potential impacts, and linkages among threats, hazards, vulnerability, and measures needed to protect life safety and health.	☐	☐	☐	☐	☐	☐	☐
O-3. Reduce the impacts of hazards on individuals with disabilities and others with access and functional needs.	☐	☐	☐	☐	☐	☐	☐
O-4. Minimize exposure to the natural hazards which exist predominantly in the undeveloped portions of the County.	☐	☐	☐	☐	☐	☐	☐
O-5. Increase housing and support opportunities for the County's vulnerable populations.	☐	☐	☐	☐	☐	☐	☐
O-6. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.	☐	☐	☐	☐	☐	☐	☐
O-7. Promote enforcement of relevant state and county regulations and local ordinances that significantly reduce life loss and injuries.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-8. Maximize the likelihood that structures are modified, as necessary, over time to meet life safety standards.	☐	☐	☐	☐	☐	☐	☐
O-9. Encourage the incorporation of mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.	☐	☐	☐	☐	☐	☐	☐
O-10. Advance community resilience through preparation, adoption, and implementation of state, county and local multi-hazard mitigation plans and projects.	☐	☐	☐	☐	☐	☐	☐
O-11. Manage development in geologically hazardous areas and floodplains to protect life and property.	☐	☐	☐	☐	☐	☐	☐
O-12. Promote disaster resistant development.	☐	☐	☐	☐	☐	☐	☐
O-13. Encourage new development to occur in locations avoiding or minimizing exposure to hazards and enhance design requirements to improve resiliency in future disasters.	☐	☐	☐	☐	☐	☐	☐
O-14. Encourage life and property protection measures for all communities and structures located in hazard areas.	☐	☐	☐	☐	☐	☐	☐
O-15. Provide incentives for development and land use techniques that reduce risks.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-16. Reduce repetitive property losses due to lava, flood, fire and earthquakes by updating land use, design, and construction policies.	☐	☐	☐	☐	☐	☐	☐
O-17. Reduce losses on properties that have been repeatedly damaged.	☐	☐	☐	☐	☐	☐	☐
O-18. Research, develop, and promote adoption of cost-effective building and development laws, regulations, and ordinances exceeding the minimum levels needed for life safety.	☐	☐	☐	☐	☐	☐	☐
O-19. Support the protection of vital records, and strengthening or replacement of buildings, infrastructure, and lifelines to minimize post-disaster disruption and facilitate short-term and long-term recovery.	☐	☐	☐	☐	☐	☐	☐
O-20. Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.	☐	☐	☐	☐	☐	☐	☐
O-21. Review all hazard mitigation projects for compliance with applicable environmental laws.	☐	☐	☐	☐	☐	☐	☐
O-22. Encourage hazard mitigation measures that promote and enhance natural processes and minimize adverse impacts on the ecosystem.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-23. Encourage all state, county and local hazard mitigation planning programs to protect the environment and promote implementation of sustainable mitigation actions.	☐	☐	☐	☐	☐	☐	☐
O-24. Implement wildfire mitigation and watershed protection strategies through local, state, tribal, federal and private partnerships.	☐	☐	☐	☐	☐	☐	☐
O-25. Promote and implement hazard mitigation plans and projects that are consistent with state, county and local climate action and adaptation goals, policies, and programs.	☐	☐	☐	☐	☐	☐	☐
O-26. Protect watershed quality.	☐	☐	☐	☐	☐	☐	☐
O-27. Maintain a maximum number of options for open space resources.	☐	☐	☐	☐	☐	☐	☐
O-28. Protect rare, endangered, unusual, or educationally important natural and cultural resources.	☐	☐	☐	☐	☐	☐	☐
O-29. Implement risk reduction actions that have minimal negative impacts on biological and other resources.	☐	☐	☐	☐	☐	☐	☐
O-30. Give higher priority to hazard mitigation measures that can increase open space and meet targets for natural environment sustainability.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-31. Control access and provide buffers to maximize resource protection where possible.	☐	☐	☐	☐	☐	☐	☐
O-32. Balance new development with environmental quality.	☐	☐	☐	☐	☐	☐	☐
O-33. Coordinate county hazard mitigation planning with state and federal programs designed to minimize the release and movement of toxic and hazardous substances in the environment.	☐	☐	☐	☐	☐	☐	☐
O-34. Encourage all cities, special districts, Councils of Governments and native organizations to develop, adopt, and implement local hazard mitigation plans to be integrated with local general plan safety elements, local coastal plans, facilities master plans, and other local plan initiatives.	☐	☐	☐	☐	☐	☐	☐
O-35. Establish a partnership among all levels of government and the business community to improve and implement methods to protect property.	☐	☐	☐	☐	☐	☐	☐
O-36. Reduce risks that may impact critical business operations.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-37. Improve the quality and effectiveness of local hazard mitigation planning through effective training and guidance that strengthens linkages between the local hazard mitigation plan, general plan safety elements, and other plans that can support or enahance mitigation efforts.	☐	☐	☐	☐	☐	☐	☐
O-38. Continually build linkages among hazard mitigation, disaster preparedness, and recovery programs within the public and private sectors.	☐	☐	☐	☐	☐	☐	☐
O-39. Strengthen local building code enforcement.	☐	☐	☐	☐	☐	☐	☐
O-40. Retrofit, purchase, or relocate structures in high hazard areas, especially those known to be repetitively damaged.	☐	☐	☐	☐	☐	☐	☐
O-41. Use mandatory local general plan, zoning, and subdivision requirements to help establish resilient and sustainable communities.	☐	☐	☐	☐	☐	☐	☐
O-42. Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of natural hazards.	☐	☐	☐	☐	☐	☐	☐
O-43. Consider risk reduction in long-term planning.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-44. Actively promote effective coordination of regional and local hazard mitigation planning and action among state agencies, cities, counties, special districts, native organizations, councils of governments, metropolitan planning organizations, and regional transportation to create resilient and sustainable communities.	☐	☐	☐	☐	☐	☐	☐
O-45. Create financial and regulatory incentives to motivate stakeholders such as homeowners, private sector businesses, and nonprofit community organizations to mitigate hazards and risk.	☐	☐	☐	☐	☐	☐	☐
O-46. Promote and enhance outreach and education efforts by state, regional and local agencies with hazard mitigation plans and programs to actively encourage engagement of stakeholder groups such as homeowners, private sector businesses, and nonprofit community organizations.	☐	☐	☐	☐	☐	☐	☐
O-47. Coordinate state and local efforts to reduce greenhouse gas emissions and implement climate adaptation strategies through hazard mitigation plans and actions.	☐	☐	☐	☐	☐	☐	☐
O-48. Improve systems that provide warning and emergency communications.	☐	☐	☐	☐	☐	☐	☐

	Goal #1	Goal #2	Goal #3	Goal #4	Goal #5	Goal #6	Goal #7
O-49. Increase public awareness of risk.	☐	☐	☐	☐	☐	☐	☐
O-50. Inform the public on the risk exposure to natural hazards and ways to increase the public's capability to prepare, respond, recover and mitigate the impacts of these events.	☐	☐	☐	☐	☐	☐	☐
O-51. Promote dialogue between government representatives, private business, non-profit organizations, and the public regarding hazard mitigation.	☐	☐	☐	☐	☐	☐	☐
O-52. Minimize impacts of hazard events to key employers.	☐	☐	☐	☐	☐	☐	☐
O-53. Consider climate change implications when selecting strategies for hazard risk reduction.	☐	☐	☐	☐	☐	☐	☐
O-54. Identify projects that simultaneously reduce risk while increasing operational area resilience and sustainability.	☐	☐	☐	☐	☐	☐	☐
O-55. Plan and develop according to a higher level through consideration of future conditions.	☐	☐	☐	☐	☐	☐	☐

3. Please list any additional suggestions for objectives that meet multiple goals or any suggestions for revisions to the objectives identified above:

Suggestion #1	
Suggestion #2	
Suggestion #3	
Suggestion #4	
Suggestion #5	
Suggestion #6	
Suggestion #7	
Suggestion #8	
Suggestion #9	
Suggestion #10	

4. If you have any additional comments, please provide them below.

Meeting 5, April 21, 2020

County of Hawai'i
Meeting Agenda

Purpose of Meeting:	MHMP Working Group Meeting
Location of Meeting:	Web Ex
Date of Meeting:	04.21.2020

Attendees:
Talmadge Magno, Barry Periatt, Bill Hanson, April Surprenant, Daniel Chun, Judy Kayduckso, Richard Baker, Robyn Matsumoto, Riley Saito, Rob Lee, David Kurohara, Bethany Morrison, Keith Okamoto, Kawika Kuyehara, Pat Steffen, Paul Agamata, Bryce Harada, David Yamamoto, Rob Flaner, Cindy Rolli, Megan Brotherton

Agenda Summary:

Item No.	Description	Action item(s):
1	Final Objectives Review • Reviewed with no questions asked • If anything else needs to be included, it can be added as actions.	

2	Draft Action Plan Review
	• 2020 Plan is a functional update.
	• 3-year performance period for grants
	• County has submitted more grant applications (9) than available funding so not all will be funded.
	• Reviewed Status of Previous Plan Actions
	  o No questions
	• Reviewed Recommended Mitigation Actions
	  o HC13 – Correct description. "Wailoa River Bridge" should be replaced with Wailuku (Singing) Bridge". Wailoa Bridge is not ready for retrofit, but Wailuku Singing Bridge is.
	  o Two more actions will be added:
	    ▪ Continuity of Operations
	    ▪ THIRA (Threat and Hazard Identification and Risk Assessment)
	  o Email Cindy if any actions are missing
	• Benefit-Cost Review
	  o No questions
	• Reviewed Action Plan Prioritization
	  o No questions
	• Reviewed Classification of Mitigation Actions
	  o Action 29 Emerging Hazards will cover the unknowns
	• Reviewed Implementation and Integration
	  o Working Group can review Draft Action Plan until April 30.
	  o Entire Draft Plan will be available for review and comment
		Email Cindy if any Recommended Mitigation Actions need to be added
		
		Correct wording of HC13. Replace "Wailoa River Bridge" with "Wailuku (Singing) Bridge"

3	Public Meeting Discussion • FEMA requires public meetings to be interactive • Possible formats: o WebEx	Paul Agamata to explore options with Microsoft Teams and report back

	o Microsoft Teams o Skype • One live webinar with chat interaction and questions submitted via email. • Recorded narrated PPT presentation will be streamed on County website with email comment capability. • Meeting advertisements will need access instructions for the decided platform. • Must have ability to capture attendance.	
4	Project Timeline Update Next Working Group Meeting: May 19	

Final Objectives – Hawaii County HMP 2020

1. Improve warning and emergency communications systems
2. Conduct studies to determine locations, potential impacts and links among threats, hazards, vulnerabilities to support the identification and implementation of mitigation and protection measures in Hawaii County
3. Utilize the best available data, science and technology to identify and communicate the risk exposure to hazards and ways to increase the planning area’s capability to prepare, respond, recover and mitigate the impacts of these events.
4. Promote and implement the retrofit/hardening, or replacement of at-risk structures and lifelines to increase community resilience.
5. Support hazard mitigation measures that promote and enhance natural processes and minimize adverse impacts on the ecosystem
6. Research, develop, promote, adopt and enforce codes and standards that are affordable and feasible for life and property protection.
7. Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life, property and environment of the planning area.
8. Minimize impacts of hazard events on the economic drivers for the County
9. Incentivize and implement mitigation measures for hazard risk and repetitive loss areas to address repairs, major alternations, development plans and practices.
10. Integrate local hazard mitigation plans with the General Plan and other agency/local plans and provide training and guidance to integrate and strengthen the linkages between the plans.
11. Advance community resilience through preparation, adoption, and implementation of state, county and local multi-hazard mitigation plans and projects

23. HAZARD MITIGATION ACTION PLAN

23.1 STATUS OF PREVIOUS PLAN ACTIONS

The 2015 County of Hawaii Multi-Hazard Mitigation Plan identified 26 mitigation actions for implementation. For the current update, these actions were reviewed by County agencies and offices and other relevant agencies. For each action, it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2020 update or removed from the plan due to a change in priorities, capabilities, or feasibility. In total, 3 (12 percent) of the identified actions have been started or completed. Of the 26 identified actions 12 (46 percent) were carried over to the 2020 update. A total of 11 (42 percent) of the identified actions were withdrawn from the plan based on a review by the planning team. The reasons for a withdrawal of an action ranged from the action no longer being considered feasible to the action being identified as a core capability by the 2020 planning process. Each carried over has a new action number assigned to it for the 2020 update, and many were reworded to more clearly state their intent. Following this review, it was determined by the County that this update process would be treated as an opportunity for a functional reset of the action plan. While some of these prior actions have been carried over to this 2020, all have been reframed and prioritized to a different schedule from prior plans.

Table 23-1 lists the status of all 26 actions identified in the 2015 plan.

Table 23-1. Prior Action Status

Action Item from Previous Plan	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Action # in Update
1-Update the building code from the 2006 IBC to the 2012 IBC		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
2-Update tsunami evacuation maps: Tsunami Inundation and Runup Mapping: Analysis of the island of Hawaii based on State Civil Defense scenarios from tsunami-genic source regions in the Aleutian Islands.		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
3-Identify hardening projects to implement 2009 seismic evaluation study of critical facilities			✓	HC15
Comment: *This action has been reframed and will be replaced by HC-15*				
4-Study hardening requirements for fuel storage and distribution to critical facilities			✓	HC15
Comment: *This action has been reframed and will be replaced by HC-15*				
5-Develop policies and procedures for establishing site specific hazard mitigation design criteria for critical facilities			✓	HC15
Comment: *This action has been reframed and will be replaced by HC-15*				

Action Item from Previous Plan	Completed	Removed; No Longer Feasible	Carried Over to Plan Update	
			Check if Yes	Action # in Update
6-Review the General Plan natural hazard policies in light of this mitigation plan and American Planning Association suggested policies			✓	HC20
Comment: *This action has been reframed and will be replaced by HC-20*				
7-Participate in the Community Rating System			✓	HC11
Comment: *This action has been reframed and will be replaced by HC-11*				
8-Conduct hazard loss estimation studies; incorporate cost-benefit methodology as a factor in prioritizing projects		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
9-Develop a GIS-based Multi-Hazard website			✓	HC21
Comment: *This action has been reframed and will be replaced by HC-21*				
10-Organize public awareness and preparedness program, including mitigation techniques and retrofit training			✓	HC21
Comment: *This action has been reframed and will be replaced by HC-21*				
11-Develop Dam Evacuation Maps	✓			
Comment: *This action is considered to be complete as of this plan update. The State of Hawaii Department of Land and Natural Resources Dam Inventory System has been completed and meets the criteria for this action (http://132.160.239.52/daminventory/Default.aspx)*				
12-Adopt tsunami design provisions and Tsunami Design Zone maps for buildings (to be released in Sept 2016) for new and for evaluating existing buildings.)		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
13-Implement State Drought Plan; improve water resources		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
14-Perform a comprehensive screening evaluation of private sector candidate building types for possible hurricane refuge use			✓	HC27
Comment: *This action has been reframed and will be replaced by HC-27*				
15-Emergency shelter evaluation: All-Hazard Assessment of Potentially capable hurricane refuges in the private sector inventory			✓	HC27
Comment: *This action has been reframed and will be replaced by HC-27*				
16-Harden public schools for emergency shelters			✓	HC27
Comment: *This action has been reframed and will be replaced by HC-27*				
17-Update the HAZUS MH model to incorporate data on State and County Bridges	✓			
Comment: *This action was completed as part of this hazard mitigation plan update*				
18-Study hardening requirements for Hilo and Kawaihae Harbors		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
19-Study hardening requirements for fuel storage		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
20-Investigate effectiveness of VOG mitigation techniques			✓	HC28
Comment: *This action has been reframed and will be replaced by HC-28*				
21-Adapt HAZUS MH for hurricane analysis	✓			
Comment: *This action was completed as part of this hazard mitigation plan update*				
22-Testing of the seismic and wind performance of single wall construction		✓		
Comment: This action has been removed as it has been determined to be no longer feasible				

Action Item from Previous Plan	Completed	Removed; No Longer Feasible	Carried Over to Plan Update: Check if Yes	Carried Over to Plan Update: Action # in Update
23-Explore incentives for existing homeowners and businesses to retrofit their structures			✓	HC18
Comment: *This action has been reframed and will be replaced by HC-27*				
24Identify landslide and coastal erosion hazard areas and mitigation actions		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
25-Study hardening requirements for electrical system		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				
26-Explore with utilities, feasibility of underground power lines		✓		
Comment: *This action has been removed as it has been determined to be no longer feasible*				

23.1.1 Status of Plan Incorporation Actions

As a demonstration of progress in local hazard mitigation efforts, 44 CFR 201.6(c)(4)(ii) requires plan updates to describe completed steps to incorporate the mitigation plan into other planning mechanisms as appropriate. The maintenance strategy for the 2015 County od Hawaii Multi-Hazard Mitigation Plan called for incorporation into other planning mechanisms, but no clear actions or metrics were identified to measure successful incorporation. The capability assessment performed for this update identifies some links between the County's hazard mitigation planning and its core capabilities, but no information is available on specific actions related to incorporation during the past performance period for this plan.

Of the 26 mitigation actions in the 2015 plan, one action relates to incorporation of the mitigation plan into other planning mechanisms. Action #6 called for a review the General Plan natural hazard policies in light of this mitigation plan and American Planning Association suggested policies. This action was identified as "ongoing" and has been carried over to this plan update.

This plan update identifies clear actions for plan incorporation with clear metrics to monitor their completion; therefore, meeting the objectives of 44 CFR 201.6(c)(4)(ii) for future updates should be easier for the County.

23.2 RECOMMENDED MITIGATION ACTIONS

The working group reviewed the catalogs of hazard mitigation alternatives and selected actions to be included in a hazard mitigation action plan. The selection of actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table 23-2 lists the recommended hazard mitigation actions that make up the action plan. The timeframe indicated in the table is defined as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

Table 23-2. Hazard Mitigation Action Plan Matrix

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC1—*Microwave Network Upgrade*. This project involves the hardening of the County's radio communications system through replacement of the following systems; microwave system, the direct current (DC) power system, photo voltaic energy systems, and tower refurbishment.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New and Existing	1,4,8,11			High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, DOF
Action HC2— *Public Safety Building Flood Mitigation and Electrical Upgrade*. This project will eliminate flooding which endangers the entire electrical system at the Public Safety complex and causes damage in other areas. The electrical system will be upgraded to prevent failure						
Hazards Mitigated: Flood						
Existing	1,4,8,11			High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, DOF
Action HC3— *IT Data Center*. install a SmartMod 12x45 with a 11x34 utility skit to support the data center that supports critical services for the County currently housed at the Civil Defense building (920 Ululani St., Hilo, HI) and the IT Department building (25 Aupuni St., Hilo, HI).						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
New	1,4,8,11			High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, DOF
Action HC4— *Wailuku Bridge #1 and Wai-**ānuenue** Avenue Bridge Hardening*. Wailuku Bridge #1 over Wailuku River on Wainaku Street is an essential part of the traffic network in the area as it serves as a detour or important alternate route for Highway 19. The existing 129-foot, 2 span concrete bridge was built in 1919 and is not in compliance with today's engineering design standards, specifically in regard to resisting seismic forces.						
Hazards Mitigated: Earthquake, Tsunami						
Existing	1,4,8,11			High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, DOF
Action HC5— *Generators for Wastewater Treatment Facilities*. Install eight stationary generators to service the Hilo Wastewater Treatment Plant (WWTP); Kulaimano WWTP; Papa'ikou WWTP; Wailuku Sewer Pump Station (SPS); Paukaa SPS; Wailoa SPS; Onekaakaha SPS; and Kolea SP during severe weather events. These facilities experience significant power outages. The installation of generators will mitigate outages during these events.						
Hazards Mitigated: Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire						
Existing	1,4,8,11			High	FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding	Short term, DOF

<table>
<tr><th>Applies to New or Existing Assets</th><th>Objectives Met</th><th>Lead Agency</th><th>Support Agency</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline[a]</th></tr>
<tr><td colspan="7">Action HC6— Emergency Power Transfer Switching Capability for Critical Water Infrastructure. The Hardening of the Parker #1, Parker #2, Lalamilo B, Lalamilo C, Honokaa, Makapala, Waiaha, Kahaluu, Queen Liliuokalani Trust (QLT), Piihonua #1, Piihonua #3A and Olaa #3 potable water producing facilities through the purchase and installation of transfer switches and supporting infrastructure (generator tap boxes, junction boxes, conduit, wire, supports, etc.) will allow the County of Hawaii, Department of Water Supply (DWS) to better protect the health and welfare of the public.</td></tr>
<tr><td><u>Hazards Mitigated:</u></td><td colspan="6">Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire</td></tr>
<tr><td>Existing</td><td>1,4,8,11</td><td>Department of Water Supply</td><td></td><td>High</td><td>FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding</td><td>Short Term, DOF</td></tr>
<tr><td colspan="7">Action HC7— Waikoloa Reservoir No. 1 – Dan Failure Retrofit. The project requires the improvements to address the stability of the embankments as well as the waterproofing of the reservoir itself. The embankments are being improved by widening the base of the embankment and increasing the overall strength supporting the reservoir walls. An underdrain at the toe of the embankment is also being installed to direct groundwater away from the embankment to minimize the chances of liquefaction. Also, waterproofing the reservoir will be accomplished by installing a synthetic liner which eliminates the possibility of leaks through the numerous cracks in the concrete panels lining the interior of the reservoir.</td></tr>
<tr><td><u>Hazards Mitigated:</u></td><td colspan="6">Dam Failure, Earthquake</td></tr>
<tr><td>Existing</td><td>1,4,8,11</td><td>Department of Water Supply</td><td></td><td>High</td><td>FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding</td><td>Short Term, DOF</td></tr>
<tr><td colspan="7">Action HC8— ArcGIS Data Management, Collection and Tracking. Create and information/Data management system to provide actionable information to the planning process during an incident and to capture data for impact statistics and hazard analysis post incident.</td></tr>
<tr><td><u>Hazards Mitigated:</u></td><td colspan="6">Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire</td></tr>
<tr><td>New and Existing</td><td>1,4,8,11</td><td>Civil Defense</td><td></td><td>High</td><td>FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding</td><td>Short Term, DOF</td></tr>
<tr><td colspan="7">Action HC9— Volcanic Risk Home Buyout Program. Develop and institute a home buyout program that targets eligible properties impacted by Lava flows from Volcanic eruptions</td></tr>
<tr><td colspan="7"><u>Hazards Mitigated:</u> Volcano</td></tr>
<tr><td>Existing</td><td>2,3,7,11</td><td></td><td></td><td>High</td><td>FEMA HMA Grant Funding, HUD, CDBG-DR, CDBG-MIT, Local Funding</td><td>Short Term, DOF</td></tr>
<tr><td colspan="7">Action HC10— Maintain NFIP Compliance. Continue to maintain good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements:
• Enforce the flood damage prevention ordinance.
• Participate in floodplain identification and mapping updates.
• Provide public assistance/information on floodplain requirements and impacts.</td></tr>
<tr><td><u>Hazards Mitigated:</u></td><td colspan="6">Flooding, Hurricane, Severe Weather, Dam Failure</td></tr>
<tr><td>New and Existing</td><td>3,4,6,7,8,9,11</td><td></td><td></td><td>Low</td><td>Local Funding, FEMA's Building Resilient Infrastructure and Communities (BRIC) program</td><td>On-going</td></tr>
</table>

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC11— *Community Rating System (CRS)*. Continue to maintain an/or enhance (were feasible) the County's classification under the CRS program						
Hazards Mitigated:	Flooding, Hurricane, Severe Weather, Dam Failure					
New and Existing	3,4,6,7,8,9,11			Low	Local Funding	On-going
Action HC12— *Flood Hazard Needs Assessments*. Perform needs assessment Riverine Flood Studies for Puna, North Kona, and South Kohala to identify flood control projects and for Hamakua (to figure out what is the real risk associated with landsides)						
Hazards Mitigated:	Flooding, Landslide, Severe Weather					
New and Existing	2,3,8,11			High	FEMA HMA (Advance Assistance), FMA, Local Funding	Short-Term
Action HC13— Wailoa River Bridge Retrofit. Coordinate with the state to upgrade/retrofit Singing Bridge to address chronic coastal flooding and impacts from tsunami. Tsunami project – criticality of the DPW bridge to get retrofitted to prevent isolated populations due to the impact of State.						
Hazards Mitigated:	Chronic Flooding, Earthquake, Tsunami					
Existing	4,7,8,11	Hawaii State DOT	Hawaii County	High	State DOT Funding, National DOT Funding	Long term
Action HC14—*Training and Exercise*. Augment the County's annual emergency operations training and exercise program with relevant hazard scenario data an models (Hazus) that were developed is support of the risk assessment for this hazard mitigation planning effort.						
Hazards Mitigated:	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	1,3,7,10	Civil Defense		Low	Local Funding, EMPG, HSGP	On-going
Action HC15— *Critical Infrastructure (roads and bridges) needs assessment.* Conduct a vulnerability/needs assessment of identified critical roads and bridges that will result in the identification of retrofitting projects and identifies critical routes in support of evacuation planning.						
Hazards Mitigated:	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
Existing	2,3,4,8,11			High	FEMA HMA (Advance Assistance), Local Funding	Short-Term
Action HC16— *Audible Notification Needs Assessment*. Conduct a needs assessment that identifies gaps in coverage in the County's audible warning (sirens) system as well as those existing systems that need to be replaced and/or updated.						
Hazards Mitigated:	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	1,2,7,8,11			High	EMPG, HSGP, Local Funding	Short-Term
Action HC17— *Rain Gauge Network*. Purchase and install rain gauges in the Hamakua Coast to support landslide and flood risk identification and notification						
Hazards Mitigated:	Flood, Landslide and Severe Weather					
New and Existing	1,2,3,7,8,11			High	NWS Grants, NOAA Coastal Resilience Grants, HMGP (5% Initiative)	Long Term

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Action HC18— *Earthquake/Hurricane Retrofit Incentive Program*. Conduct a study to determine the feasibility for the County to deploy and incentive-based program that would encourage private property owners to retrofit their properties from the impacts of earthquake and Hurricanes. Key to this study will be a vulnerability analysis that attempts to identify the general building stock within the County that is most vulnerable to these hazards.						
<u>Hazards Mitigated:</u>	Earthquake, Volcanic Eruption					
Existing	2,3,4,11			Medium	FEMA HMA (Advance Assistance, Local Funding	Long Term
Action HC19— *Vulnerable Property Protection*. Where appropriate, support retrofitting, purchase or relocation of structures located in hazard areas, prioritizing those that have experienced repetitive losses and/or are located in high- or medium-risk hazard areas.						
<u>Hazards Mitigated:</u>	Flooding, Hurricane, Severe Weather, Dam Failure, Wildfire, Volcano					
Existing	4,7,11			High	FEMA HMA, HUD-CDBG (DR and MIT), Local Funding	Long-Term
Action HC20—— *Plan Integration*. Integrate the hazard mitigation plan into other plans, ordinances and programs that dictate land use decisions in the community, including Capital Improvement Programs, General Plans, recovery plans and Strategic Plans.						
<u>Hazards Mitigated:</u>	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	3,6,8,10,11	Planning	Mayor's Office, Public Works	Low	Local Funding	On-going
Action HC21— *Risk Communication*. Leveraging existing County public outreach programs, utilize the best available data and science to communicate the risk from all hazards assessed by this plan to the public to promote prevention, preparedness, response, recovery and mitigation actions at the local scale.						
<u>Hazards Mitigated:</u>	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	3,7,11	Civil Defense	Mayor's Office, County Public Information Officer	Low	Local Funding	On-going
Action HC22— *Damage Assessment Protocol and Capacity Building*. Develop protocol for collecting and storing data necessary to develop damage assessments. Research use of drone technology and IT solutions to take footage and convert into assessments.						
<u>Hazards Mitigated:</u>	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	3,7,11	Civil Defense	Public Works	Low	Local Funding	Short Term
Action HC23— *Codes and Policies for Sea Level Rise*: Update county codes and policies to require that all coastal development consider and incorporate measures to address sea level rise.						
<u>Hazards Mitigated:</u>	Climate Change/Sea Level Rise, Flooding, High Surf/Storm Surge/Coastal Flood, Tropical Cyclone					
New and Existing	3,5,6,11	Planning	Public Works	Medium	Local Funding, FEMA's Building Resilient Infrastructure and Communities (BRIC) program	Short term
Action HC24—*Fire Protection*: Establish fire breaks around communities and along roadways.						

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Hazards Mitigated:	Fire, Volcano					
New and existing	5, 8, 11, 12,	Fire	CD	Medium	Local Funds, AFG, FEMA HMA Programs	Short Term, DOF
Action HC25— *Shoreline setback for Coastal Erosion*: Update county shoreline setback policies to include Coastal Erosion in order to better regulate development in the high-risk areas						
Hazards Mitigated:	Chronic Flooding, Hurricane, Severe Weather					
New and Existing	3,6,11	Planning	Public Works	Low	Local Funds	Short Term
Action HC26— *Reduce development in high risk hazard areas*: Update and overlay hazard zones and develop conditions for land use and design within high risk zones and within or adjacent to Urban Growth Areas outside of high-risk areas.						
Hazards Mitigated:	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	2, 3, 5, 6, 8, 9, 10, 11	Planning	Mayor's Office	Low	Local Funds	Short term
Action HC27—Evacuation and Sheltering Assessment and Protocol: Perform and assessment of facilities utilized as shelters and identify mitigation needs as well as develop evacuation and sheltering protocol, policies, and procedures.						
Hazards Mitigated:	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	3,7	Civil Defense	DPR	Medium	Local Funds	Short Term
Action HC28—Volcanic Gas Monitoring (VOG): Provide training and develop monitoring plan to support gas monitoring system						
Hazards Mitigated:	Volcano					
New and Existing	1, 7, 10, 11	Fire	Civil Defense	Low	Local Funds	Short Term
Action HC29—Emerging Hazards: As this plan update was being completed during the COVID-19 Pandemic, it illustrates the need for this plan to be dynamic and have the flexibility to adapt to emerging hazards that fall outside of the "traditional" natural hazards targeted by Local Hazard Mitigation Plans developed pursuant to the Disaster Mitigation Act of 2000. This action is an open-ended action that positions the County to adapt this plan as needed through the Plan maintenance strategy contained in Chapter 24 to address new and emerging hazards of concern as they present impacts to the Hawaii County planning area during the performance period of this plan.						
Hazards Mitigated:	New and emerging					
New and Existing	1,2,3,4,5,6,7,8,9, 10,11	Civil Defense	County Government	High	FEMA HMA, Local Funding	Short Term
Action HC30—Disaster Distribution System: develop internal protocol, policies and procedure for logistics, management and resource support during disasters, and develop agreement with State, Federal and private partners to implement the plan.						
Hazards Mitigated:	Climate Change/Sea Level Rise, Dam Failure, Drought, Earthquake, Flood, High Surf/Storm Surge/Coastal Flood, High Windstorms, Landslide, Tropical Cyclone, Tsunami, Volcanic Eruption, Wildfire					
New and Existing	1,7,8,10,11	Civil Defense	County Government	Medium	Local Funds, EMPG, HSGP	Short term
Action HC31—Mass Gathering Plan: Develop a plan that includes policies, procedures and protocols for conducting mass gathering events with an emphasis on Terrorism.						

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
Hazards Mitigated:	Terrorism					
New and Existing	2,7,8,10,11	Civil Defense	County Government	Medium	Local Funds, EMPG, HSGP	Short Term

a. Short-term = Completion within 5 years; Long-term = Completion within 10 years; Ongoing= Continuing new or existing program with no completion date, DOF = Depending upon funding

See the introduction to this volume for list of acronyms used here.

23.3 BENEFIT-COST REVIEW

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed actions were weighed against estimated costs as part of the action prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some actions may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each action was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these actions.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the action; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The action could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
- **Low**—The action could be funded under the existing budget. The action is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Action will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Action will have a long-term impact on the reduction of risk exposure for life and property, or action will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the action are difficult to quantify in the short term.

Using this approach, actions with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, financial assistance may be available through the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For actions not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

23.4 ACTION PLAN PRIORITIZATION

Table 23-3 lists the priority of each action. A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **Implementation Priority**
  - **High Priority**—An action that meets multiple objectives, has benefits that exceed costs, and has a secured source of funding. Action can be completed in the short term (1 to 5 years).
  - **Medium Priority**—An action that meets multiple objectives, has benefits that exceed costs, and is eligible for funding though no funding has yet been secured for it. Action can be completed in the short term (1 to 5 years), once funding is secured. Medium-priority actions become high-priority actions once funding is secured.
  - **Low Priority**—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no secured source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions are generally "wish-list" actions. They may be eligible for grant funding from programs that have not yet been identified.
- **Grant Pursuit Priority**
  - **High Priority**—An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium implementation priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.
  - **Medium Priority**—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low implementation priority; local funding options are unavailable.
  - **Low Priority**—An action that has not been identified as meeting any grant eligibility requirements.

Table 23-3. Prioritization of Mitigation Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
HC-1	4	High	High	Yes	Yes	No	Medium	High
HC-2	4	High	High	Yes	Yes	No	Medium	High
HC-3	4	High	High	Yes	Yes	No	Medium	High
HC-4	4	High	High	Yes	Yes	No	Medium	High
HC-5	4	High	High	Yes	Yes	No	Medium	High
HC-6	4	High	High	Yes	Yes	No	Medium	High
HC-7	4	High	High	Yes	Yes	No	Medium	High
HC-8	4	High	High	Yes	Yes	No	Medium	High
HC-9	4	High	High	Yes	Yes	No	Medium	High
HC-10	7	Medium	Low	Yes	Yes	Yes	High	Medium
HC-11	7	Medium	Low	Yes	No	Yes	High	Low
HC-12	4	High	High	Yes	Yes	No	Medium	High
HC-13	4	High	High	Yes	No	Yes	High	Low
HC-14	4	Medium	Low	Yes	No	Yes	High	Low
HC-15	5	High	High	Yes	Yes	No	Medium	High
HC-16	5	High	High	Yes	No	No	Medium	Low
HC-17	6	High	High	Yes	Yes	No	Medium	High
HC-18	4	Medium	Medium	Yes	Yes	Yes	High	High
HC-19	3	High	High	Yes	Yes	No	Medium	Medium
HC-20	5	Medium	Low	Yes	No	Yes	High	Low
HC-21	3	Medium	Low	Yes	No	Yes	High	Low

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Action Grant Eligible?	Can Action be Funded under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority
HC-22	3	Medium	Low	Yes	No	Yes	High	Low
HC-23	4	Medium	Medium	Yes	No	Yes	High	Low
HC-24	4	High	Medium	Yes	Yes	Yes	High	High
HC-25	3	Medium	Low	Yes	No	Yes	High	Low
HC-26	8	Medium	Low	Yes	No	Yes	High	Low
HC-27	2	Medium	Medium	Yes	No	Yes	High	Low
HC-28	4	Medium	Low	Yes	No	Yes	High	Low
HC-29	11	High	High	Yes	Yes	No	Medium	High
HC-30	5	Medium	Medium	Yes	No	Yes	Medium	Low
HC-31	5	Medium	Medium	Yes	No	Yes	Medium	Low

23.5 CLASSIFICATION OF MITIGATION ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 23-4 shows these classifications.

Table 23-4. Analysis of Mitigation Actions

Hazard	Actions That Address the Hazard, by Mitigation Type[a]						
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Community Capacity Building
Climate Change/Sea Level Rise	8,10,11,12,20,23,26	3,11,15,19	11,21,27	10,11,20,26	1,5,11,14,16,22,30	11	11,15,16,22
Dam Failure	8,10,11,20,236	3,11,15,19	11,21,27	10,11,20,26	1,5,11,14,16,22,30	7,11	11,15,16,22
Drought	8,20,26	3,15	21,27	20,26	1,5,14,16,22,30		15,16,22
Earthquake	8,18,20,26	3, 4,13,15	21,27	20,26	1,5,14,16,22,30	7	15,16,22
Flood	8,10,11,12.20,26	2,3,11,13,15,19	11,21,27	10,11,20,26	1,5,11,14,16,17,22,30	11,13	11,12,15,16,22
High Surf/Storm Surge/Coastal Flood	8,10,11,12,20,25,26	3,11,15,19	11,21,27	20,25,26	1,5,11,14,16,22,30	11,13	11,15,16,22
High Windstorms	8,20,26	3,15	21,27	20,26	1,5,14,16,22,30		15,16,22
Landslide	8,20,25,26	3,15,19	21,27	20,26	1,5,14,16,17,22,30		15,16,22
Tropical Cyclone	8,10,11.20,26	3,11,15	11,21,27	10,11,20,26	1,5,11,14,16,17,22,30	11,13	11,15,16,22
Tsunami	8,10,11,20,26	3,13,15,19	21,27	20,26	1,5,14,16,22	4,13	15,16,22
Volcanic Eruption	8,20,26	3,9,15,19	21,27	9,20,26	1,5,14,16,22,28,30		15,16,22
Wildfire	8,20,26	3,15,19,24	21,27	20,26	1,5,14,16,22,30		15,16,22

Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

23.6 ACTION PLAN IMPLEMENTATION

The action plan presents a range of action items for reducing loss from hazard events. The County has prioritized actions and can begin to implement the highest-priority actions over the next five years. The effectiveness of the hazard mitigation plan depends on its effective implementation and incorporation of the outlined action items into existing County plans, policies, and programs. Some action items do not need to be implemented through regulation but can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. Hawaii County Civil Defense will have lead responsibility for overseeing the plan implementation and maintenance strategy.

23.7 INTEGRATION INTO OTHER PLANNING MECHANISMS

Integrating relevant information from this hazard mitigation plan into other plans and programs where opportunities arise will be the ongoing responsibility of the County. By adopting a general plan and zoning ordinances, the County has planned for the impact of natural hazards, and these documents are integral parts of this hazard mitigation plan. The hazard mitigation planning process provided an opportunity to review and expand on policies contained within these documents, based on the best science and technology available at the time this plan was prepared. The County should use its general plan and the hazard mitigation plan as complementary documents to achieve the ultimate goal of reducing risk exposure to citizens of the planning area. A comprehensive update to a general plan may trigger an update to the hazard mitigation plan.

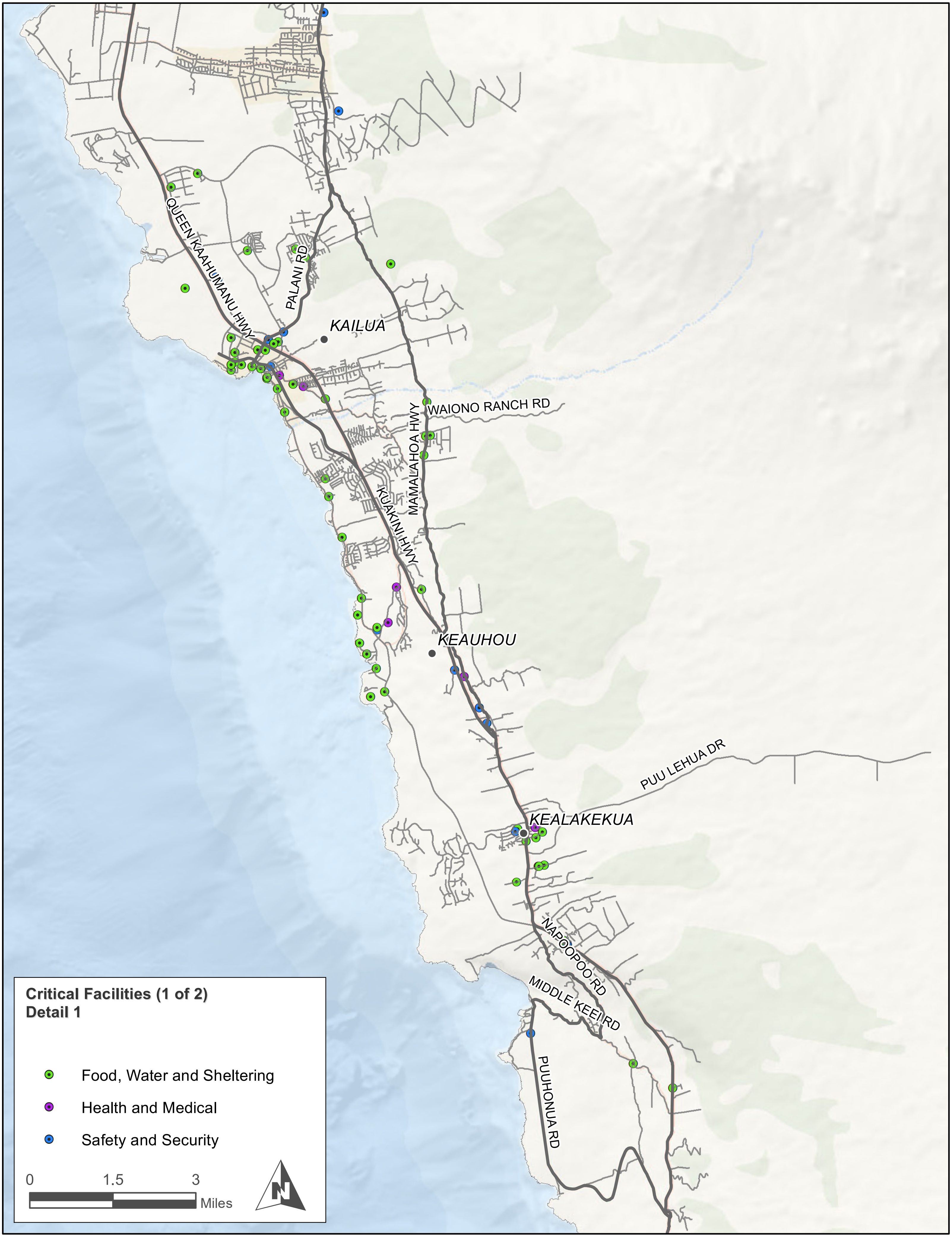
The County has committed to creating a linkage between the hazard mitigation plan and its general plan and similar plans identified in the core capability assessment. The action plan includes a high-priority mitigation action to create such a linkage.

Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan may include the following:

- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments.
- Climate action/adaptation plans
- Debris Management plans
- Post disaster action/Recovery plans

County of Hawai‘i Multi-Hazard Mitigation Plan

Appendix B. Detail Area Maps



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MAMALAHOA HWY
KUAKINI HWY
PUU LEHUA DR
NAPOOPOO RD
MIDDLE KEEI RD
PUUHONUA RD
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Health and Medical
Safety and Security
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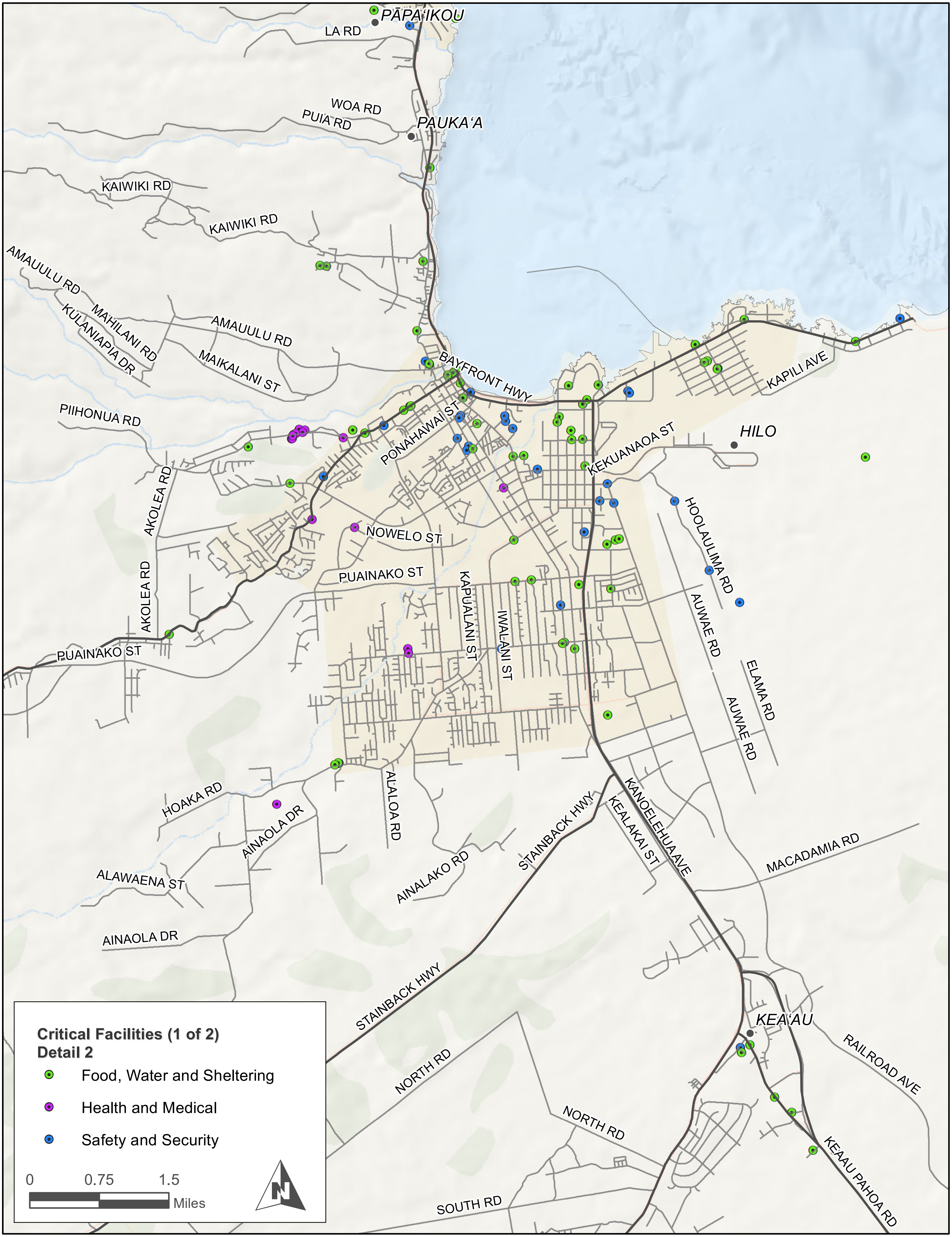
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PUIA RD
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AMAUULU RD
MAIKALANI ST
PIIHONUA RD
BAYFRONT HWY
KAPILI AVE
PONAHAWAI ST
HILO
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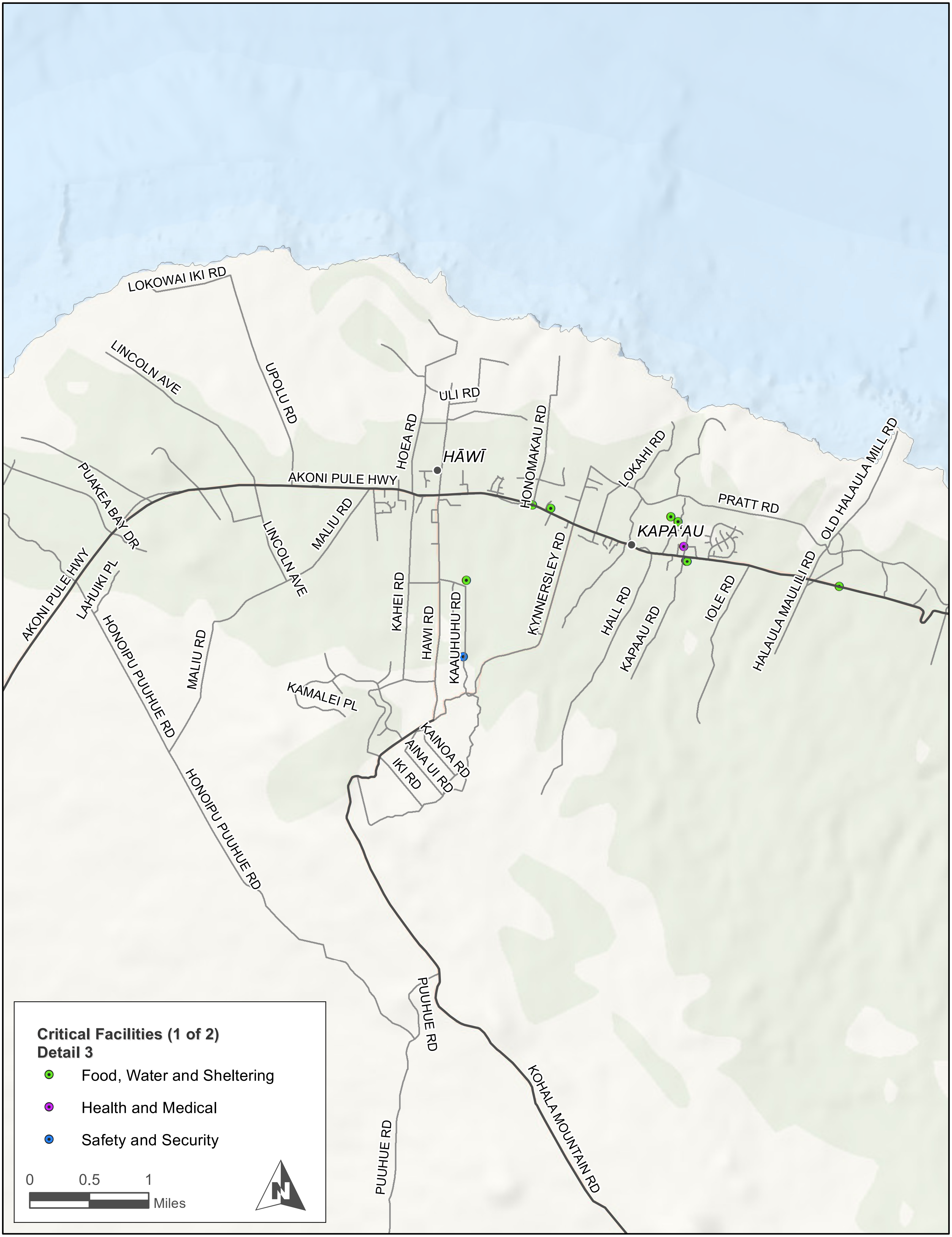
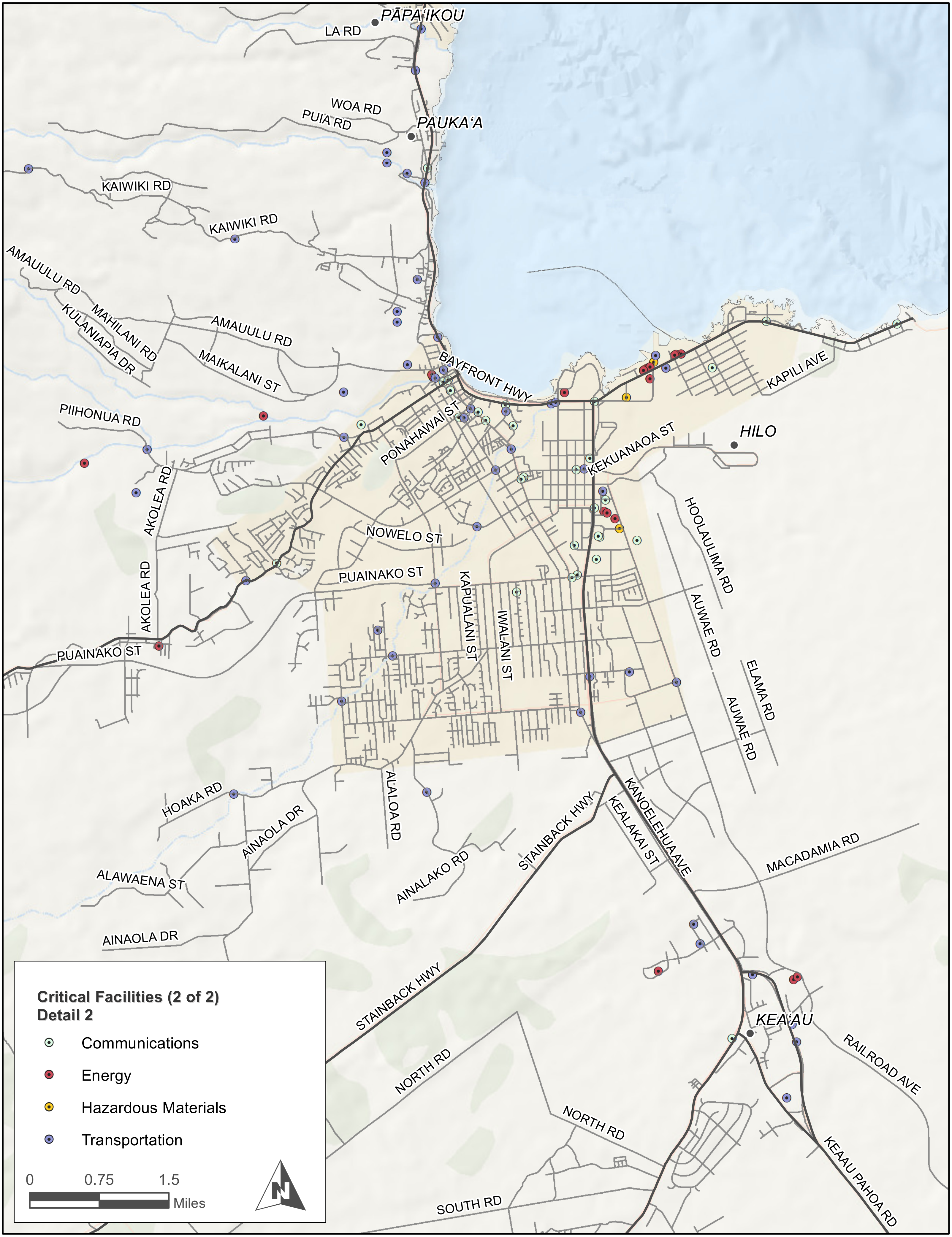
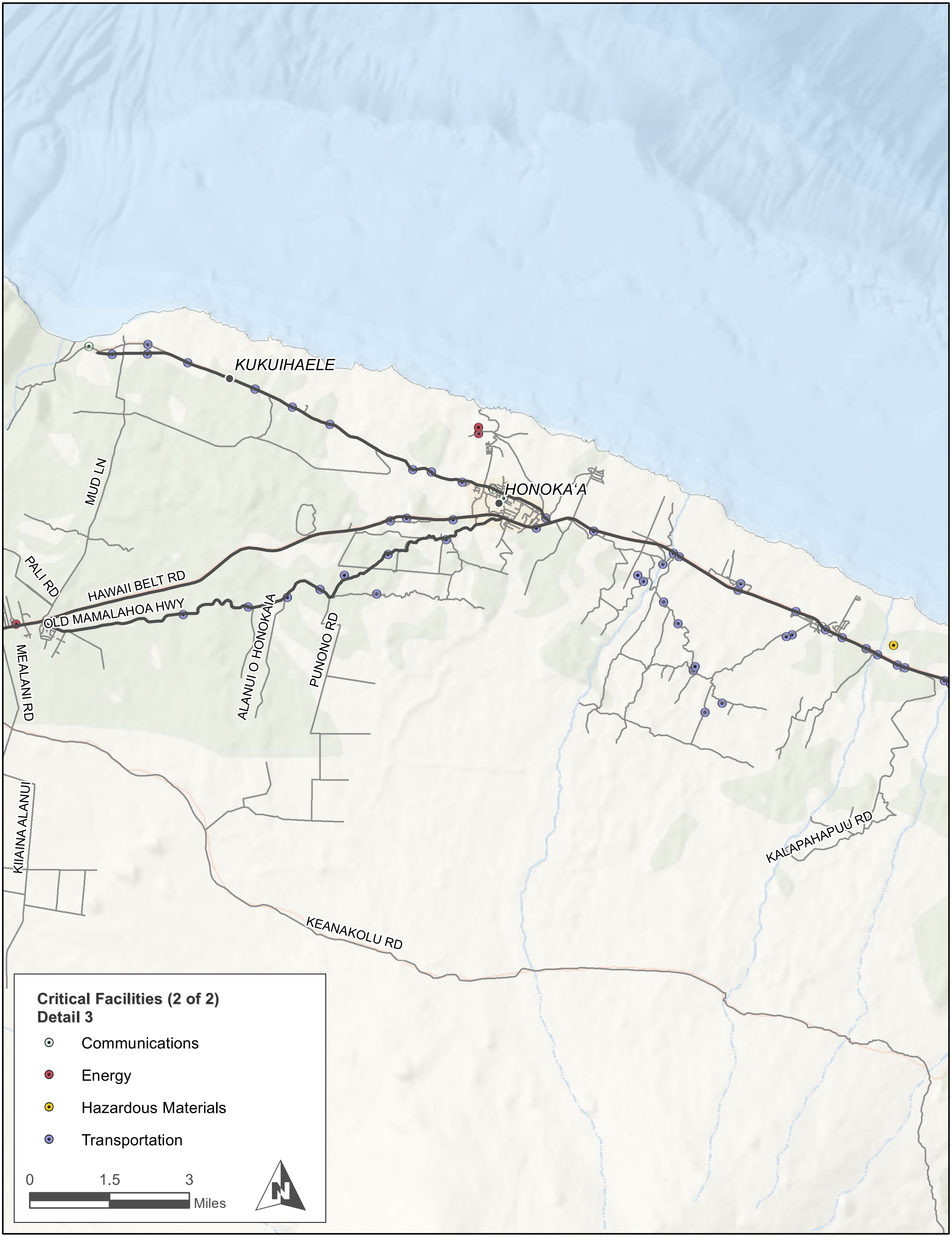
AKOLEA RD
NOWELO ST
HOOLAULIMA RD
PUAINAKO ST
KAPUALANI ST
IWALANI ST
AUWAE RD
AKOLEA RD
PUAINAKO ST
ELAMA RD
AUWAE RD
ALALOA RD
KANOELEHUA AVE
HOAKA RD
STAINBACK HWY
KEALAKAI ST
AINAOLA DR
MACADAMIA RD
AINALAKO RD
ALAWAENA ST
AINAOLA DR
STAINBACK HWY
KEAʻAU
RAILROAD AVE
NORTH RD
NORTH RD
KEAAU PAHOA RD
SOUTH RD
Critical Facilities (1 of 2)
Detail 2
Food, Water and Sheltering
Health and Medical
Safety and Security
0
0.75
1.5
Miles
N

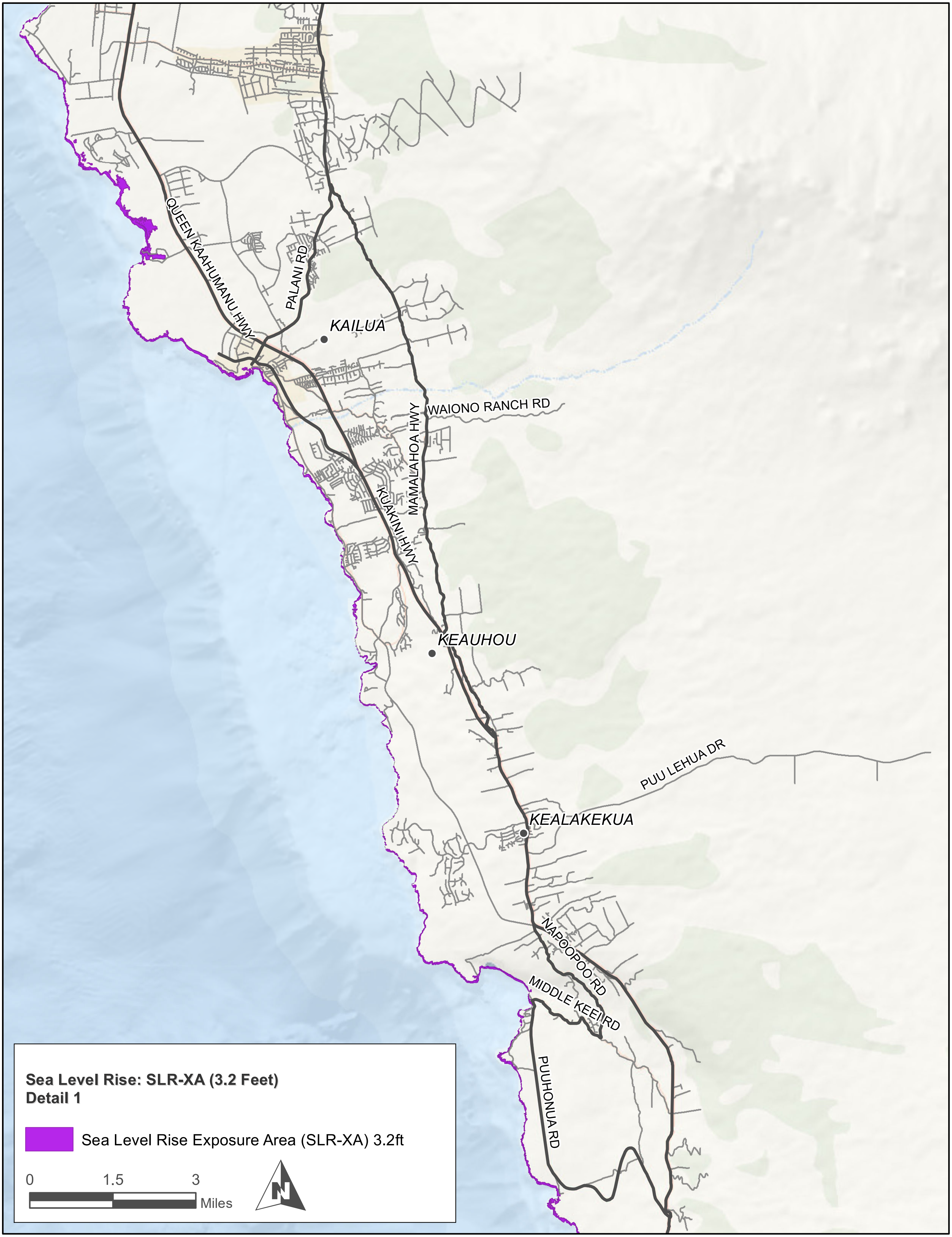


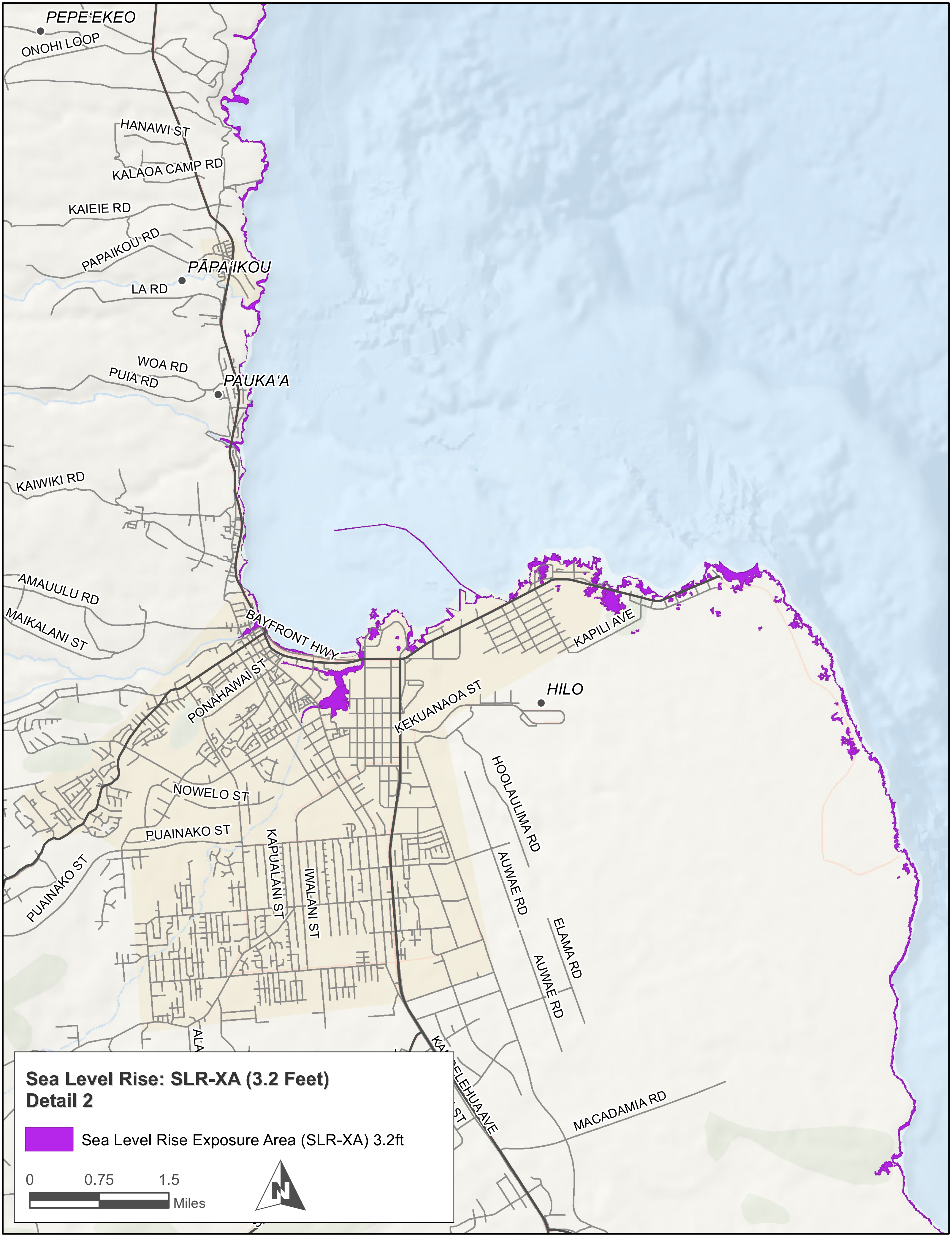
LOKOWAI IKI RD
LINCOLN AVE
UPOLU RD
ULI RD
HOEA RD
HĀWĪ
HONOMAKAU RD
LOKAHI RD
OLD HALAULA MILL RD
PRATT RD
AKONI PULE HWY
PUAKEA BAY DR
LINCOLN AVE
MALIU RD
KAPAʻAU
KYNNERSLEY RD
HALL RD
KAPAAU RD
IOLE RD
HALAULA MAULILI RD
AKONI PULE HWY
LAHUIKI PL
HONOIPU PUUHUE RD
MALIU RD
KAHEI RD
HAWI RD
KAAUHUHU RD
KAMALEI PL
KAINOA RD
AINA UI RD
IKI RD
HONOIPU PUUHUE RD
PUUHUE RD
KOHALA MOUNTAIN RD
PUUHUE RD
Critical Facilities (1 of 2)
Detail 3
Food, Water and Sheltering
Health and Medical
Safety and Security
0
0.5
1
Miles
N

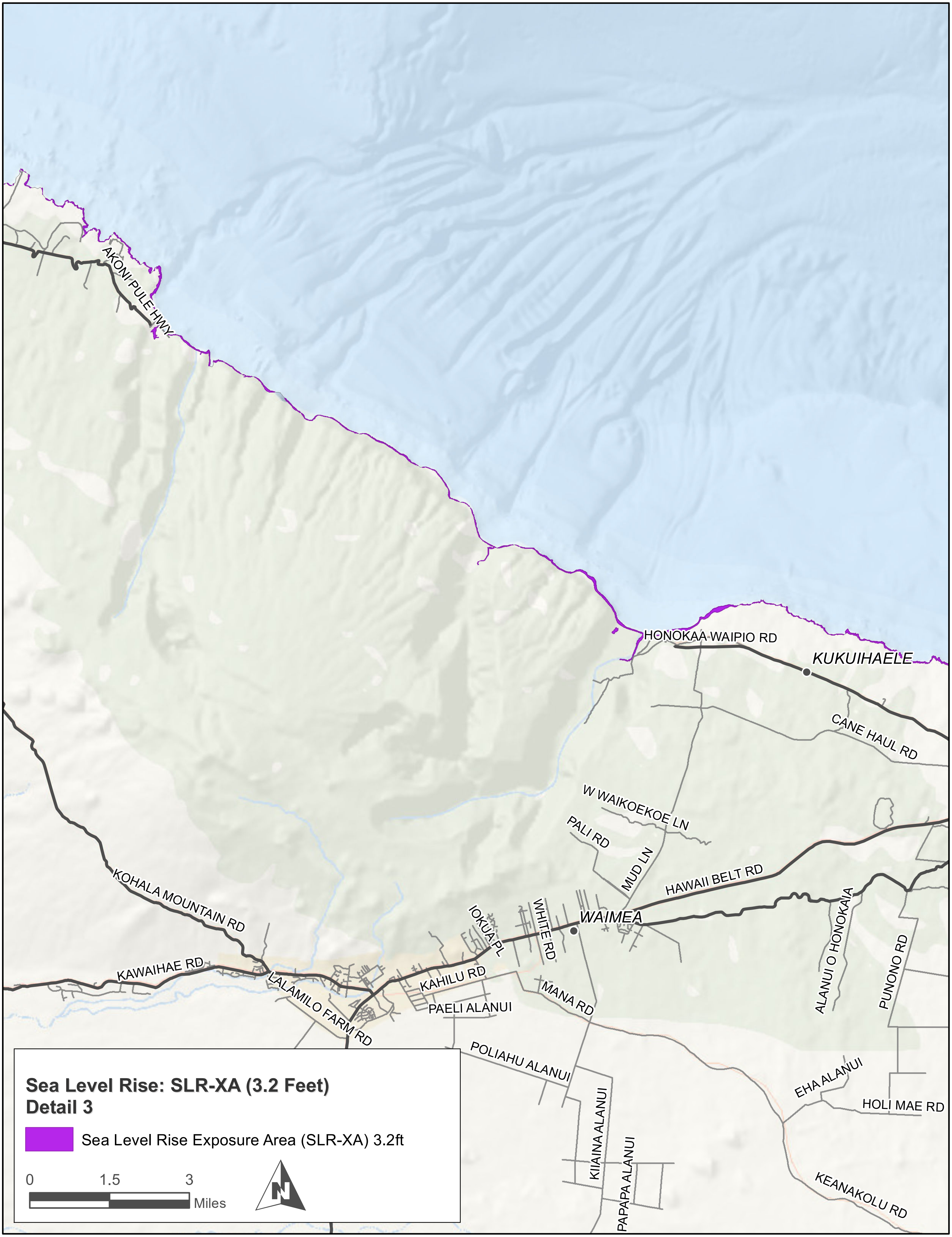
QUEEN KAAHUMANU HWY
PALANI RD
KAILUA
MAMALAHOA HWY
WAIONO RANCH RD
KUAKINI HWY
KEAUHOU
PUU LEHUA DR
KEALAKEKUA
NAPOOPOO RD
MIDDLE KEEI RD
PUUHONUA RD
Critical Facilities (2 of 2)
Detail 1
Communications
Energy
Hazardous Materials
Transportation
0
1.5
3
Miles
N

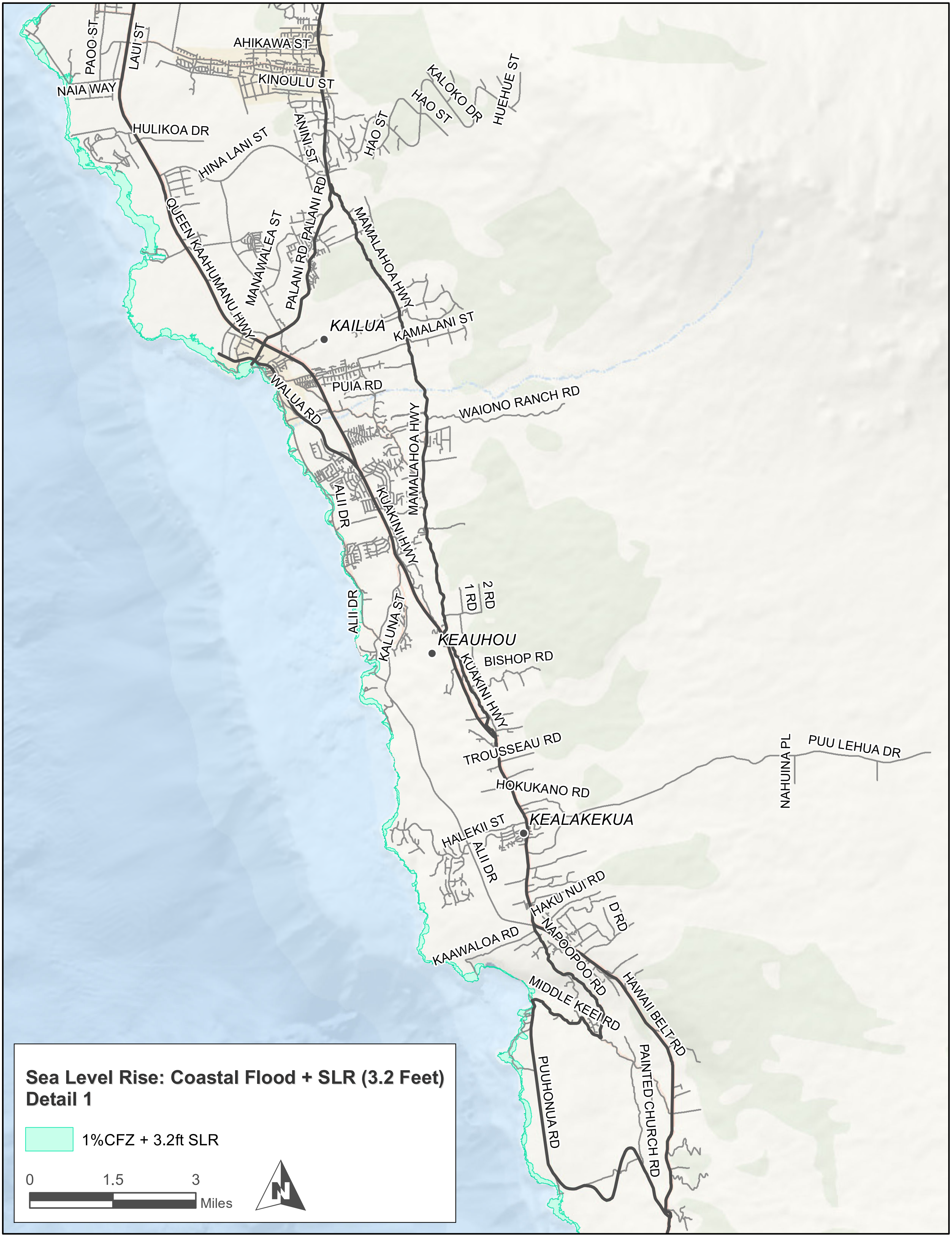

PĀPA'IKOU
LA RD
WOA RD
PUIA RD
PAUKA'A
KAIWIKI RD
KAIWIKI RD
AMAUULU RD
MAHILANI RD
KULANIAPIA DR
AMAUULU RD
MAIKALANI ST
BAYFRONT HWY
PIIHONUA RD
PONAHAWAI ST
KEKUANAOA ST
HILO
KAPILI AVE
AKOLEA RD
NOWELO ST
PUAINAKO ST
KAPUALANI ST
IWALANI ST
HOOLAULIMA RD
AUWAE RD
AKOLEA RD
PUAINAKO ST
ELAMA RD
AUWAE RD
ALALOA RD
HOAKA RD
AINAOLA DR
KANOELEHUA AVE
STAINBACK HWY
KEALAKAI ST
MACADAMIA RD
ALAWAENA ST
AINALAKO RD
AINAOLA DR
STAINBACK HWY
KEA'AU
RAILROAD AVE
NORTH RD
NORTH RD
KEAAU PAHOA RD
SOUTH RD
Critical Facilities (2 of 2)
Detail 2
Communications
Energy
Hazardous Materials
Transportation
0
0.75
1.5
Miles
N

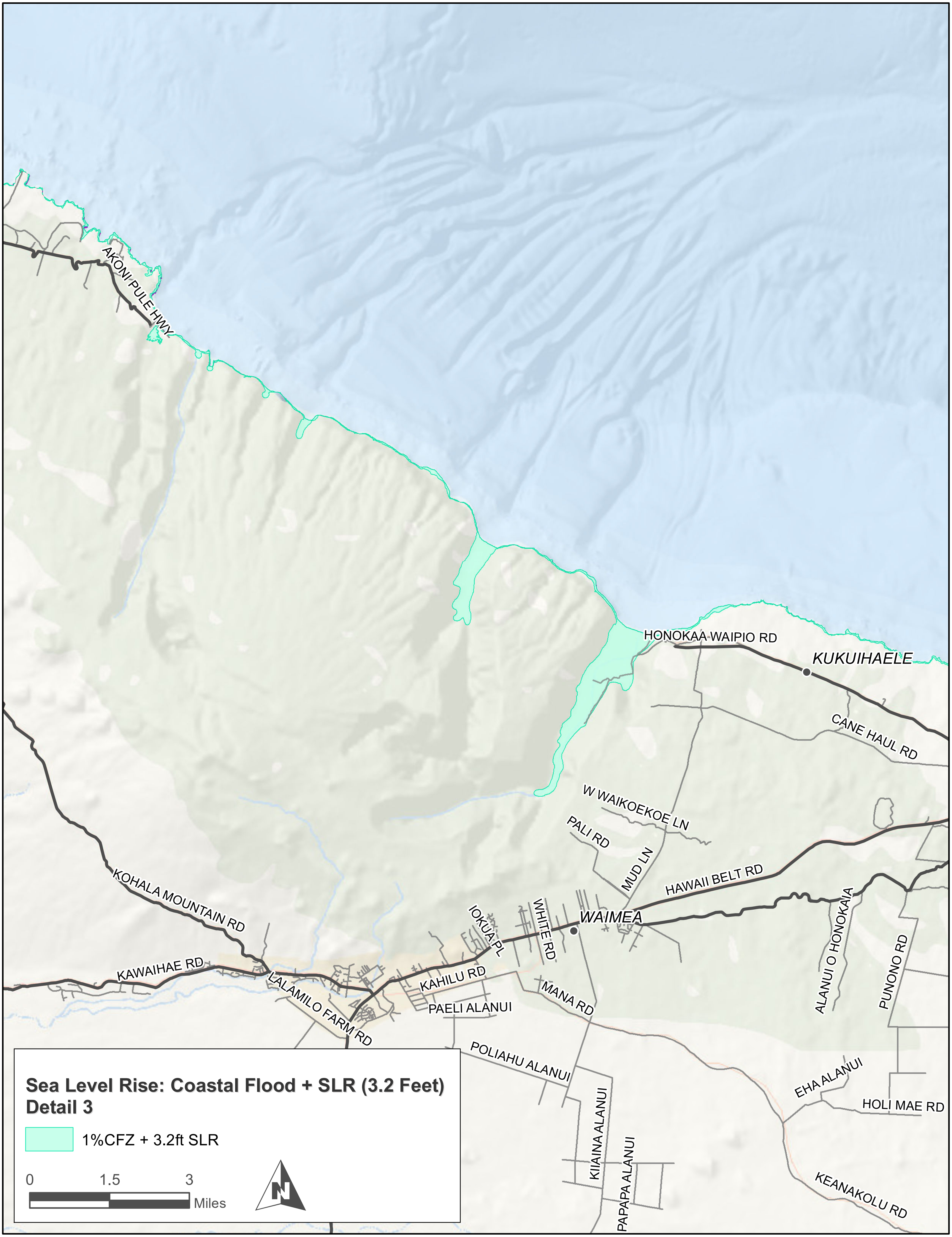

KUKUIHAELE
HONOKA'A
MUD LN
PALI RD
HAWAII BELT RD
OLD MAMALAHOA HWY
MEALANI RD
ALANUI O HONOKAIA
PUNONO RD
KIIAINA ALANUI
KALAPAHAPUU RD
KEANAKOLU RD
Critical Facilities (2 of 2)
Detail 3
Communications
Energy
Hazardous Materials
Transportation
0
1.5
3
Miles
N


KAILUA
KEAUHOU
KEALAKEKUA
QUEEN KAAHUMANU HWY
PALANI RD
WAIONO RANCH RD
MAMALAHOA HWY
KUAKINI HWY
PUU LEHUA DR
NAPOOPOO RD
MIDDLE KEEI RD
PUUHONUA RD
Sea Level Rise: SLR-XA (3.2 Feet)
Detail 1
Sea Level Rise Exposure Area (SLR-XA) 3.2ft
0
1.5
3
Miles
N

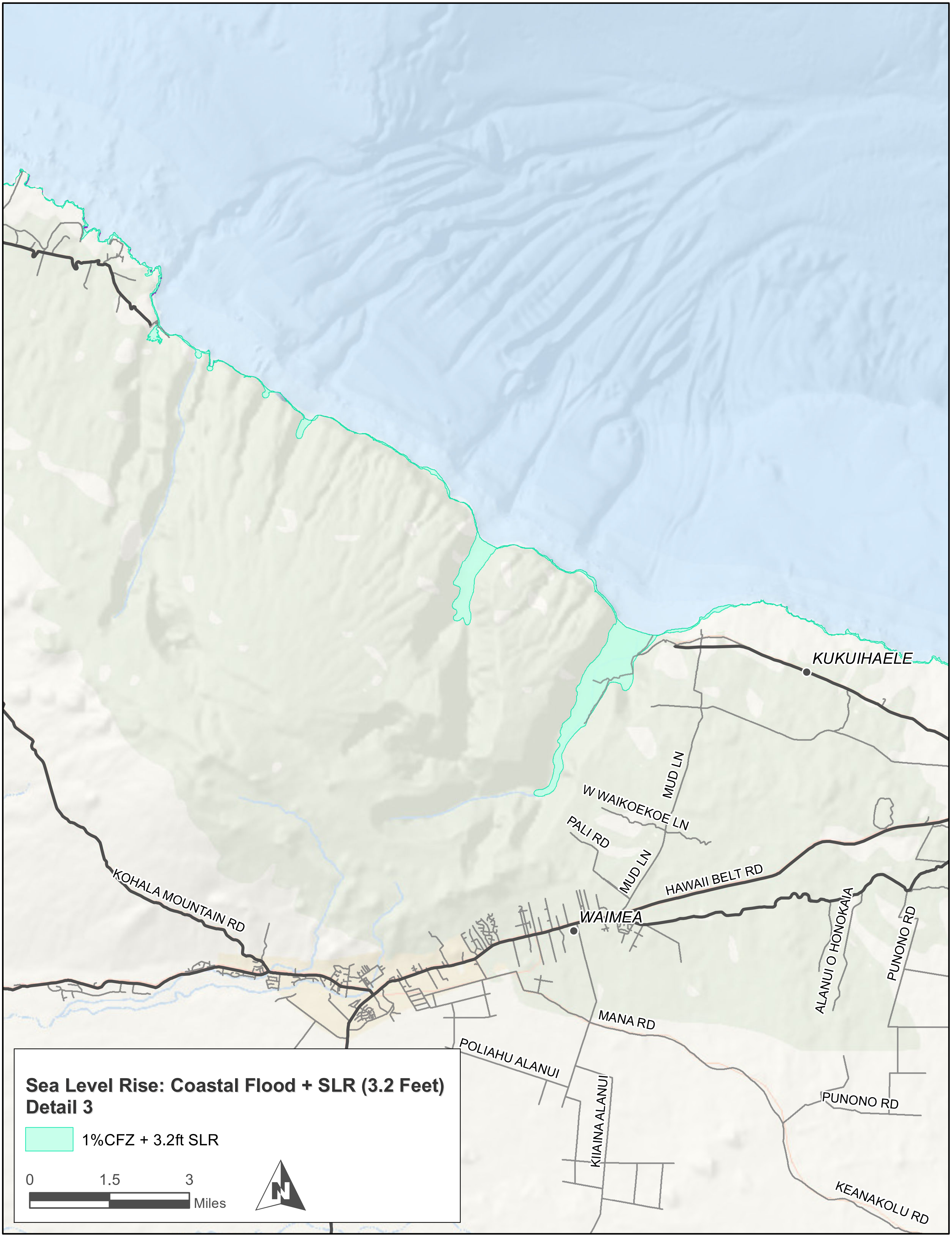

PEPEʻEKEO
ONOHI LOOP
HANAWI ST
KALAOA CAMP RD
KAIEIE RD
PAPAIKOU RD
PĀPAʻIKOU
LA RD
WOA RD
PUIA RD
PAUKAʻA
KAIWIKI RD
AMAUULU RD
MAIKALANI ST
BAYFRONT HWY
KAPILI AVE
PONAHAWAI ST
HILO
KEKUANAOA ST
HOOLAULIMA RD
NOWELO ST
PUAINAKO ST
KAPUALANI ST
IWALANI ST
AUWAE RD
ELAMA RD
MACADAMIA RD
Sea Level Rise: SLR-XA (3.2 Feet)
Detail 2
Sea Level Rise Exposure Area (SLR-XA) 3.2ft
0
0.75
1.5
Miles
N


AKONI PULE HWY
HONOKAA WAIPIO RD
KUKUIHAELE
CANE HAUL RD
W WAIKOEKOE LN
PALI RD
MUD LN
HAWAII BELT RD
KOHALA MOUNTAIN RD
IOKUA PL
WHITE RD
WAIMEA
ALANUI O HONOKAIA
PUNONO RD
KAWAIHAE RD
LALAMILO FARM RD
KAHILU RD
PAELI ALANUI
MANA RD
POLIAHU ALANUI
KIIAINA ALANUI
PAPAPA ALANUI
EHA ALANUI
HOLI MAE RD
KEANAKOLU RD
Sea Level Rise: SLR-XA (3.2 Feet)
Detail 3
Sea Level Rise Exposure Area (SLR-XA) 3.2ft
0
1.5
3
Miles
N

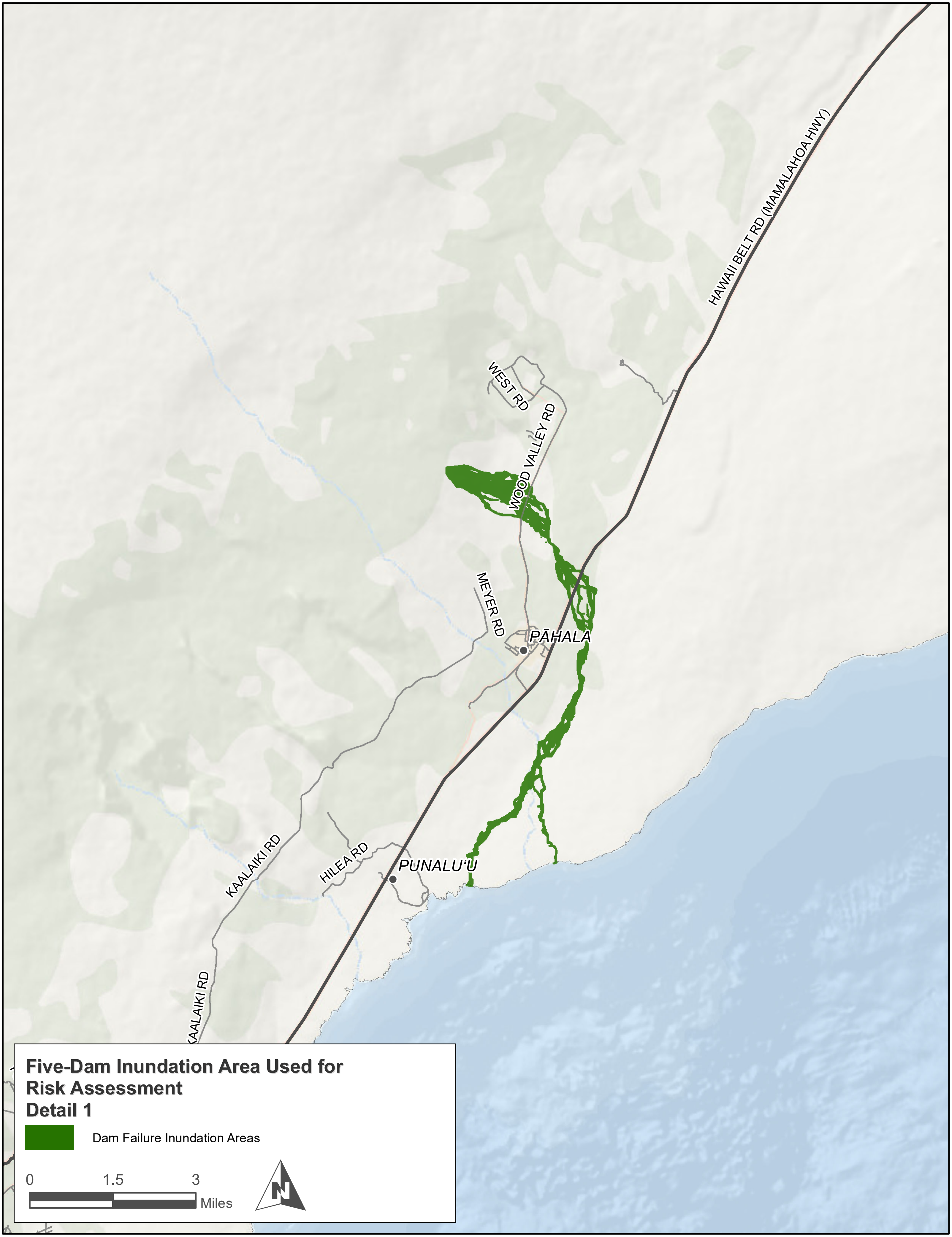

AHIKAWA ST
PAOO ST
LAUI ST
KINOULU ST
NAIA WAY
KALOKO DR
HUEHUE ST
HAO ST
HULIKOA DR
ANINI ST
HAO ST
HINA LANI ST
PALANI RD
QUEEN KAAHUMANU HWY
MAMALAHOA HWY
MANAWALEA ST
PALANI RD
KAILUA
KAMALANI ST
PUIA RD
WALUA RD
WAIONO RANCH RD
MAMALAHOA HWY
ALII DR
KUAKINI HWY
2 RD
1 RD
ALII DR
KALUNA ST
KEAUHOU
BISHOP RD
KUAKINI HWY
TROUSSEAU RD
PUU LEHUA DR
NAHUINA PL
HOKUKANO RD
KEALAKEKUA
HALEKII ST
ALII DR
HAKU NUI RD
D RD
NAPOOPOO RD
KAAWALOA RD
MIDDLE KEEI RD
HAWAII BELT RD
PAINTED CHURCH RD
PUUHONUA RD
Sea Level Rise: Coastal Flood + SLR (3.2 Feet)
Detail 1
1%CFZ + 3.2ft SLR
0
1.5
3
Miles
N

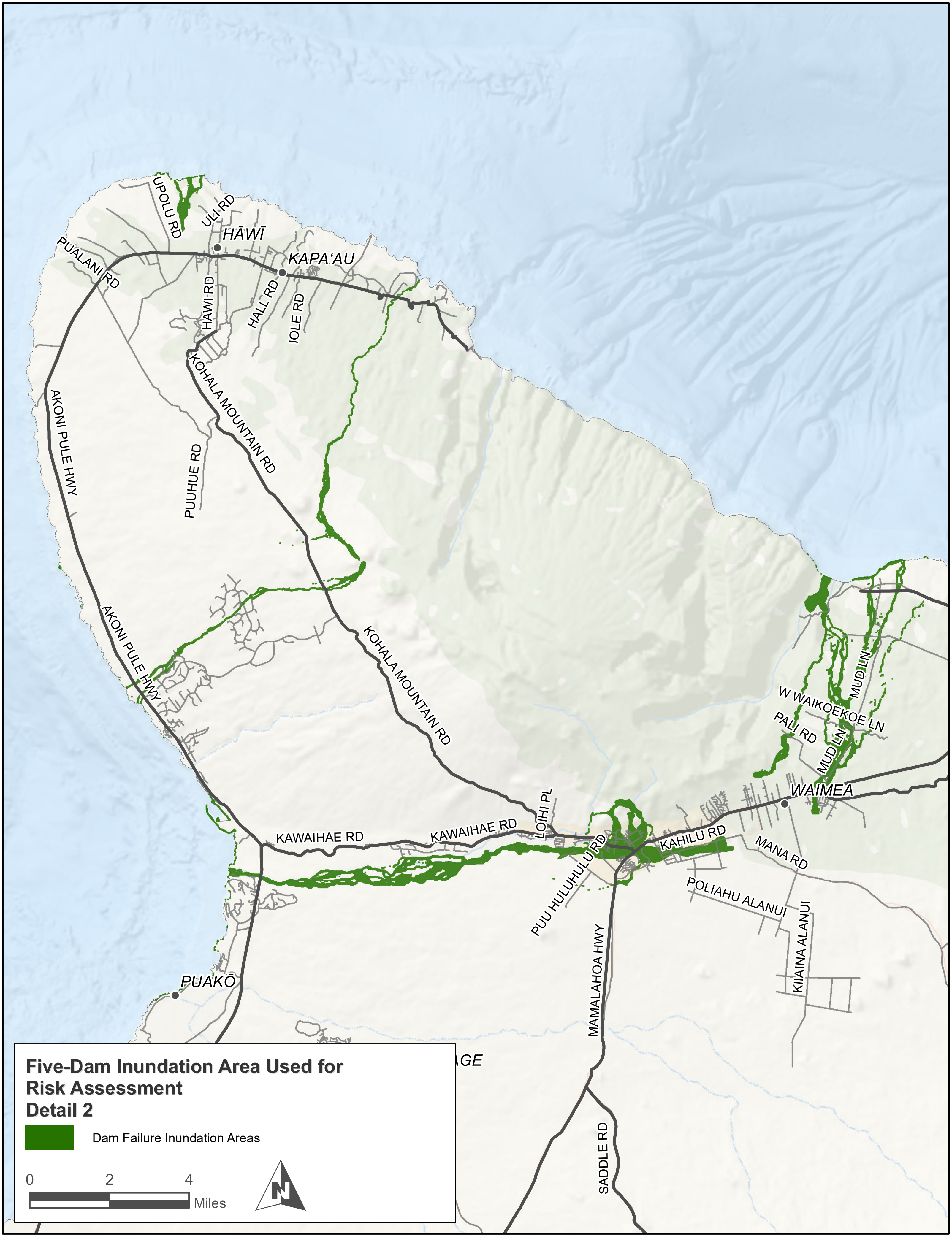


AKONI PULE HWY
HONOKAA WAIPIO RD
KUKUIHAELE
CANE HAUL RD
W WAIKOEKOE LN
PALI RD
MUD LN
HAWAII BELT RD
KOHALA MOUNTAIN RD
IOKUA PL
WHITE RD
WAIMEA
ALANUI O HONOKAIA
PUNONO RD
KAWAIHAE RD
LALAMILO FARM RD
KAHILU RD
PAELI ALANUI
MANA RD
POLIAHU ALANUI
EHA ALANUI
HOLI MAE RD
KIIAINA ALANUI
PAPAPA ALANUI
KEANAKOLU RD
Sea Level Rise: Coastal Flood + SLR (3.2 Feet)
Detail 3
1%CFZ + 3.2ft SLR
0
1.5
3
Miles
N


KUKUIHAELE
MUD LN
W WAIKOEKOE LN
PALI RD
MUD LN
HAWAII BELT RD
WAIMEA
KOHALA MOUNTAIN RD
ALANUI O HONOKAIA
PUNONO RD
MANA RD
POLIAHU ALANUI
KIIAINA ALANUI
PUNONO RD
KEANAKOLU RD
Sea Level Rise: Coastal Flood + SLR (3.2 Feet)
Detail 3
1%CFZ + 3.2ft SLR
0
1.5
3
Miles
N

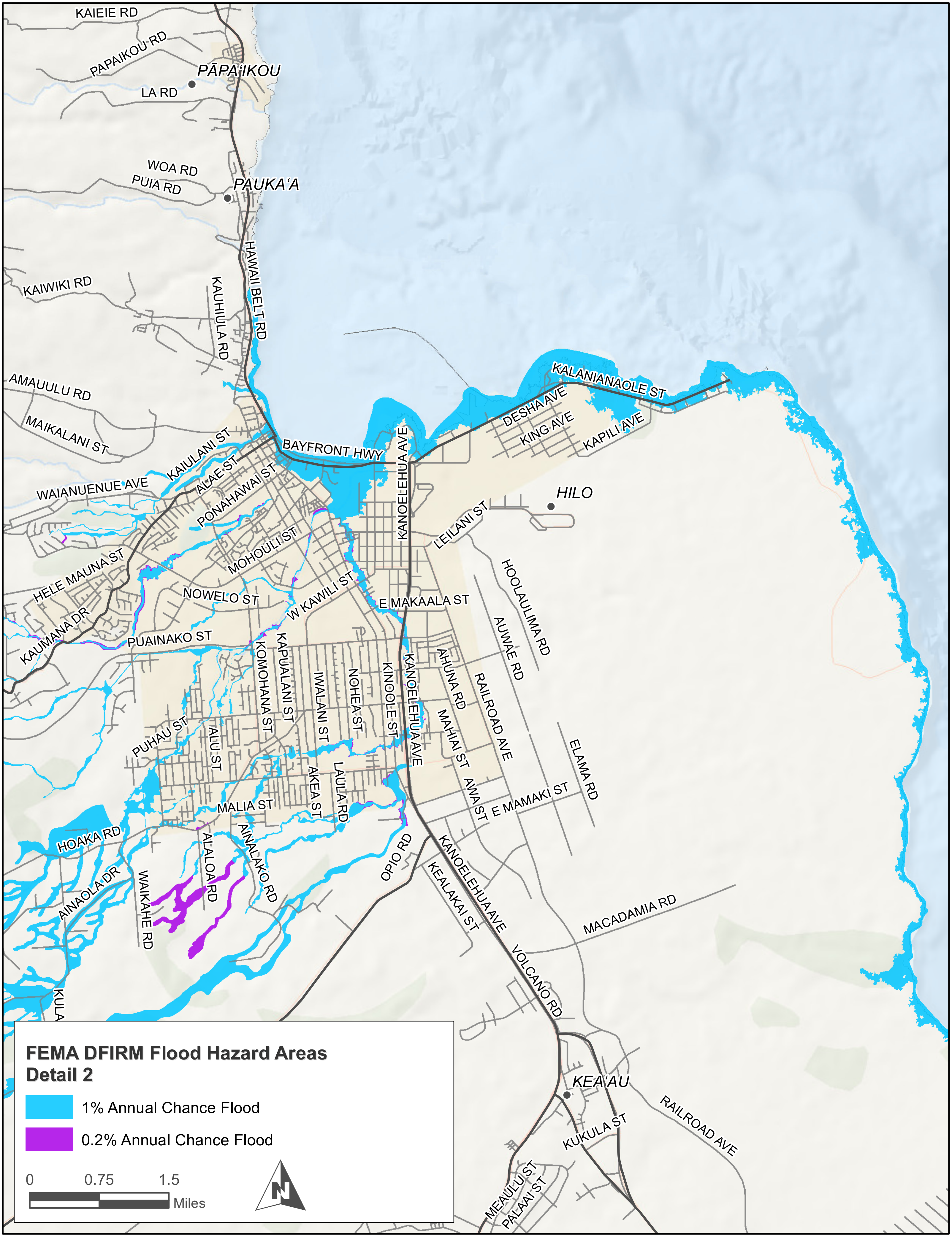
KUKUIHAELE
CANE HAUL RD
HONOKA'A
MUD LN
W WAIKOEKOE LN
PALI RD
MUD LN
HAWAII BELT RD
WAIMEA
ALANUI O HONOKAIA
PUNONO RD
MANA RD
POLIAHU ALANUI
KIIAINA ALANUI
MAMALAHOA HWY
PUNONO RD
KEANAKOLU RD
NA ALANUI
Locations of Dams in Hawaii County
Detail 1
High Hazard Potential
Significant Hazard Potential
Low Hazard Potential
0
2
4
Miles
N


Five-Dam Inundation Area Used for Risk Assessment
Detail 1
Dam Failure Inundation Areas
0
1.5
3
Miles
N
HAWAII BELT RD (MAMALAHOA HWY)
WEST RD
WOOD VALLEY RD
MEYER RD
PĀHALA
KAALAIKI RD
HILEA RD
PUNALU'U
KAALAIKI RD

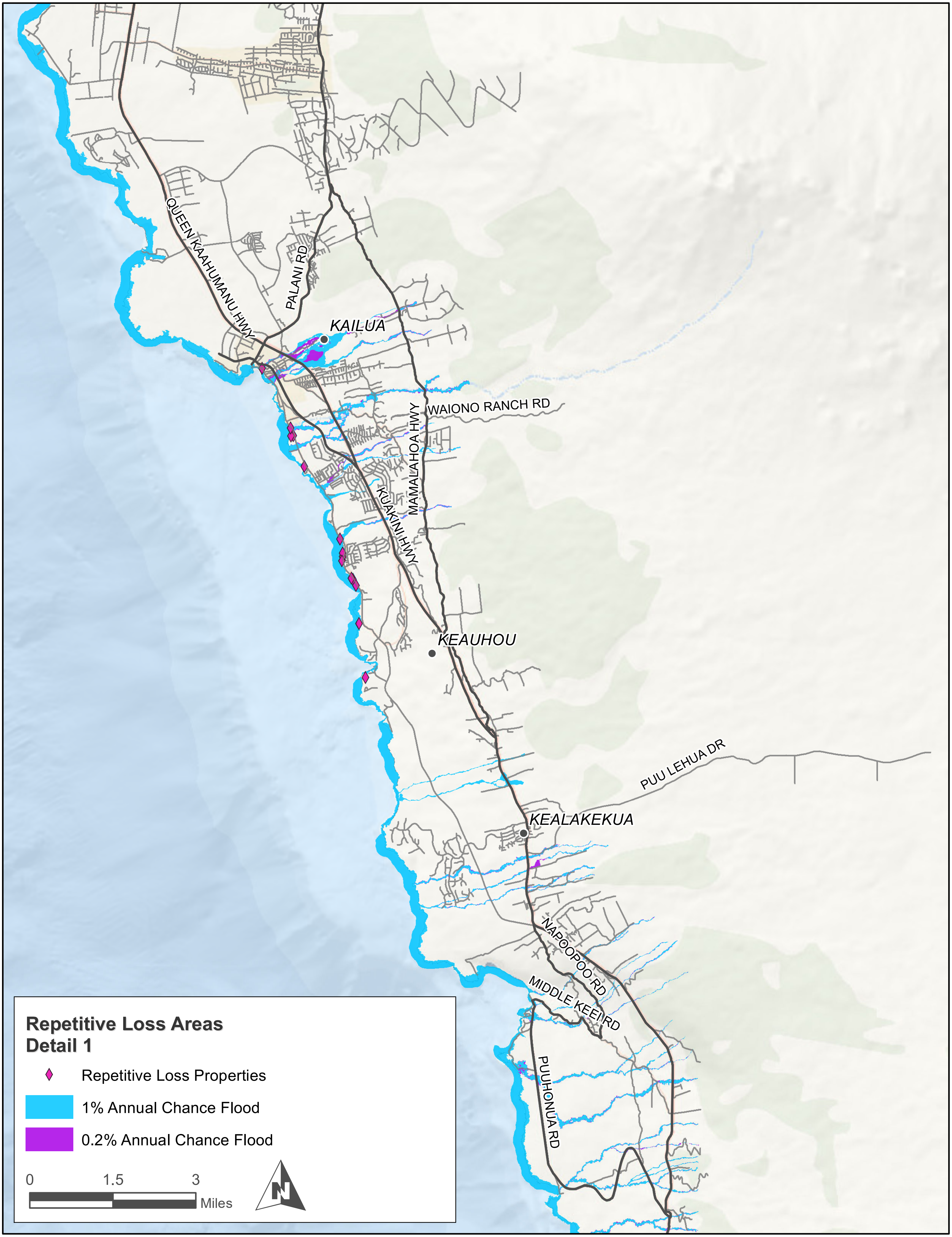


Five-Dam Inundation Area Used for Risk Assessment Detail 2

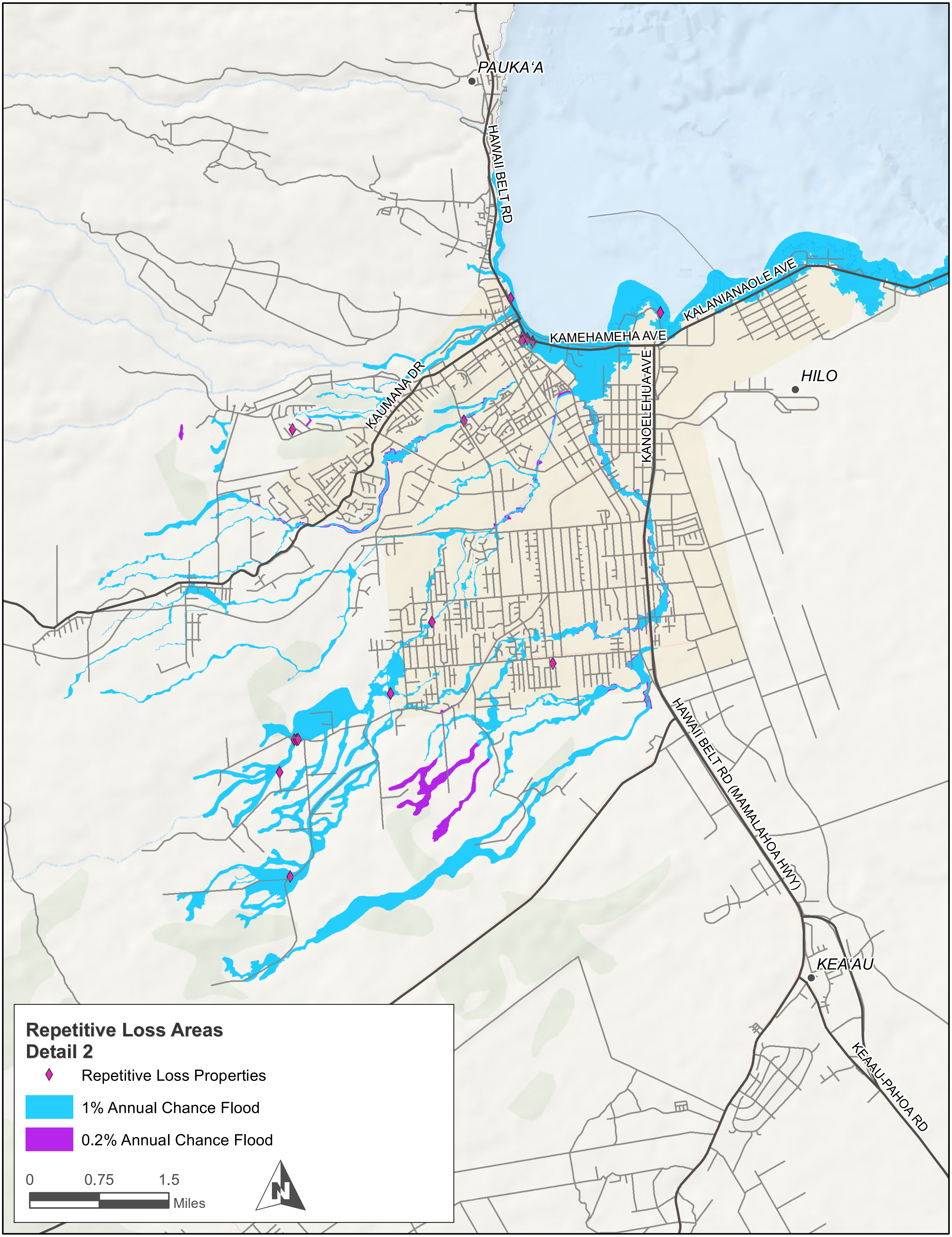
QUEEN KAAHUMANU HWY
PALANI RD
KAILUA
WAIONO RANCH RD
MAMALAHOA HWY
KUAKINI HWY
KEAUHOU
PUU LEHUA DR
KEALAKEKUA
NAPOOPOO RD
MIDDLE KEEI RD
PUUHONUA RD
FEMA DFIRM Flood Hazard Areas
Detail 1
1% Annual Chance Flood
0.2% Annual Chance Flood
0
1.5
3
Miles
N


FEMA DFIRM Flood Hazard Areas
Detail 2
1% Annual Chance Flood
0.2% Annual Chance Flood
0
0.75
1.5
Miles
N
KAIEIE RD
PAPAIKOU RD
PĀPAʻIKOU
LA RD
WOA RD
PUIA RD
PAUKAʻA
HAWAII BELT RD
KAUHIULA RD
KAIWIKI RD
AMAUULU RD
MAIKALANI ST
KAIULANI ST
ALAE ST
WAIANUENUE AVE
PONAHAWAI ST
BAYFRONT HWY
KANOELEHUA AVE
KALANIANAOLE ST
DESHA AVE
KING AVE
KAPILI AVE
HILO
LEILANI ST
MOHOULI ST
HELE MAUNA ST
NOWELO ST
W KAWILI ST
E MAKAALA ST
KAUMANA DR
PUAINAKO ST
HOOLAULIMA RD
AUWAE RD
KAPUALANI ST
KOMOHANA ST
IWALANI ST
NOHEA ST
KINOOLE ST
AHUNA RD
RAILROAD AVE
MAHIAI ST
PUHAU ST
ALU ST
AKEA ST
LAULA RD
AWA ST
E MAMAKI ST
ELAMA RD
MALIA ST
HOAKA RD
ALALOA RD
AINALAKO RD
OPIO RD
KEALAKAI ST
AINAOLA DR
WAIKAHE RD
MACADAMIA RD
VOLCANO RD
KULA
KEAʻAU
KUKULA ST
RAILROAD AVE
MEʻAULU ST
PALAAI ST


FEMA DFIRM Flood Hazard Areas
Detail 3
1% Annual Chance Flood
0.2% Annual Chance Flood
0
1.5
3
Miles
N
AKONI PULE HWY
HONOKAA WAIPIO RD
KUKUIHAELE
CANE HAUL RD
W WAIKOEKOE LN
PALI RD
MUD LN
HAWAII BELT RD
KOHALA MOUNTAIN RD
IOKUA PL
WHITE RD
WAIMEA
KAWAIHAE RD
LALAMILO FARM RD
KAHILU RD
PAELI ALANUI
MANA RD
ALANUI O HONOKAIA
PUNONO RD
POLIAHU ALANUI
ALAHOA HWY
EHA ALANUI
HOLI MAE RD
KIIAINA ALANUI
PAPAPA ALANUI
KEMOLE ALANUI
KEANAKOLU RD

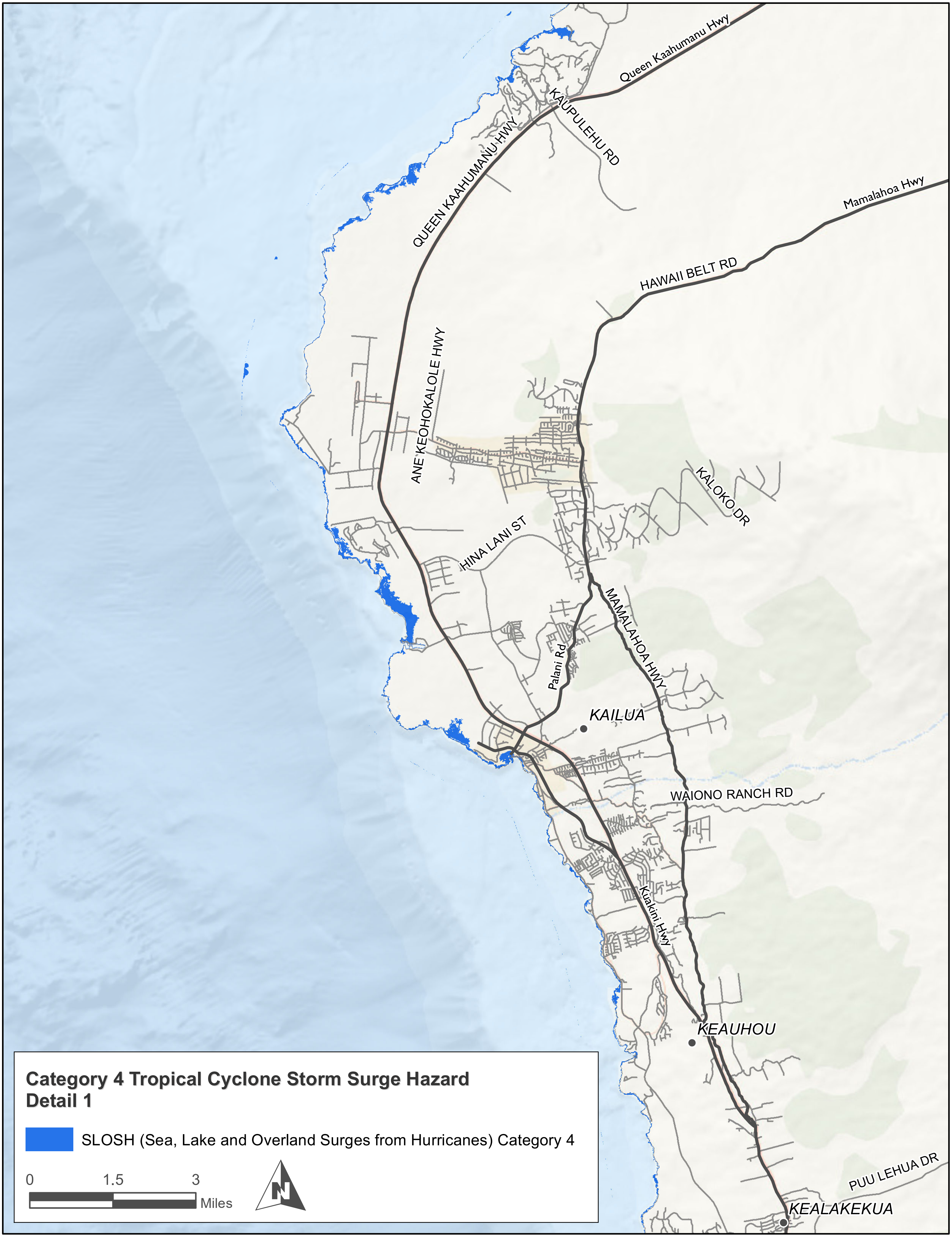


KAILUA
KEAUHOU
KEALAKEKUA
QUEEN KAAHUMANU HWY
PALANI RD
WAIONO RANCH RD
MAMALAHOA HWY
KUAKINI HWY
PUU LEHUA DR
NAPOOPOO RD
MIDDLE KEEI RD
PUUHONUA RD
Repetitive Loss Areas
Detail 1
Repetitive Loss Properties
1% Annual Chance Flood
0.2% Annual Chance Flood
0
1.5
3
Miles
N

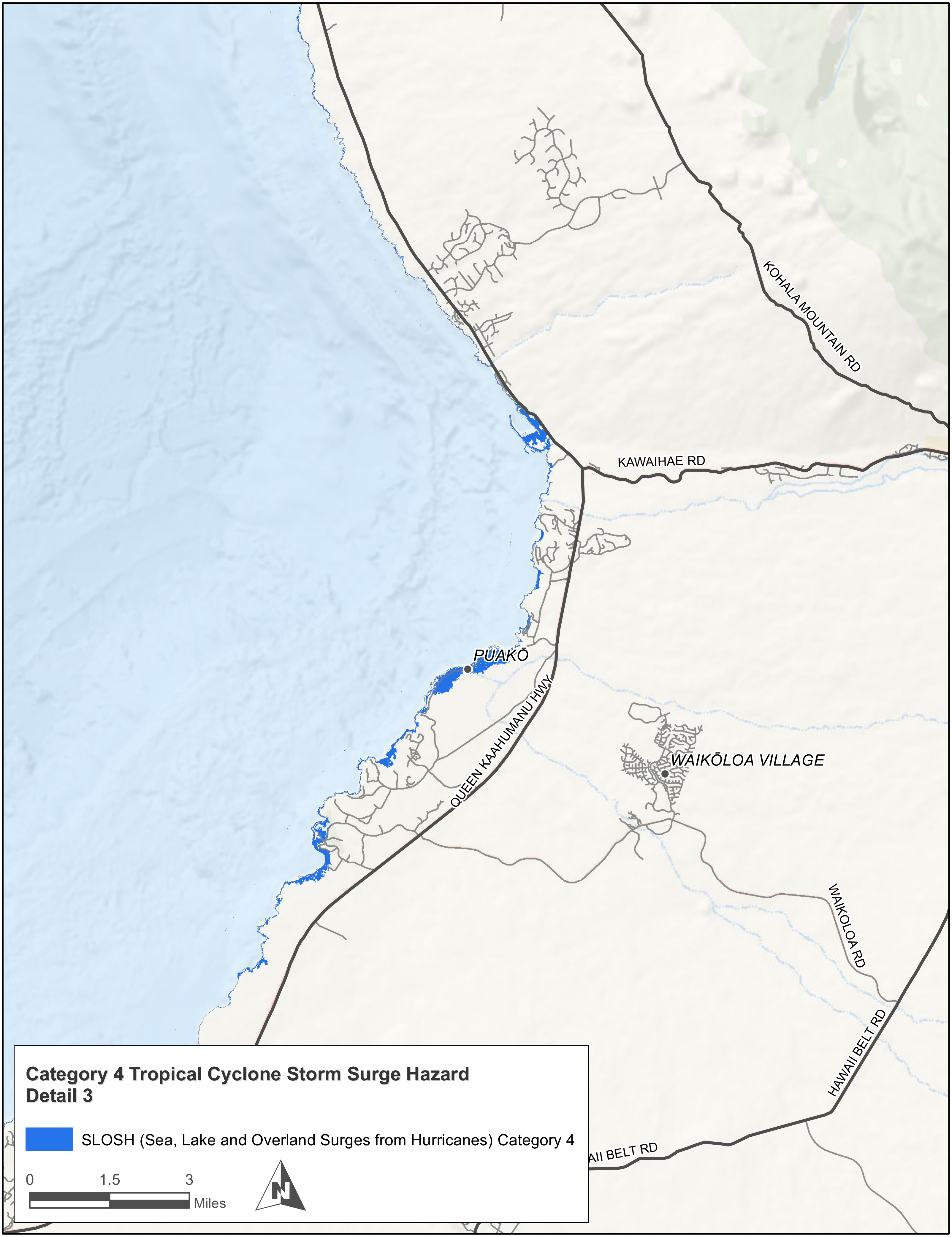


PAUKA'A
HAWAII BELT RD
KALANIANAOLE AVE
KAMEHAMEHA AVE
HILO
KAUMANA DR
KANOELEHUA AVE
HAWAII BELT RD (MAMALAHOA HWY)
KEA'AU
KEAAU-PAHOA RD
Repetitive Loss Areas
Detail 2
Repetitive Loss Properties
1% Annual Chance Flood
0.2% Annual Chance Flood
0
0.75
1.5
Miles
N


AKONI PULE HWY
HONOKAA-WAIPIO RD
KUKUIHAELE
CANE HAUL RD
W WAIKOEKOE LN
PALI RD
MUD LN
HAWAII BELT RD
KOHALA MOUNTAIN RD
IOKUA PL
WHITE RD
WAIMEA
ALANUI O HONOKAIA
PUNONO RD
KAWAIHAE RD
LALAMILO FARM RD
KAHILU RD
PAELI ALANUI
MANA RD
POLIAHU ALANUI
MAMALAHOA HWY
EHA ALANUI
HOLI MAE RD
KIIAINA ALANUI
PAPAPA ALANUI
KEMOLE ALANUI
KEANAKOLU RD
FEMA DFIRM Flood Hazard Areas
Detail 3
1% Annual Chance Flood
Flood500YR
0
1.5
3
Miles
N

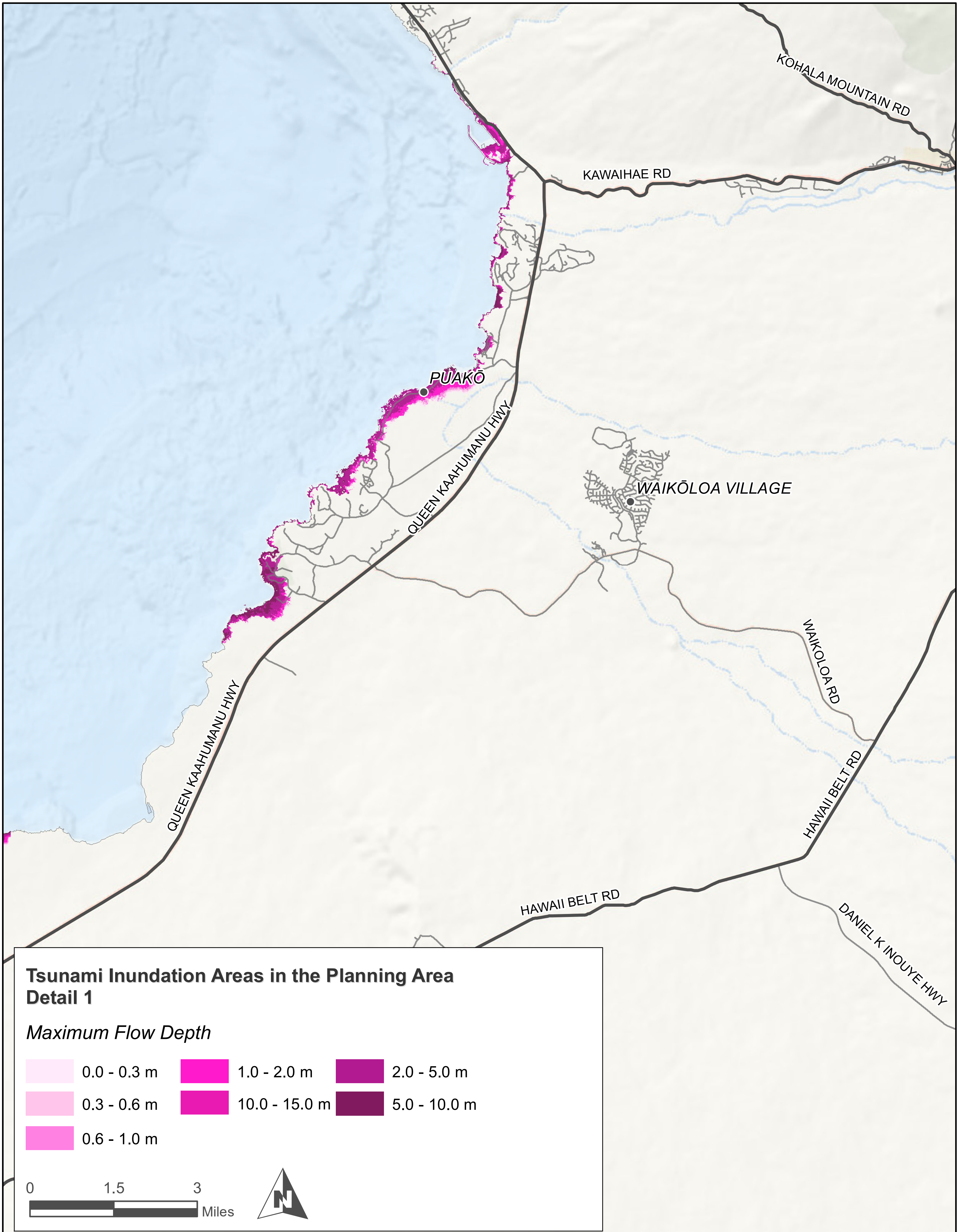

Queen Kaahumanu Hwy
KAUPULEHU RD
QUEEN KAAHUMANU HWY
Mamalahoa Hwy
HAWAII BELT RD
ANE KEOHOKALOLE HWY
KALOKO DR
HINA LANI ST
MAMALAHOA HWY
Palani Rd
KAILUA
WAIONO RANCH RD
Kuakini Hwy
KEAUHOU
PUU LEHUA DR
KEALAKEKUA
Category 4 Tropical Cyclone Storm Surge Hazard
Detail 1
SLOSH (Sea, Lake and Overland Surges from Hurricanes) Category 4
0
1.5
3
Miles
N

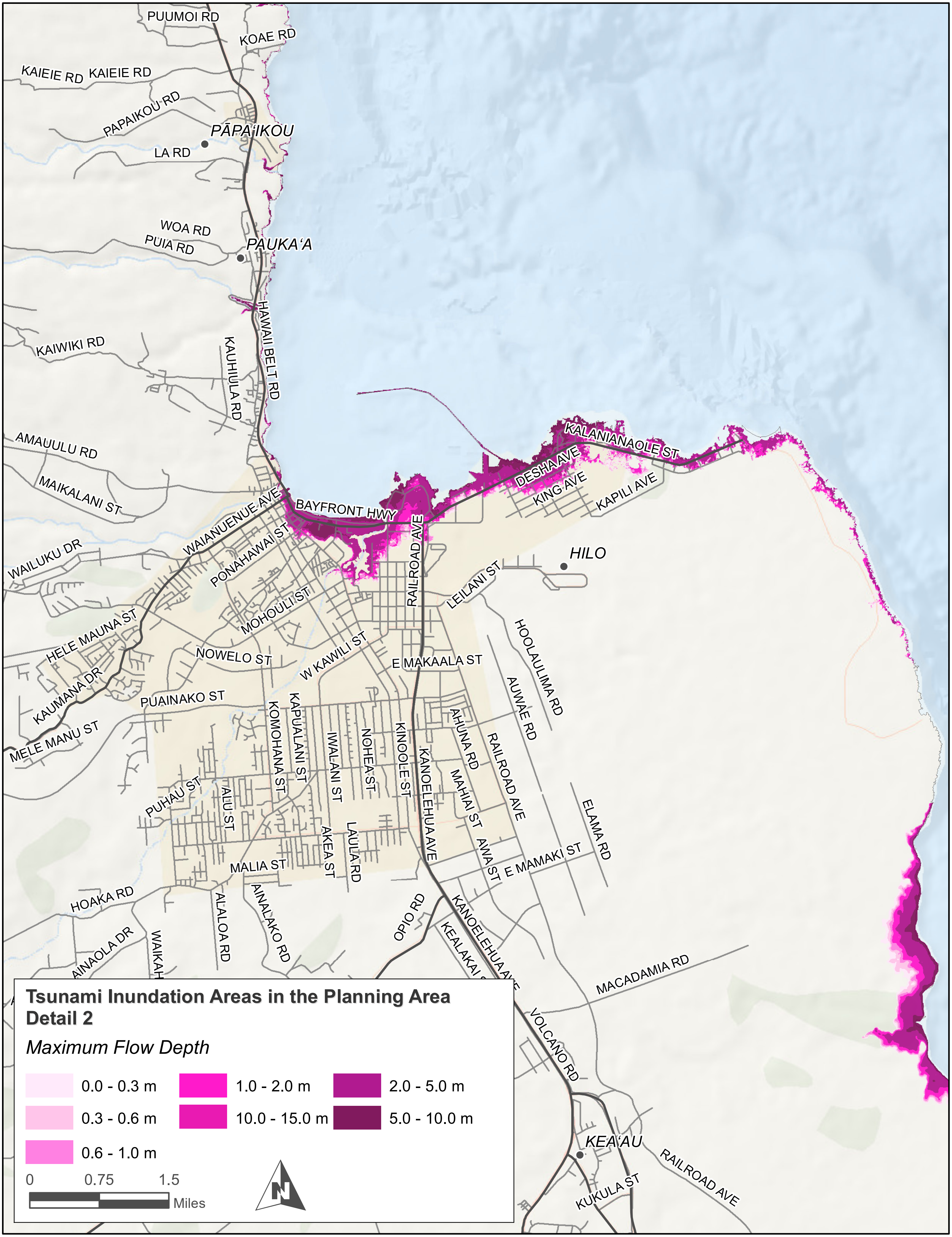
Category 4 Tropical Cyclone Storm Surge Hazard
Detail 2



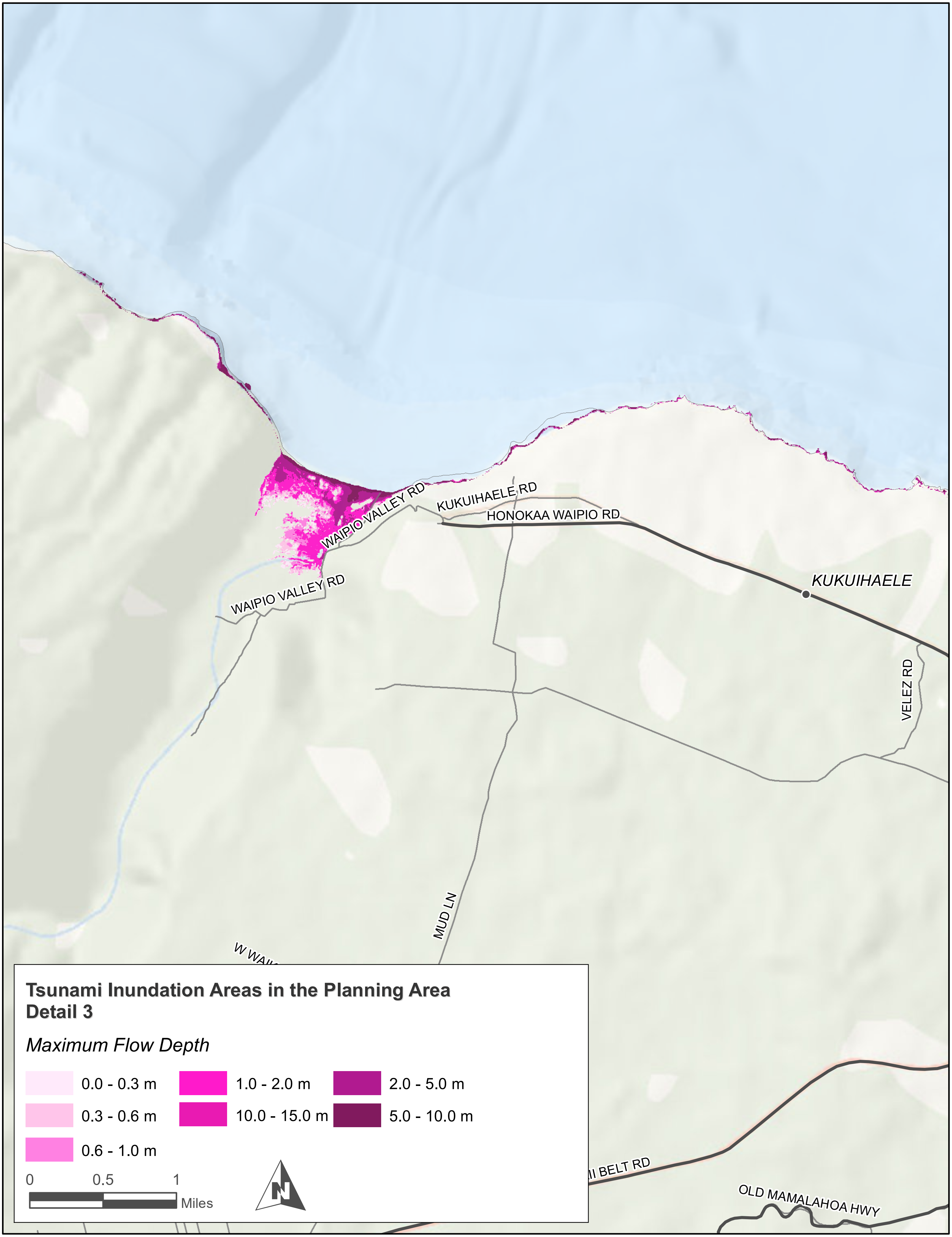
Category 4 Tropical Cyclone Storm Surge Hazard
Detail 3

SLOSH (Sea, Lake and Overland Surges from Hurricanes) Category 4


KOHALA MOUNTAIN RD
KAWAIHAE RD
PUAKŌ
QUEEN KAAHUMANU HWY
WAIKŌLOA VILLAGE
WAIKOLOA RD
QUEEN KAAHUMANU HWY
HAWAII BELT RD
HAWAII BELT RD
DANIEL K INOUYE HWY
Tsunami Inundation Areas in the Planning Area
Detail 1
Maximum Flow Depth
0.0 - 0.3 m
0.3 - 0.6 m
0.6 - 1.0 m
1.0 - 2.0 m
10.0 - 15.0 m
2.0 - 5.0 m
5.0 - 10.0 m
0
1.5
3
Miles
N



Tsunami Inundation Areas in the Planning Area
Detail 2
Maximum Flow Depth
0.0 - 0.3 m
0.3 - 0.6 m
0.6 - 1.0 m
1.0 - 2.0 m
10.0 - 15.0 m
2.0 - 5.0 m
5.0 - 10.0 m
0
0.75
1.5
Miles
N
PUUMOI RD
KOAE RD
KAIEIE RD
KAIEIE RD
PAPAIKOU RD
PĀPAʻIKOU
LA RD
WOA RD
PUIA RD
PAUKAʻA
HAWAII BELT RD
KAUHIULA RD
KAIWIKI RD
AMAUULU RD
MAIKALANI ST
WAIANUENUE AVE
BAYFRONT HWY
KALANIANAOLE ST
DESHA AVE
KING AVE
KAPILI AVE
HILO
WAILUKU DR
PONAHAWAI ST
RAILROAD AVE
LEILANI ST
MOHOULI ST
HELE MAUNA ST
NOWELO ST
W KAWILI ST
E MAKAALA ST
HOOLAULIMA RD
AUWAE RD
KAUMANA DR
PUAINAKO ST
MELE MANU ST
KOMOHANA ST
KAPUALANI ST
IWALANI ST
NOHEA ST
KINOOLE ST
KANOELEHUA AVE
AHUNA RD
RAILROAD AVE
MAHIAI ST
ELAMA RD
PUHAU ST
ALU ST
AKEA ST
LAULA RD
AWA ST
E MAMAKI ST
MALIA ST
HOAKA RD
ALALOA RD
AINALAKO RD
OPIO RD
KEALAKAI
KANOELEHUA AVE
AINAOLA DR
WAIKAH
MACADAMIA RD
VOLCANO RD
KEAʻAU
KUKULA ST
RAILROAD AVE



WAIPIO VALLEY RD
KUKUIHAELE RD
HONOKAA WAIPIO RD
WAIPIO VALLEY RD
KUKUIHAELE
VELEZ RD
MUD LN
OLD MAMALAHOA HWY
Tsunami Inundation Areas in the Planning Area
Detail 3
Maximum Flow Depth
0.0 - 0.3 m
0.3 - 0.6 m
0.6 - 1.0 m
1.0 - 2.0 m
10.0 - 15.0 m
2.0 - 5.0 m
5.0 - 10.0 m
0
0.5
1
Miles
N

County of Hawai‘i Multi-Hazard Mitigation Plan

Appendix C. Relevant Federal and State Agencies, Programs and Regulations

C. Relevant Federal and State Agencies, Programs and Regulations

Existing laws, ordinances, plans and programs at the federal and state level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used to review local capabilities to implement recommended mitigation actions in this plan.

FEDERAL

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have all necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or other visual alerts. Two technical documents for shelter operators address physical accessibility needs of people with disabilities, as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Bureau of Land Management

The U.S. Bureau of Land Management (BLM) funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands. BLM works closely with the Forest Service and state and local governments to coordinate fire safety activities. The Interagency Fire Coordination Center in Boise, Idaho serves as the center for this effort.

Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or nation origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation’s surface waters so that they can support “the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.”

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. Numerous issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

The CWA is important to hazard mitigation in several ways. There are often permitting requirements for any construction within 200 feet of water of the United States, which may have implications for mitigation projects identified by a local jurisdiction. Additionally, CWA requirements apply to wetlands, which serve important functions related to preserving and protecting the natural and beneficial functions of floodplains and are linked with a community’s floodplain management program. Finally, the National Pollutant Discharge Elimination System is part of the CWA and addresses local stormwater management programs. Stormwater management plays a critical role in hazard mitigation by addressing urban drainage or localized flooding issues within jurisdictions.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster
- Be a CDBG-eligible activity (according to regulations and waivers)

- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. CDBG-DR funding is a potential alternative source of funding for actions identified in this plan.

Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The discount partially depends on location of the property. Properties outside the special flood hazard area receive smaller discounts: a 10-percent discount if the community is at Class 1 to 6 and a 5-percent discount if the community is at Class 7 to 9. The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016). Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

Emergency Watershed Program

The USDA Natural Resources Conservation Service (NRCS) administers the Emergency Watershed Protection (EWP) Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. EWP is an emergency recovery program. Financial and technical assistance are available for the following activities (Natural Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- Endangered means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- Threatened means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- Critical habitat means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- Section 4: Listing of a Species—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.

- Section 7: Consultation—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- Section 9: Prohibition of Take—It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- Section 10: Permitted Take—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- Section 11: Citizen Lawsuits—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors seismic research and applies it in performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication Engineering Guidelines for the Evaluation of Hydropower Projects guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

Federal Wildfire Management Policy and Healthy Forests Restoration Act

Federal Wildfire Management Policy and Healthy Forests Restoration Act (2003). These documents call for a single comprehensive federal fire policy for the Interior and Agriculture Departments (the agencies using federal fire management resources). They mandate community-based collaboration to reduce risks from wildfire.

Hazard Mitigation Assistance Grant Programs

Hazard mitigation assistance grant programs to state and county agencies and qualifying nonprofits include the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation (PDM) grant program, and the Flood Mitigation Assistance (FMA) grant program, which funds mitigation of high loss insured properties through the National Flood Insurance Program. State and local mitigation strategies that qualify for funding are:

- Hazard mitigation planning
- Retrofit of critical facilities
- Acquisition, elevation, relocation or drainage improvements of repetitive flood loss structures
- Construction or upgrade of general population shelters
- Enhancement of development codes and standards
- Safe rooms and storm shelters
- Generators for critical facilities
- Warning systems

In Hawai‘i, the Hawai‘i Emergency Management Agency (HI-EMA) administers the hazard mitigation assistance grant programs. State and county agencies are eligible to apply for all three programs (HMGP, PDM and FMA). Certain private, non-profit organizations are eligible to apply for HMGP only. Individuals and businesses are not eligible to apply directly; however, an eligible applicant may apply on behalf of individuals or businesses

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Inspection Act in 1972, creation of the National Dam Safety Program in 1996, and reauthorization of the program through the Dam Safety Act in 2006. National Dam Safety Program, administered by FEMA requires a periodic engineering analysis of the majority of dams in the country; exceptions include the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission
- Dams constructed pursuant to licenses issued under the Federal Power Act
- Dams that the Secretary of the Army determines do not pose any threat to human life or property.

The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA’s leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States.

National Environmental Policy Act

The National Environmental Policy Act requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations.

The National Environmental Policy Act established the Council on Environmental Quality, whose regulations (40 CFR Parts 1500-1508) set standards for compliance. Consideration and decision-making regarding environmental impacts must be documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

National Fire Plan (2001)

The 2001 National Fire Plan was developed based on the National Fire Policy. A major aspect of the National Fire Plan is joint risk reduction planning and implementation carried out by federal, state and local agencies and communities. The National Fire Plan presented a comprehensive strategy in five key initiatives:

- Firefighting—Be adequately prepared to fight fires each fire season.
- Rehabilitation and Restoration—Restore landscapes and rebuild communities damaged by wildfires.
- Hazardous Fuel Reduction—Invest in projects to reduce fire risk.
- Community Assistance—Work directly with communities to ensure adequate protection.
- Accountability—Be accountable and establish adequate oversight, coordination, program development, and monitoring for performance.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities that enact floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act.

For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the 1-percent-annual-chance flood and the 0.2-percent-annual-chance flood. Base flood elevations and the boundaries of the flood hazard areas are shown on Flood Insurance Rate Maps, which are the principle tool for identifying the extent and location of the flood hazard. Flood Insurance Rate Maps are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under the local floodplain management program. In recent years, Flood Insurance Rate Maps have been digitized as Digital Flood Insurance Rate Maps, which are more accessible to residents, local governments and stakeholders.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 1-percent-annual-chance flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

In the State of Hawaiʻi, the Department of Land and Natural Resources (DLNR) is the coordinating agency for floodplain management. DLNR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, and participating in statewide flood hazard mitigation planning. Compliance is monitored by FEMA regional staff and by DLNR. Maintaining compliance under the NFIP is an important component of flood risk reduction.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In some cases, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency responder disciplines. These cases necessitate coordination across a spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, technological hazards, and human-caused hazards) regardless of size or complexity.

Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards. The content of this plan is considered to be a viable support tool for any phase of emergency management. The NIMS program is considered as a response function, and information in this hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the planning area.

Presidential Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities:

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Presidential Executive Order 11990, Protection of Wetlands

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers operates and maintains approximately 700 dams nationwide. It is also responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety. The Corps maintains the National Inventory of Dams, which contains information about a dam's location, size, purpose, type, last inspection and regulatory status (U.S. Army Corps of Engineers, 2017).

U.S. Army Corps of Engineers Flood Hazard Management

The U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and flood hazard management:

- The Floodplain Management Services program offers 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000 with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
    - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
    - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
    - Watershed management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance is provided in the flowing categories:
    - Preparedness—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
    - Response Activities—Public Law 84-99 allows the Corps of Engineers to supplement state and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a project cooperation agreement signed by the public sponsor and the sponsor must remove all flood fight material after the flood has receded. Public Law 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for "advance measures" assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.
    - Rehabilitation—Under Public Law 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to

the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems considered eligible for Public Law 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

All of these authorities and programs are available to the County to support any intersecting mitigation actions.

U.S. Fire Administration

There are federal agencies that provide technical support to fire agencies/organizations. For example, the U.S. Fire Administration, which is a part of FEMA, provides leadership, advocacy, coordination, and support for fire agencies and organizations.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service fire management strategy employs prescribed fire to maintain early successional fire-adapted grasslands and other ecological communities throughout the National Wildlife Refuge System.

STATE

Hawai‘i Coastal Zone Management Program

In response to the federal Coastal Zone Management Act, the State of Hawai‘i established its coastal zone management program in 1977 (Chapter 205A, Hawai‘i Revised Statutes). Managed by the State Office of Planning, Hawai‘i's CZM program provides a common focus for state and county actions dealing with land and water uses and activities. Under the CZM program, agencies must look at resources from a broader ecosystem perspective instead of individual species or resources. The CZM law builds upon the authorities and responsibilities of state and county agencies to form a network based on legal and operational compliance with the law's objectives and policies. All agencies must ensure that their statutes, ordinances, rules, and actions comply with the CZM objectives and policies (State of Hawai‘i Office of Planning, 2015).

The CZM area encompasses the entire state because there is no point of land more than 30 miles from the ocean. What occurs on land, even on the mountains, impacts and influences the quality of coastal waters and marine resources. The CZM area extends seaward to the limit of the state's police power and management authority, to include the territorial sea. This legal seaward boundary definition is consistent with Hawai‘i's historical claims over the Hawaiian archipelagic waters, based on ancient transportation routes and submerged lands.

Hawai‘i Hazards Awareness and Resilience Program

The aim of the Hawai‘i Hazards Awareness and Resilience Program (HHARP) is to help communities prepare to be self-reliant during and after natural hazard events, improve their ability to take care of their own needs, and reduce the negative impacts of disasters. HHARP can enhance community resilience through education and outreach sessions that build awareness and understanding of hazard mitigation, preparedness, response and recovery. State and county emergency management agencies have partnered to administer HHARP in support of community leaders willing to implement the program. The resources in the HHARP program and accompanying HHARP resource kit will help communities build resilience through:

- Increasing awareness of hazards

- Enhancing understanding of official warning information
- Educating residents about response actions
- Improving personal preparedness
- Helping communities identify useful skills and resources they already have
- Developing the understanding needed to select appropriate hazard mitigation measures
- Guiding communities in the development of emergency plans and exercises
- Providing support for community outreach events
- Identifying opportunities for additional training and education

Hawai'i State Grants-in-Aid for Capital Improvement Projects

The Hawai'i State Legislature makes appropriations for grants in accordance with Chapter 42F of the Hawai'i Revised Statutes. The grants support events, programs, and facilities that benefit the community. There are two types of grants: operating and capital improvement project grants. Funds are available on a reimbursement basis and payments are contingent upon fulfillment of the terms and conditions of the grant agreement. Grantees must submit documents to verify that they meet the standards for the award of grants.

Hawai'i State Plan

The Hawai'i State Plan is a long-range comprehensive plan that includes an overall theme, goals, objectives, policies, priority guidelines, and implementation mechanisms. The Hawai'i State Plan achieves the following:

- Serves as a guide for the future long-range development of the state
- Identifies the goals, objectives, policies, and priorities for the state
- Provides a basis for determining priorities and allocating limited resources, such as public funds, services, human resources, land, energy, water, and other resources
- Improves coordination of federal, state, and county plans, policies, programs, projects, and regulatory activities
- Establishes a system for plan formulation and program coordination to provide for an integration of all major state, and county activities

The State Plan is divided into three parts:

- Part I lists the State Plan's overall theme and goals. Objectives and policies focus on general topic areas, including population, economy, physical environment, facility systems, and socio-cultural advancement.
- Part II establishes a statewide planning system to coordinate and guide all major state and county activities and to implement the overall theme, goals, objectives, policies, and priority guidelines. The system implements the State Plan through the development of functional plans and county general plans.
- Part III establishes overall priority guidelines to address areas of statewide concern. This part lays out the overall direction for the state in five major areas of statewide concern: economic development, population growth and land resource management, affordable housing, crime and criminal justice, and quality education.

Ocean Resources Management Plan

The Ocean Resources Management Plan is a comprehensive plan for conservation and sustainability of ocean and coastal resources (Chapters 205A and 225M, Hawai'i Revised Statues). Hawai'i is facing pressures that will have a significant impact on ocean and coastal environments, including urbanization, tourism, recreational and commercial ocean uses, sea level rise and other natural hazards to include beach erosion, inundation of land, increased flood and storm damage, saltwater intrusion into the freshwater lens aquifer, the rising of the water table, and more frequent or more powerful weather events, marine debris, and invasive species. The Ocean Resources Management Plan was updated in 2013 to address these issues.

State Building Code and Design Standards

In 2007, the State Legislature created State Building Code Council with the authority to establish codes applicable to all construction in the State of Hawaiʻi (Chapter 107, Hawaiʻi Revised Statues). The State Building Code Council evaluates model building codes and develops amendments necessary to make the codes appropriate for conditions in Hawaiʻi. Once the Council develops and approves a code for Hawaiʻi, it is legally adopted into the Hawaiʻi Administrative Rules (HAR). Counties have two years from the date of establishment of the HAR State Building Code to adopt the Hawaiʻi State Building Code as local county code, with the addition of any locally approved county amendments. The process has successfully enabled a unified set of nearly comprehensive building codes to be adopted by the state and the counties.

State General Flood Control Plan

As authorized by the Hawaiʻi Revised Statutes Chapter 179 Flood Control and Flood Water Conservation, the State General Flood Control Plan (SGFCP) serves as a guide for linking partnering agencies and community groups. The plan provides these stakeholders with the data and tools required to strategize flood improvement needs and goals.

The most recent update allows all stakeholders to view and analyze flood-prone areas and/or flood mitigation needs. The updated SGFCP also enables users to locate project partners and build on current or previously completed flood improvement efforts. The plan update increases each stakeholder's ability to complete projects by integrating best practices and lessons learned from other partner agencies and through resource sharing.

State of Hawaiʻi Hazard Mitigation Plan

The *State of Hawaiʻi 2018 Hazard Mitigation Plan* identifies the major natural hazards that affect Hawaiʻi, assesses the risk that each hazard poses, analyzes the vulnerability of people, property and infrastructure to the specific hazard, and recommends actions that can be taken to reduce the risk and vulnerability to the hazard. The State Hazard Mitigation Plan also contains a description of programs, policy, statues and regulations applicable to hazard mitigation statewide.

State of Hawaiʻi Land Use Law

The Hawaiʻi State Legislature adopted the State Land Use Law (Chapter 205, Hawaiʻi Revised Statutes) in 1961. The Land Use Commission administers statewide zoning established in the State Land Use law. The law classifies lands throughout the state into one of four districts:

- The Urban District generally includes lands characterized by "city-like" concentrations of people, structures and services. This district also includes vacant areas for future development. Jurisdiction of this district lies primarily with counties.
- The Rural District consists primarily of small farms intermixed with low-density residential lots with a minimum size of 0.5-acre. The Land Use Commission and County governments share jurisdiction over rural districts. Permitted uses include those relating or compatible with agricultural use and low-density residential lots.
- The Agricultural District includes land with significant potential for agriculture uses as well as lands used for the cultivation of crops, aquaculture, raising livestock, wind energy generation, timber cultivation, and agriculture-support (mills, employee quarters, etc.). Uses permitted in the highest productivity agricultural

categories (A or B) are governed by statute. Uses in lower-productivity categories (C, D, E, or U) include those allowed on A or B lands as well as uses stated under Section 205-4.5, Hawai‘i Revised Statutes.

- The Conservation District consists primarily of lands in existing forest and water reserve zones. These include areas necessary for protecting watersheds and water sources; scenic and historic areas; parks, wilderness, open space and recreational areas; habitats of endemic plants, fish and wildlife; submerged lands seaward of the shoreline; and lands subject to flooding and soil erosion. The State Board of Land and Natural Resources administrates conservation districts.

Appendix D. Detailed Assessment of Hawai‘i County Legal and Regulatory Capabilities

D. Detailed Assessment of Hawai‘i County Legal and Regulatory Capabilities

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated?
CODES, ORDINANCES & REQUIREMENTS				
County of Hawai‘i Building Code, County Ordinance Chapter 5, Section 5-3 adopted 2006 International Building Code (IBC) with Amendments; adopted and amended by Chapter 180 of Title 3, of the Hawai‘i Administrative Rules (HAR) State Building Code; County in process of adopting 2012 IBC as per HAR State Building Code.	Countywide	Public Works, Building Division	None	Yes
Comments: ***Hazards specified: hurricane high winds, flood, tsunami.*** *Appendix U101 Section 421 specifies building requirements for community storm shelters in accordance with ICC 500-08 ICC/NSSA Standard to provide safe refuge from storms that produce high winds, such as hurricanes. No construction of safe rooms in coastal zones “V” or “A”; Includes Appendix W, Hawai‘i Wind Design Provisions for New Constructions; Includes Map Figure 1609.1.1.1 Effective Wind Contour Map for Component & Cladding for Buildings - (p.5-83) State IBC code specifies different maps for buildings in different risk categories; Wind-borne Debris Protection requirements with Fastener Schedule for wood panels (Table 1609.1.2); Section 423 State and County Owned High Occupancy Buildings - Design Criteria for Enhanced Hurricane Protection Areas, includes site criteria for Flood and Tsunami zones, Emergency vehicle access, Landscaping and Utility Laydown Impact Hazards, and Adjacent Buildings.*				
Hawai‘i Administrative Rules (HAR) State Building Code, Chapter 180, Title 3, eff. 1/1/2018, adopted 2012 International Building Code	Statewide	N/A	State Building Code Council	Yes
Comments: ***Hazards specified: hurricane high winds, flood, tsunami, earthquake.*** *Appendix U Hurricane Sheltering, Section U101 for Community Storm Shelters in accordance with ICC/NSSA 500 Standard to provide safe refuge from storms that produce high winds, such as hurricanes. No construction of safe rooms in coastal zones “V” or “A”; Section U102 Hawai‘i residential safe room - temporarily provide an enhanced protection area in accordance with minimum performance specifications and shall not be sited in FEMA SFHA, Coastal Zone “V” and “A” or areas subject to dam failure; Appendix W, Hawai‘i Wind Design Provisions for New Constructions; Includes Maps, Figure 1609.3.2.1(a), Figure 1609.3.2.2 (a), Figure 1609.3.2.3 (a), Figure 1609.3.2.4 (a)Effective Wind Contour Map for Component & Cladding for Buildings Risk Categories I-IV; Revised Wind-borne Debris Protection requirements with Fastener Schedule for wood panels (Table 1609.1.2). Section U103 State- and County-owned public high occupancy buildings - design criteria for enhanced hurricane protection areas. 1905.1.2 ACI 318, Section 21.1.1 - Seismic/earthquake resistant structural requirements. SECTION 1615 Tsunami Loads and Effects - Defines ASCE database (version 2016-1.0) of Tsunami Design Zone maps and associated design data for State of Hawai‘i.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Zoning Code, 1999 (amended in 2015) - Adopted by Ordinance, Ord 96-160, sec 2. applied and administered within the framework of the Hawai‘i County General Plan.	Countywide	Planning Department	None	Yes
Comments: ***Hazards specified: general.*** *To promote health, safety, morals, or the general welfare of the County, zoning code regulates and restricts the height, size of buildings, and other structures, the percentage of a building site that may be occupied, and other characteristics and use of structures and land. Concurrency requirement for civil defense sirens with zoning amendment applications; Section 25-6-44 & Section 25-6-54 - Requirements for "project district" and "agricultural project district" applications can include "open space areas preserved because of natural hazards."*				
MOA Between County of Hawai‘i and Department of Hawaiian Homelands (DHHL), signed 12/27/2002.	Countywide	N/A	DHHL	No
Comments: ***Hazards specified: none.*** *Purpose is to clarify roles, responsibilities relating to land use planning, infrastructure, enforcement. DHHL is responsible for land use & land use designations on DHHL lands as according to Hawai‘i Island Plan, various Development and Subdivision Plans, and Homestead Community Plans.*				
Hawai‘i Coastal Zone Management (CZM)- Hawai‘i Revised Statutes (HRS) CHAPTER 205A.	Statewide	Planning Director	State	Yes
Comments: ***Hazards specified: flood, tsunami, erosion, subsidence, pollution****. Objectives and policies provide overarching guidance to Shoreline Management Area permitting and Shoreline Setbacks. CZM Objective 6(a) Coastal Hazards: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.*				
Special Management Areas (SMA)- §205A-26, 28 & 29 Hawai‘i Revised Statutes, established 1975.	Statewide	Planning Director	None	Yes
Comments: ***Hazards specified: flood, tsunami, erosion, subsidence.*** *Special controls on developments within an area of land extending inland from and along the shoreline. County sets SMA boundaries and permit requirements for development. SMA permit regulates permissible development that are already allowed by zoning designations, development plans, the county General Plan. If lack of mitigation measures or inconsistent with CZM policies and objectives or SMA guidelines, permit will be denied. Reduction of threats to coastal hazards from erosion, storm waves, flooding, hurricanes, tsunamis, subsidence of the land must be taken into account in the SMA permit*				
Subdivisions - Chapter 23 Hawai‘i County Code (HCC) Subdivision Control Code, as authorized by chapter 46, Hawai`i Revised Statutes, adopted 1983, last updated February 2018.	Countywide	Planning Department	None	No
Comments: ***Hazards specified: flood.*** *Requirement for containing stormwater on site for the one-hour, ten-year storm event. The subdivider "shall not alter the general drainage pattern above or below the subdivision." Must also comply with Chapter 27 Hawai‘i County Code Floodplain Management. Must provide drainage easement when subdivision is traversed by a natural water course, drainage way, channel or stream. Section 23-37: Lot suitable for intended use; inundation area. "A lot shall be suitable for the purposes for which it is intended to be sold. No area subject to periodic inundation which endangers the health or safety of its occupants may be subdivided for residential purposes." Requirements to show elevations, contours, slopes during platting process, as well as provisions for proposed sewage disposal, conceptual drainage and flood control.*				
Flood management - Chapter 27 Hawai‘i County Code (HCC) Floodplain Management adopted 1993 by ordinance, last amended 2017, as authorized by Hawai‘i Revised Statutes 46-1.5(5), 46-1.5(14), 46-11, 46-11.5, and 46-12 and from the U.S National Flood Insurance Act and Flood Disaster Protection Act.	Countywide	Public Works	None	Yes
Comments: ***Hazards specified: flood.*** *To promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by establishing building code and infrastructure requirements to mitigate flood hazard damage. Restricts or prohibits certain uses in FEMA defined special flood hazard areas (SFHA) as identified by FEMA Flood Insurance Rate Maps, construction requirements for buildings in SFHA built on or after May 1982, controls alteration of floodplain, no fill, dredging or development in SFHA that may increase flood damage, prevent construction of flood barriers. Revised FIRM maps adopted Sept. 29, 2017.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Flood management - Hawai'i County Eligible FEMA Community Rating System, Class 7 (2017)	Countywide	Public Works	None	No
Comments: ***Hazards specified: flood.*** *Voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Hawai'i County current Class 7 - gives 15% premium discount on eligible flood insurance. Activities credited: Activity 310—Elevation Certificates, Activity 320—Map Information Service, Activity 330—Outreach Projects, Activity 340—Hazard Disclosure, Activity 350—Flood Protection Information, Activity 420—Open Space Preservation, Activity 430—Higher Regulatory Standards, Activity 440—Flood Data Maintenance, Activity 450—Stormwater Management, Section 502—Repetitive Loss Category, Activity 510—Floodplain Management Planning, Activity 630—Dams, Activity 710—County Growth Adjustment.*				
Transfer of Development Rights - Chapter 46-161 Hawai'i Revised Statutes, enacted 1998	Statewide		None	No
Comments: ***Hazards specified: flood.*** *Enabling legislation for County to exercise power to transfer development rights within a comprehensive planning program to Protect the natural, scenic, recreational, and agricultural qualities of open lands including critical resource areas; Draft of General Plan Update (2019) identifies action 546.3 To Conduct a feasibility study for a County-wide Transfer of Development Rights (TDR) and If feasible, adopt any necessary enabling County legislation.*				
Purchase of Development Rights - N/A				
Comments:				
Stormwater Management - Storm Drainage Standards (1970).	Countywide	Department Public Works	None	No
Comments: ***Hazards specified: Flood.*** *Standards that guide the design of storm drainage facilities. All new development that generates runoff shall be disposed of on site and not directed toward any adjacent properties. A drainage plan may be required by the Plan Approval process (administered by the County of Hawai'i, Planning Department) in accordance with Section 25-2-72(3) of the Hawai'i County Code.*				
Post-Disaster Recovery - N/A				
Comments:				
Real Estate Disclosure - Hawai'i Revised Statutes Title 28 Property, 508D Mandatory Seller Disclosures in Real Estate Transactions, 508D-15 Notification required; ambiguity, 2013.	Statewide	N/A	None	Yes
Comments: ***Hazards specified: Flood, Tsunami.*** *Notification required when residential property lies (1) Within the boundaries of a special flood hazard area as officially designated on Flood Insurance Administration map...; (2) Within the anticipated inundation areas designated on the Department of Defense's civil defense tsunami inundation maps*				
Housing Policy - Chapter 11, Article 1 Affordable Housing, Hawai'i County Code, 1983, (last updated 2016)	Countywide	Housing Administrator	None	
Comments: ***Hazards specified: none.*** *Section 11.2 (1) Implement goals and policies of the general plan; (2) Promote and assist private development of housing for senior citizens, persons with disabilities; (3) Use available governmental grants and funds in the development of affordable housing and increase the capabilities of qualified households to obtain affordable housing;(4)Support innovative, lower-cost approaches; (5) Require large resort and industrial enterprises to address related affordable housing needs as a condition of rezoning approvals, based upon current economic and housing conditions; (6) Require residential developers to include affordable housing in their projects or contribute to affordable housing off-site. (1998, Ord 98-1, sec 2; am 2005, Ord 05-23, sec 2.)*				
Site Plan Review - County of Hawai'i Building Code, County Ordinance Chapter 5, 2006	Countywide	Public Works, Building Division	None	
Comments: ***Hazards specified: flood, tsunami.*** *Site review criteria Section 423.3 for single family and two-family detached residential dwelling (R-3 Occupancy) and accessory structures (U Occupancy). Includes Hazards references include - 423.3.1 Flood and Tsunami Zones. 423.3.2 Emergency Vehicle Access, 423.3.3 Landscaping and Utility Laydown Impact Hazards, and 423.3.4 Adjacent Buildings.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Environmental Protection - Hawai‘i Revised Statutes, HRS 343. “Hawai‘i Environmental Policy Act”; HAR Chapter 11-200.1 August 2019.	Statewide	N/A	State Agencies	Yes
Comments: ***Hazards specified: flood, tsunami, erosion, “geologically hazardous lands” and sea level rise****. HEPA requires State agencies to consider the impact of governmental actions on the environment and mandates the completion of an environmental assessment (EA) for any of the instances or “triggers” identified in HRS 343-5(a) and in OEQC’s Guide to the Implementation and Practice of HEPA 1.6. This review process includes consideration of sensitive areas (such as floodplains, geologically hazardous areas, and sea-level rise exposure areas).*				
Water Code - Hawai‘i Revised Statutes, HRS § 174c. “State Water Code” 1987	Statewide	N/A	State Commission of Water Resource Mgmt (CWRM)	Yes
Comments: ***Hazards specified: none.*** *It is recognized that the waters of the State are held for the benefit of the citizens of the State. Adequate provision shall be made for the protection of traditional and customary Hawaiian rights, the protection and procreation of fish and wildlife, the maintenance of proper ecological balance and scenic beauty, and the preservation and enhancement of waters of the State for municipal uses, public recreation, public water supply, agriculture, and navigation.*				
Hawai‘i Water Plan - Hawai‘i Revised Statutes, HRS § 174C-31. “Hawai‘i Water Plan” 1987	Statewide	N/A	CWRM	Yes
Comments: ***Hazards specified: flood.*** *The Hawai‘i water plan shall consist of four parts: (1) a water resource protection plan which shall be prepared by the commission, to include studies related to flood hazards; (2) water use and development plans for each county which shall be prepared by each separate county and adopted by ordinance, setting forth the allocation of water to land use in that county; (3) a state water projects plan which shall be prepared by the agency which has jurisdiction over such projects in conjunction with other state agencies; and (4) a water quality plan which shall be prepared by the department of health.*				
Groundwater - Hawai‘i Revised Statutes, HRS § 174c-44. “Ground water criteria for designation”	Statewide	N/A	CWRM	Yes
Comments: ***Hazards specified: none.*** *Groundwater criteria for designating area for water use regulation*				
Cultural and Historical Resource Protection - Hawai‘i Revised Statutes, HRS § 6E	Statewide	N/A	State Historic Preservation Division	Yes
Comments: ***Hazards specified: none.*** *The Constitution of the State of Hawai‘i recognizes the value of conserving and developing the historic and cultural property within the State for the public good.*				
Hawai‘i State Burial Law (HRS§6E-41, HRS§6E-43, HRS§6E-43.5, HRS§6E-43.6)	Statewide	N/A	State Historic Preservation Division	Yes
Comments: ***Hazards specified: none.*** *Establishes Burial Councils on each county and regional representation on councils.*				
Land Fire Protection Law, Chapter 185, Hawai‘i Revised Statutes (1953, amended 1994)	Statewide	N/A	State Division of Forestry and Wildlife	Yes
Comments: ***Hazards specified: Wildfire.*** *The State Division of Forestry and Wildlife (DOFAW) is statutorily mandated by the Land Fire Protection Law as the primary responder for wildfires on lands managed by DOFAW, as well as co-responds with county fire departments and federal agencies to additional lands dictated by mutual aid agreements and MOUs. Risk reduction programs (including prevention and mitigation measures) along with post-fire restoration and recovery projects are also implemented by DOFAW.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Wastewater Systems - Hawai‘i Administration Rules, Title 11, Chapter 62, "Wastewater Systems" (1988, Amended 2016)	Statewide	Department of Environmental Management	State Department of Health	Yes
Comments: ***Hazards specified: Flooding and general.*** *to ensure that the use and disposal of wastewater and wastewater sludge from wastewater systems does not contaminate or pollute any valuable water resource, does not give rise to public nuisance, and does not become a hazard or potential hazard to the public health, safety, and welfare.§11-62-31.2 Site evaluation (for individual wastewater systems). A site evaluation shall be performed by an engineer for depth of permeable soil over seasonal high groundwater, bedrock, or other limiting layer, soil factors, land slope, flooding hazard, and amount of suitable area available.*				
Flood Damage Prevention - N/A				
Comments: *ask flood manager in DPW*				
Urban Renewal Law - H.R.S. Chapter 53 (1949, last amended 2018)	Statewide	Planning Department	None	Yes
Comments: ***Hazards specified: Seismic, wave, flood, fire, hurricane, earthquake, storm, volcanic activity, explosion, or other catastrophe, natural or of human origin****. Establishment of a redevelopment agency, initiates a redevelopment plan, authorizes urban renewal projects in a disaster area and defines a disaster area. As per Section 2-35.1. Urban Renewal of the Hawai‘i County Code, the Hawai‘i County Planning department is the lead agency in enabling the County to directly exercise its powers as provided for in parts I and II of chapter 53, Hawai‘i Revised Statutes. As the lead agency, the planning department shall delegate the responsibilities of the Hawai‘i redevelopment agency to the appropriate departments, commissions and agencies to ensure that the procedures of compliance are adhered to. (1992, Ord. No. 92-37, sec. 2.)*				
Emergency Management - Hawai‘i Revised Statutes, Chapter 127A - Hawai‘i Emergency Management Agency (HIEMA)	Statewide	Mayor; Civil Defense	State HIEMA	Yes
Comments: ***Hazards specified: General.*** *Establishes the Hawai‘i Emergency Management Agency within the Department of Defense. Section 127A-5 County emergency management agency. (a) The mayor of each county shall have direct responsibility for emergency management within the county, including the organization, administration, and operation of a county emergency management agency.*				
Climate Change - Hawai‘i State Act 83, Hawai‘i Climate Change Mitigation and Adaptation Initiative, 2017	Statewide	N/A	State Office of Planning and DLNR	Yes
Comments: ***Hazards specified: Sea level rise.*** *Mandated the statewide Sea Level Rise Vulnerability and Adaptation Report, published December 2017, provides the first state-wide assessment of Hawai‘i's vulnerability to sea level rise using best available science on climate change and sea level rise. Provides recommendations to reduce our exposure and sensitivity to sea level rise and increase Hawai‘i's capacity to adapt. Statewide sea level rise data (including passive flooding, erosion, and wave run-up) is made available on Pacific Islands Ocean Observing System (PacIOOS) Voyager website (https://www.pacioos.Hawai‘i.edu/voyager/)*				
Disaster Recovery Ordinance - N/A				
Comments: *underway*				
Disaster Reconstruction Ordinance - N/A				
Comments:				
Short Term Vacation Rental Law, Ordinance 2018-114, November 2018.	Countywide	Planning Department	None	No
Comments: ***Hazards specified: None.*** *Regulates Short-Term Vacation Rentals (STVR) on the island of Hawai‘i. The new law: 1) defines where the use will be allowed; 2) establishes provisions and standards to regulate this use; and 3) provides an avenue for an existing STVR to apply for a Nonconforming Use Certificate that would allow continued operation outside of a permitted zoning district.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Erosion and sedimentation Control - Section 23-92. Subdivisions - Drainage, flood, and erosion mitigation measures. (1983, Amended 2007)	Countywide	Public Works	None	Yes
Comments: ***Hazards specified: Flood.*** *The subdivider shall construct a storm water disposal system to contain runoff caused by the subdivision improvements within the boundaries of the subdivision, up to the expected one- hour, ten-year storm event, as shown in Plate 1 of the Department of Public Works "Storm Drainage Standards", dated October 1970.*				
PLANNING DOCUMENTS				
Hawai'i County General Plan (GP), first adopted December 15, 1971, most recently updated in 2005 and amended in 2006 by ordinance. Currently being updated with estimated completion in 2019.	Countywide	Planning Department	None	Yes
Comments: ***Hazards specified: Flood and general.*** *The GP is the policy document for the long range comprehensive development of the island and provides a framework for regulatory decisions, capital improvement priorities, acquisition strategies, and government programs. The plan specifies long-range goals and includes 9 specific area districts each relating to their own Community Development Plans(Hilo, Kona, Kohala, Ka'ū, etc.), 16 different sections related to functions (e.g. economic; energy; environmental quality; flooding and other natural hazards; land use, etc.) and specific areas within a region (Kailua Kona, Downtown Hilo, etc.). It also includes zoning and subdivision codes as well as operating and capital improvement program budgets. It also Land Use Allocation Guide Maps and Facilities Maps. Entire section focuses on "Flood and Natural Disaster Risks." Recognizes that certain areas susceptible to natural hazards may need to be kept open and not utilized for buildings, structures or other economic development purposes.*				
Draft Update Hawai'i County General Plan Element Compilation Rationale (estimated 2019)	Countywide	Planning Department	None	Yes
Comments: ***Hazards specified: General.*** *This document is in progress, but when finished it will be the policy document for the long-range comprehensive development of the island and provides a framework for regulatory decisions, capital improvement priorities, acquisition strategies, and government programs. Update includes elements that specify specific hazard related goals including insuring air quality, mitigating & adapting to hazards and climate change. Also identifies a number of actions that integrate multi-hazards and climate change planning and protection.*				
Community Development Plans (CDP) pursuant to the County of Hawai'i General Plan, 2005, Section 15.1 and Chapter 16, section16-2, Hawai'i County Code, 1983.	***Individual Districts as Listed Below***	Planning Department (with local community partners)	None	No
Comments: *Comment:* ***Hazards specified: General.*** *County of Hawai'i General Plan section 15. 1 (February 2005, as amended) calls for the preparation of community development plans " to translate the broad General Plan statements to specific actions as they apply to specific geographical areas."*				
Kona CDP adopted by ordinance September 25, 2008	Kona District	Planning Department (with local community partners)	None	No
Comments: ***Hazards specified: flood, seismic, tsunami, hurricane, drought, and wildfire.*** *Emphasis on TOD, mixed-use and compact development, strengthening of public facilities like hazardous material, police and fire stations. Focused on sustainable development and smart growth. Plan acknowledges Kona is vulnerable to floods, earthquakes, tsunamis, hurricanes, droughts, and wildfires (p2-6); Policies and actions in plan include Policy ENV- 1.7 to identify flood corridors and planned natural flow ways to serve as open space amenities. Actions include improve flood mapping, study regional stormwater management system, identify corridors, improve disaster shelters pg. 4-109, Improve emergency services pg. 4-107.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Puna CDP adopted by ordinance in 2008, amended 2010, 2011	Puna District	Planning Department (with local community partners)	None	No
Comments: ***Hazards specified: flood, subsidence, and wildfire.*** *Goals integrated with Traditional Hawaiian concepts of land stewardship, Three theme: Malama I ka Aina, Growth Management and Transportation. Goals include, (1) address storm water runoff and localized flooding problems; (2) intend to reduce "Exposure of development to the risks of shoreline subsidence and coastal flooding"; (3) Give residents an equitable level of service access to police, fire, and paramedical services; (4) provide adequate emergency and evacuation routes and connectivity throughout Puna's Roadway Network; Goals that redirect development (4) Incentives, disincentives, regulations and other methods are used to diminish land speculation; (5) Reduced overall number of buildable lots in Puna.*				
North Kohala CDP adopted by ordinance November 2008.	North Kohala District	Planning Department (with local community partners)	North Kohala Community	No
Comments: ***Hazards specified: flood, seismic, tsunami, and general****. Overall vision and goals encompassed by "Keep Kohala, Kohala" with general goals to manage growth, provide community access to resources, provide affordable housing, and update infrastructure and community facilities. Relevant mitigation goals of plan include: Protecting natural resources, Aim for emergency facility upgrades including fire station (pg.85)and police station(pg. 87), preserve coastal areas (pg. 28); acknowledges districts vulnerability to natural hazards - Emergency preparedness should be a priority (p.12).*				
South Kohala CDP adopted by ordinance November, 2008	South Kohala District	Planning Department (with local community partners)	South Kohala Community	No
Comments: ***Hazards specified: flood, seismic, hurricane, tsunami, lava, and wildfire.*** *CDP outlines four issue areas: Preserve Culture/ Sense of Place, Transportation, Emergency Preparedness, and Environmental Stewardship / Sustainability. Policy no.4: Develop programs and standards that will protect the South Kohala Community from natural Hazards, including majors storms, flooding, tsunami, lava flows, and wildfire; Includes Section 2.5.3 Natural Disasters and Hazards with specific mitigation strategies to reduce risk/impact of wildfires, earthquakes, and general readiness to disasters in general; Acknowledges future coastal development should take into account sea level rise. Several communities have begun to implement wildfire management strategies including Waikoloa, Puakō, and Waialea Bay.*				
Ka' u CDP adopted by ordinance October 2017	Ka‘u	Planning Department (with local community partners)	None	No
Comments: *Comment:* ***Hazards specified: Flood, seismic, tsunami, hurricane, erosion, lava, vog, sea level rise, and wildfire.*** *Policies and strategies are organized in four sections: Advances Preferred conservation and settlement patterns; Protect and Enhance Natural and Cultural resources; Strengthen infrastructure, facilities, and services; Build a Resilient, sustainable local economy. Identifies Hazard Mitigation Plans and the expansion of Neighborhood Watch and CERT programs as priorities and goals. Specifies as a preferred settlement pattern, to manage "growth to protect people and facilities from lava hazards" (p.37). Policy 28 - On lots that are at least partially within the Special Management Area (SMA) in the Ka' u CDP Planning Area, establish shoreline setbacks at a minimum of 1, 320 feet (1/ 4 -mile) - (p.52); Policy 29 Specifies No development, including subdivision, shall be approved in the SMA unless the development will not have any substantial adverse environmental or ecological effect. (HRS 205A-22(3) & 205A -26(2)(A)) with assessment of impacts on hazard risk, including flooding, tsunami, and coastal erosion and/ or sea level rise over the life of the development (PC Rule 9- 10(h)(9)) - (p.53).*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Hāmākua CDP adopted by ordinance August 2018	Community of Hāmākua, North Hilo, and a portion of South Hilo (rural Hilo)	Planning Department (with local community partners)	None	No
Comments: ***Hazards specified: Flood, seismic, tsunami, hurricane, erosion, lava, vog, sea level rise, and wildfire.*** *Policies and strategies are organized in four sections: Preferred Land Use & Settlement Patterns; Protect and Enhance Natural and Cultural Resources; Strengthen infrastructure, facilities, and services; Build a sustainable, local economy. Includes section dedicated to hazard mitigation; Recognition of climate change, coastal erosion, earthquake, floods, landslides, wildfires, and tsunamis as consistent hazards and threats. Includes specific policies to reduce risk to lava flows, tsunamis, wildfires.*				
Hilo CDP adopted by ordinance 1975	Hilo	Planning Department (with local community partners)	Hilo Community	No
Comments: ***Hazards specified: Flood, seismic, tsunami, volcanic***. *Long-range development plan for Hilo town for specific improvements over a 10-year period. Objectives include planning and development of future land use taking into account environmental assets and environmental constraints, such as recurring tsunamis, earthquakes, flooding and volcanic activity.*				
EnVision Downtown Hilo 2025: A Community Based Vision and Living Action Plan adopted by resolution 192 - 05 November 2005, updated November 2010	Specific District, the Downtown Hilo Commercial District	Planning Department (with local community partners)	None	No
Comments: ***Hazards specified: Flood, tsunami, hurricane, sea level rise, and wildfire.*** *Long -range visioning document and action plan with six (6) focus areas: Creating Economic Vitality; Preserving Our Environment; Strengthening and Sustaining Our Community; Enhancing Education, Culture, and the Arts; Promoting Health and Safety; and Managing Growth. Section within Health and Safety that is dedicated to disaster resiliency. Hazard mitigation actions identified include: Develop drainage and flood abatement system; Include sea -level rise data in long -term implementation strategies; Develop and coordinate a program to foster disaster resiliency in Downtown Hilo by: updating 2005 Hazard Mitigation Plan, developing & conducting a tsunami education, preparation, and recovery program, Develop and implement plan to reduce risk of large scale fire, Assist businesses and facilities to prepare emergency response plans, Implement educational programs on all hazards preparedness, Form a Hilo Bay CERTeam, Establish long -term recovery policies to implement in the event of a disaster (Actions 5. 11 - 5.17).*				
Capital Improvement Plan adopted by ordinance month 2018	Countywide	County Council	None	Yes
Comments: ***Hazards specified: Flood and general.*** *Outlines the projects and allocation of monies for Capital Improvement Projects on annual basis. The document is organized by government departments receiving funds. A project is eligible for funding from the capital budget if it is a major nonrecurring expenditure, such as: land acquisition, Infrastructure improvement, New buildings or structures or additions to buildings, Nonrecurring rehabilitation, remodeling or expansion of infrastructure and buildings, Planning, feasibility, engineering, or design studies, Information and communications technology infrastructure. For FY 2019-2020, Projects related to hazard mitigation: Dept. of Public Works- Flood Control Improvement Projects, Islandwide; Office of Housing and Community Improvements - The Ouli Ekahi Housing Projects install drainage system to eliminate flooding; Dept. of Public Works- Hardening projects for County facilities*				
County of Hawai'i Disaster Debris Action Manual, December 18, 2001.				
Comments: *Missing plan, could not find a copy*				
Hawai'i State Marine Debris Action Plan, December 2012	N/A	N/A	NOAA	No
Comments: ***Hazards specified: Tsunami.*** *Purpose is to establish a framework for strategic action to reduce the ecological, health and safety, and economic impacts of marine debris in Hawai'i by 2020. Addresses debris from natural disasters including tsunamis; Goals relevant to tsunamis: Section 4.3 Goal 3 - Incidence of abandoned and derelict vessels decreased.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Three Mountain Alliance (TMA) Watershed Plan, December 2007	ʻŌlaʻa-Kīlauea, La'u-Kapāpala, South Kona, and North Kona management areas	N/A	Three Mountain Alliance Members	No
Comments: ***Hazards specified: Flood, wildfire.*** *Identifies TMA management goals, objectives, and operational protocols; Identify and develop strategies to address high priority management issues that affect multiple land owners and natural resources across the TMA landscape; Relevant goals includes watershed protection and habitat protection; Reduce wildfire occurrence and minimize wildfire impacts. TMA watersheds provide ecosystem services including flood control; Flooding is considered a problem in parts of the North and South Kona Districts as well as in Ka'; Flooding and sedimentation problems in makai communities are often attributed to land management practices in mauka areas; Encourage forest cover to reduce the severity of flooding. Fire Priority : Reduce wildfire occurrence and minimize wildfire impacts by implementing; fire prevention measure and pre-suppression planning. This includes mapping of fuels/fire history, fuels reduction projects, fire potential monitoring, creating/maintaining firebreaks, and community awareness and education, - Assist willing private landowners with development of fire plans; Coordination for fire protection services; Section identifies lava flows of varying ages influencing vegetation succession patterns.*				
Kohala Watershed Alliance (KWA) Watershed Plan, 2007	Kohala watershed area	N/A	Kohala Partnership	No
Comments: ***Hazards specified: Flood, wildfire, landslides.*** *Volunteer alliance of large landowners. Plan describes the watershed resources and associated values, identifies the threats to those resources, and directs the activities of the KWP toward their protection. Includes goals and strategies associated with prevention of wildfires, reduce risk of floods, reduce invasive species and ungulates to minimize landslides.*				
Mauna Kea Alliance Watershed Plan, April 2010	Mauna Kea Watershed	N/A	Mauna Kea Alliance	No
Comments: ***Hazards specified: Flood, wildfire.*** *Document establishes management goals and objectives, and recommends specific actions to implement these goals and objectives, to the benefit of Mauna Kea's unique watershed resources. Goals include Protect and enhance native terrestrial and aquatic ecosystems and their biodiversity and species; Protect and enhance riparian buffers to protect stream corridors; Prevent and minimize wildfires on Mauna Kea. Collaborations with state/federal partners and detail strategies identified to minimize wildfires and reduce spread of fire. Included Establish water sources to help with reforestation efforts. Develop a water catchment system at Pu'u Mali and Ka'ohe Mitigation Areas that can be used as a water source for outplanting, invasive plant control, and fire suppression.*				
Hawaiʻi Drought Plan, 2017	Statewide	N/A	CWRM	Yes
Comments: ***Hazards specified****: Drought, wildfire. Hawaiʻi Drought Plan (HDP) updated for use by the Hawaiʻi Drought Council to improve coordination and implementation of drought management strategies for the State of Hawaiʻi. The revised plan is intended to serve as a "framework" through which State and local entities can work together to proactively implement mitigation measures and appropriate response actions during periods of drought. Details sector impacts including economic from past droughts; Identifies two key activities: 1) short-term, immediate response actions to address specific, imminent drought impacts, and 2) long-term, ongoing mitigation actions that will help prepare for future drought occurrences. Hawaiʻi Drought Program includes County-Level Drought Program Leadership and State and County Coordination. County Drought Mitigation Strategies will be updated through a series of county meetings involving agencies and stakeholders that have a role in drought mitigation and response. Projects identified through this process are integrated within the County Hazard Mitigation Plans, and the strategies developed shall incorporate the necessary coordination between government agencies and affected stakeholders. Strategies identified to increase water conservation, reuse, wildfire prevention, as well specific practices that may be employed by the county to encourage drought management in land use planning.*				
Floodplain Plan - N/A				
Comments:				
Stormwater Plan - Hawaiʻi County "Drainage Master Plan" (date)				
Comments: *Missing plan, could not find a copy*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Hawai‘i County Water Use and Development Plan: Hawai‘i Water Plan, in compliance with Hawai‘i Water Code and Section 13-170-31, Hawai‘i Administrative Rules, adopted May 1990 by ordinance, updated in 2010	Countywide	Department of Water Supply	None	Yes
Comments: ***Hazards specified: Drought.*** *Mention of The Waimea Irrigation System, Lower Hāmākua Ditch System, and Kohala Ditch System known to have sustained significant damage from the October 15, 2006 earthquake. For droughts, Waimea Water System has four large reservoirs with the combined capacity to store 158.5 million gallons of untreated water.*				
State of Hawai‘i Water Quality Management Plan, State Water Code and Chapter 174C, Hawai‘i Revised Statures (HRS), as a requirement of State Water Plan, 2019	Statewide	N/A	State Department of Health	Yes
Comments: ***Hazards specified: Pollution.*** *2019 WQP describes DOH's priorities that align with the water protection goals including devising a long-term strategy for the operation of the Red Hill Bulk Fuel Storage Facility, developing and implementing a long-term strategy for the upgrade and replacement of cesspools, and establishment of a Nonpoint Source Pollution Branch.*				
County of Hawai‘i Emergency Operations Plan, legal authority contained in Hawai‘i Revised Statures (HRS), Chapters 121-130, the Charter of the County of Hawai‘i, 2011	Countywide	Civil Defense Agency	None	Yes
Comments: ***Hazards specified: Flood, seismic, hurricane, landslide, tsunami, lava flow, volcanic, tsunami.*** *Provides county dept. with the basis for their internal disaster preparedness programs, addressing disaster mitigation, preparedness, response and recover. References 2005 Multi-Hazard mitigation plan. Identifies district vulnerabilities to dam failure, floods, earthquakes, hurricane, landslides, wildfire, tsunamis, lava flow, and explosive eruptions with organizational responsibilities and evacuation/shelters identified.*				
Hawai‘i County EOP - Emergency Support Function #11, Agriculture and Natural Resources: Standard Operating Guide Workbook, 2012	Countywide	Department of Research and Development	None	Yes
Comments: ***Hazards specified: General.*** *This plan highlights the logistics of food preservation and distribution in the event of an emergency. Allocates roles and responsibilities to all federal, state, county, and NGO Agencies in the event of emergency; Establishes the policies and procedures that the county of Hawai‘i will follow to enable continued agricultural operations during the response and recovery phases pf Type 1 through to type 3 incidents.*				
Hawai‘i County EOP - Emergency Support Function #12, Energy: Standard Operating Guide Workbook, 2012	Countywide	Department of Research and Development	None	Yes
Comments: ***Hazards specified: General.*** *This plan focuses on the restoration, protection, and continuation of energy services during a disaster. The document clearly delegates roles for government agencies in a disaster event. Agencies responsible to enact times of disaster, including Office of the Mayor, Civil Defense Administrator, Directors of Research and Development, Director of Water Supply. Maintains lists of energy-centric critical assets and infrastructures, and continuously monitors those resources to identify or mitigate vulnerabilities to the energy system. - Establishes policies and procedures regarding preparedness for "all hazards" and response and recovery due to shortages and disruptions in the supply and delivery of petroleum products.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Hawai‘i County EOP - Emergency Support Function #14, Long-term Community Recovery, 2012	Countywide	Department of Research and Development	None	Yes
Comments: ***Hazards specified: General.*** *This plan integrated the Hazard Mitigation Plan into its concept of operations, pg. 6 Concept of Operations - "ESF #14 is responsible for returning communities to pre-incident conditions. To accomplish this task ESF #14 will use the General Plan and the Multi-Hazard Mitigation Plan as the basis for all actions. ESF #14 will follow the strictest building code standards in regard to repairs to critical infrastructure to mitigate future incident impacts. (e.g., in repairing hospitals or emergency operations centers to mitigate for future seismic or hurricane risk).”; pg. 6 Concept of operations - Establishing procedures to integrate pre-incident risk assessment and planning into post-incident recovery and mitigation efforts.*				
County Comprehensive Economic Development Strategy, 2016	Countywide	Hawai‘i Island Economic Development Board	None	No
Comments: ***Hazards specified: General.*** *Serves as the blueprint for generating economic growth, diversification, job creation, and resiliency for Hawai‘i County. Relevant objectives in infrastructure, resilience, and sustainability. “Connect hazard mitigation to community and infrastructure planning where possible”, “Increase awareness of climate change, develop and implement climate adaptation and related resource management strategy plans” (p.59).Calls on Collaborative integration of public and private sector resources to strategize and implement successful recovery and response programs for residents, businesses and others affected by Tropical Storm Iselle and lava flow; Inventory vulnerabilities and assets; Anticipate ALL potential hazards; Align hazard mitigation plans with land use and other plans, and regulations. 4.Anticipate and reduce future risks (i.e. do not simply return to pre-disaster conditions). 5.Support projects that reduce and mitigate risks and improve resiliency. 6.Recognize economic impact, value of and retain Pōhakuloa Training Area”; pg. 60 Industry Clusters - Technology and Innovation - “Strategies: 1. Modernizing tsunami warning buoys and preventing hackers from disrupting, shutting down the buoys. ... 3.Recognize and begin mitigation on longer-term global climate change threats to sea level elevation and changes to soil and water (including ocean) chemistry. ... 7. Introduce high performing computing systems to host software algorithms to accept real-time data streams, analyze data received, and provide advanced decision-making tools to help respond to threats.”*				
Rural Economic Development Planning Report, 2010	Statewide	N/A	Office of Planning, Department of Business, Economic Development & Tourism, State of Hawai‘i	No
Comments: ***Hazards specified: General.*** *Identify ways in which rural communities can increase jobs and businesses while retaining their rural character and lifestyle. It is also intended to examine communities which have retained their cultural heritage while expanding their economy. The Study provides economic and demographic information to establish an important baseline of information. Identifies supporting local food production - could aid in reducing food dependence from elsewhere, which might aid in a disaster.*				
Natural Disaster Economic Recovery Strategy, 2014	Statewide	N/A	None	No
Comments: ***Hazards specified: General.*** *This Hawai‘i Natural Disaster Economic Recovery Strategy (NDERS) addresses pre-disaster business continuity planning and post-disaster recovery actions for both public and private sectors. This strategy especially focuses on small business and economic recovery since small businesses are the major driver of the State of Hawai‘i’s economy. The process to develop a strategy sought input from multiple stakeholders and resulted in 49 recommended implementation strategies grouped in four types (1) State or Federal legislative action is needed to change statutes and ordinances, or provide funding; (2) State government agency action could change administrative rules, policies, or programs; (3) public-private partnerships; and (4) private sector initiatives and actions (OP 2014a).*				

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Hawai‘i Island Tourism Strategic Plan 2006-2015	Countywide	Department of Research and Development	None	No
Comments: ***Hazards specified: None.*** *Establishes overall direction for all visitor industry stakeholders to move forward in a coordinated and complementary path.*				
Hawai‘i Island Tourism Road Map, 2016	Countywide	Department of Research and Development	None	No
Comments: ***Hazards specified: None.*** *This document further explores the implementation of a concept from the Tourism Strategic Plan. It focuses on the relationship between good local quality of life and how that translates to a strong tourism industry.*				
Consolidated Plan 2015-2019, 2015	Countywide	Office of Housing & Community Development	None	No- but a requirement to receive block grants from HUD
Comments: ***Hazards specified: General.*** *The County of Hawai‘i is required to submit a Consolidated Plan (CP) to the U S. Department of Housing and Urban Development (HUD) in order to receive the Community Development Block Grant (CDBG) funds: The purpose of the County' s CP is to ensure that jurisdictions receiving direct federal assistance utilize and develop a plan for its housing and related needs. The plan is centered around creating more affordable housing in the county of Hawai‘i, as well as improving housing stocks. More access to adequate and well-constructed housing, aids in reducing the impact and severity, and recovery of disasters.*				
Housing Planning Study, For County of Hawai‘i November 2011	Countywide	County of Hawai‘i	None	No
Comments: ***Hazards specified: General.*** *Study is centered around creating more affordable housing in the county of Hawai‘i, as well as improving housing stocks. More access to adequate and well-constructed housing, aids in reducing the impact and severity, and recovery of disasters. Includes data on 2011 County of Hawai‘i housing conditions, housing supply, housing demand, housing forecasts, housing issues, special needs housing.*				
Affordable Rental Housing 10-year Report, July 2018	Statewide	N/A	Special Action Team on Affordable Rental Housing*	Yes
Comments: ***Hazards specified: Flood, sea level rise.*** *On June 29, 2016, Governor David Y. Ige signed Act 127 (Session Laws of Hawai‘i 2016) to address this crisis. Act 127 establishes a goal of developing 22,500 affordable rental units statewide to be ready for occupancy by December 31, 2026, and a Special Action Team on Affordable Rental Housing to recommend actions to achieve the goal. This Affordable Rental Housing Report and Ten-Year Plan provides policy makers with a plan to achieve the affordable rental housing goal of 22,500 units by December 31, 2026. Recommended actions related to climate change - "4. As part of due diligence, monitor sea level rise modeling to determine if and when it could pose an infrastructure challenge related to groundwater." Maps of potential housing development areas ranked in 3 tiers. County Assessment of Public Parcels for County of Hawai‘i- "The team's considerations included the County of Hawai‘i General Plan, the presence or lack of infrastructure, SLUD designation, flood prone areas, existing and proposed uses, neighborhood setting, and government ownership."; Appendix E - Pg. 2 0f 2 County of Hawai‘i Affordable Rental Housing Inventory - PUA Melia Project- "Flood Route Cuts Through entrance Area, FUDS"* ** Special Action Team includes Office of Planning; Hawai‘i Housing Finance and Development Corporation; Hawai‘i public Housing; Hawai‘i Community Development Authority; private developers*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Community Wildfire Protection Plans - Kaʻu (2010), South Kona (2010), North Kona (2016), Northwest Hawaiʻi (2007), Ocean View (2006), and Hawaiʻi Volcanoes National Park (2006)	Kaʻu, South Kona, North Kona, Northwest Hawaiʻi, Ocean View, Hawaiʻi Volcanoes National Park	Hawaiʻi Fire Department	None	No
Comments: ***Hazards specified: Wildfire.*** *These plans include elements of fire protection, hazard assessment, wildfire mitigation priorities, and community outreach and education.*				
Firewise USATM	Countywide	• Honokoa • Kanehoa • Kohala by the Sea • Kohala Waterfront • Puʻukapu • Waialea • Waikiʻi Ranch • Waikoloa Village	DLNR-DOFAW	No
Comments: ***Hazards specified: Wildfire.*** *Firewise USATM is a recognition program that encourages residents to work with neighbors to reduce home ignition potential and increase home survivability leading to the prevention of wildfire disasters. As of 2017, there were 8 Firewise USA recognized communities throughout the county.*				
Integrated Wildland Fire Management Plan (IWFMP)	Statewide	N/A	None	No
Comments: ***Hazards specified: Wildfire.*** *Developed by the U.S. Army of Hawaiʻi, the Integrated Wildland Fire Management Plan presents a comprehensive approach to reduce the frequency of wildfire and the associated costs and damages. This plan contains details on pre-suppression, fire suppression, post-fire actions, and detailed area descriptions. The goal of this plan is to convey the methods and protocols necessary to minimize fire frequency, severity, and size in Hawaiʻi.*				
County of Hawaiʻi Transit and Multi-Modal Master Plan, 2018	Countywide	Mass Transit Agency	None	No
Comments: ***Hazards specified: Lava.*** *This Final Transit and Multi-Modal Transportation Master Plan identifies policies and standards for the delivery of service as well as criteria for measuring what can be expected. Among the most basic purposes for the Master Plan is to assist decision makers with funding and expenditure choices. This plan acknowledges the impact that lava flow has on the transit system, specifically in the Puna District.*				
Hawaiʻi County Food Self-Sufficiency Baseline Study 2012	Countywide	Department of Research and Development	None	No
Comments: ***Hazards specified: General.*** *The Hawaiʻi County Food Self-Sufficiency Baseline study was commissioned by the County of Hawaiʻi Research and Development Division to help inform the public and policy makers about the current status of food production on the island of Hawaiʻi. It is intended to provide a context for shaping individual and collective initiatives to help increase the island's capability to be more food self-reliant. The report follows a recommendation in the Hawaiʻi County Agricultural Plan to set a baseline from which to measure change in the islands local food system. This study provides details about the types and locations of crops and fisheries on the island of Hawaiʻi. Maps are provided throughout. Knowledge of local crops can help protect them in a future disaster. Documents need for major repairs to the ditch system from earthquakes - interrupted water flows for long periods of time, ending the efforts of many farmers. In Waipio, Periodic flooding can also impact production.*				
A Blueprint for Action: Water Security for an Uncertain Future, 2016-2018	Statewide	N/A	None	No
Comments: ***Hazards specified: Drought.*** *The Hawaiʻi Fresh Water Initiative was launched in 2013 to bring together diverse parties to develop strategies to increase water security for the Hawaiian Islands. Hawaiʻi Freshwater Blueprint provides Hawaiʻi policy and decision-makers with a set of solutions that should be adopted to help Hawaiʻi reach 100 million gallons per day in additional, reliable water capacity by 2030. To achieve this goal, three water strategy areas have been outlined to reach this statewide goal: Conservation, Recharge, and Reuse.*				

	Applies Countywide or to Specific District? (If district, specify)	County Authority	Other Jurisdiction Authority	State Mandated ?
Hawai'i Sea-level Rise Vulnerability and Adaptation Report, December 2017, as part of Hawai'i Climate Change Mitigation and Adaptation Initiative (Act 32, SLH 2017)	Statewide	N/A	DLNR/Office of Planning	Yes
Comments: ***Hazards specified: Flood, erosion.*** *Assessment of Hawai'i's coastline to future sea level rise including impacts from passive flooding, higher erosion rates and wave run-up. Estimated exposure impacts include economic property and building loss. Recommendations include policies and strategies to integrate sea-level rise and hazard mitigation into existing plans and regulations.*				
Puna Regional Circulation Plan	Puna District	Planning Department	None	No
Comments: ***Hazards specified: General.*** *Addresses future automobile, bicycle, pedestrian, and transit corridors of the Puna District. The Plan was initiated to evaluate existing regional transportation systems and propose future transportation corridors in Puna till year 2030. Proposed circulation routes and alternatives in case of emergency.*				
County of Hawai'i Energy Sustainability Program Five Year Roadmap Report, 2012	Countywide	Department of Research and Development	None	No
Comments: ***Hazards specified: Seismic, volcanic.*** *Describes role of the County of Hawai'i in the pursuit of the island's sustainable energy future and to provide the County with a set of high-priority policies and programs in the areas of renewable electricity, energy efficiency, and transportation systems. Aims for make the County of Hawai'i sustainable in terms of energy production; helpful in time of disaster to be less reliant on outside sources of energy. "Two of the major hazards likely to impact energy supply and delivery include earthquake and volcanic eruption" (p.54). "Safety and reliability are also important considerations that may affect the feasibility of different technologies, particularly with respect to the earthquake and volcanic risks" (p.66).*				
Hawai'i County Food Self-Sufficiency Baseline 2012	Countywide	Department of Research and Development	None	No
Comments: ***Hazards specified: General.*** *The Hawai'i County Food Self-Sufficiency Baseline study was commissioned by the County of Hawai'i Research and Development Division to help inform the public and policy makers about the current status of food production on the island of Hawai'i. Provides details about the types and locations of crops and fisheries on the island of Hawai'i. Maps are provided throughout. Knowledge of local crops can help protect them in a future disaster. Document impacts to ditch/irrigation systems*				
RESPONSE/RECOVERY PLANNING - TO BE UPDATED AS NEEDED				
Threat & Hazard Identification & Risk Assessment	Statewide	Civil Defense	Hawai'i Emergency Management Agency	Yes
Comments: State of Hawai'i Threat Identification and Risk Assessment of 2012, subsequently updated as the 2013 and then 2018 versions of the statewide hazard mitigation plan				
Continuity of Operations Plan	Countywide	Civil Defense	None	
Comments:				
Public Health Plan	Statewide	N/A	Department of Health	
Comments: State of Hawai'i, Department of Health, 2015-2018 Strategic Plan				

Opportunities for Hazard Mitigation Integration into Plans/Regulations

OPPORTUNITIES: SUMMARY OF RULES/PLANS REVIEWED

This document summarizes gaps and opportunities where Hazard Mitigation can be integrated into existing Hawaiʻi County plans and regulations. For the purposes of this review, the summary is organized into nine categories of planning activities1. Each identifies relevant rules, codes and plans followed by identified gaps and opportunities. This draft (July 19, 2019) emphasizes Volcanic Hazard Mitigation including volcanic explosions, lava flow, tsunami, seismic, ground failure/subsidence, ashfall and VOG.

1 Land use*
2 Transportation*
3 Other Infrastructure Lifeline Facilities & Systems*
4 Climate Change
5 Sustainability
6 Natural Resource Protection*
7 Cultural Resource Protection*
8 Economic Development
9 Emergency Management

LIST OF PLANS AND REGULATIONS REVIEWED

Land Use

1. Building code, Chapter 5, Hawaii County Code (Building Division, Public Works)

   a. Gap: the last Hawaii County building codes from HAR State Building Code were adopted in 2009. County in process of adopting 2012 IBC as per HAR State Building Code.
   b. Opportunities:

      - (From 2015 HMP) Hawaiʻi County building code shall be updated to maintain consistency with the Hawaiʻi State Building Code no later than two years after adoption of the Hawaii State Building Codes.

   c. Gap: Delays in updating the building code most likely resulted in vast majority of structures in the County not conforming to the minimum seismic design requirements (From 2015 HMP).

[1] FEMA 2015. Plan Integration: Linking Local Planning Efforts.
[*] Draft 7/19/2019 focuses on these categories

d. Opportunities:

  - (From 2015 HMP) Harden critical facilities. A 2009 study conducted a seismic evaluation of essential fire stations and hospitals. The findings of that study need to be fully implemented. Similar evaluations need to be made of the communication systems and fuel tanks.
  - Consider adopting a seismic ordinance requiring the evaluation and retrofit of specific building types (similar to California cities).

e. Gap: County building code does not provide design loads for critical facilities and structures in Tsunami zones

f. Opportunity:

  - Adopting Hawaii State Building Code (2018) includes ASCE 7 Standard Tsunami loads and ASCE database (version 2016-1.0) of Tsunami Design Zone maps for Hawaii.

g. Gap: Section 423 for State and County Owned High Occupancy Buildings - Design Criteria for Enhanced Hurricane Protection Areas, includes site criteria for Flood and Tsunami zones but no reference to volcanic risk.

h. Opportunity:

  - Amend to include specific reference to volcanic hazards by locating outside of volcanic high risk hazard area.

2. Zoning Code, Chapter 25, Hawaii County Code (Planning Department)

a. Gap: High hazard areas, including volcanic hazards not incorporated in zoning code.

b. Opportunity:

  - Amend zoning code to adopt natural hazards overlay zones, including high risk volcanic zones
  - Set appropriate conditions for land use, siting, and design within high risk zones.

c. Gap: Rules for zoning amendment do not recognize natural hazards including volcanic hazards such that a zoning amendment for higher density development could be approved in a high hazard area

d. Opportunity:

  - Amend procedure for zoning amendment to consider natural hazards and restrict higher use development in high risk hazard areas.

e. Gap: Current zoning code does not allow density transfers or transfer of development rights where high hazard areas exist

f. Opportunities:

  - Transfer of Development Rights (TDR) - Chapter 46-161 Hawaii Revised Statutes, enacted 1998 enables Hawaii County to exercise power to transfer development rights within a comprehensive planning program.

- Conduct background research on TDR, including a real estate market analysis (REMA) as part of feasibility analysis2.
- If feasible, amend County Code to allow for special permits or other mechanism that authorizes TDR.

3. Subdivision Code, Chapter 23, Hawaii County Code (Planning Department)

   a. Gap: Subdivision code allows subdivision of land within or adjacent to natural hazard areas, including high risk volcanic areas
   b. Opportunity
      - Restrict subdivision of land within or adjacent to high risk volcanic areas, as well as other identified high risk hazard areas
   c. Gap: Current subdivision code does not allow density transfers or transfer of development rights where high hazard areas exist
   d. Opportunity:
      - Amend subdivision code to allow for density transfers or transfer of development rights.
   e. Gap: County codes address wildfires by requiring adequate fire truck access, hydrant placement, and water system sizing but does not include "Firewise landscaping principles" or "defensible space" for common areas and for individual homes.
   f. Opportunities
      - (From S. Kohala CDP and APA Hazard Mitigation Policies) Strategic use of green spaces, vegetation management "defensible space" landscaping, placement of dip tanks
      - (From S. Kohala CDP) County Planning Department should consider requiring all applicants for subdivision approvals to complete a wildfire hazard mitigation plan with specific elements identified, including Firewise landscaping principles.
      - (From APA Hazard Mitigation Policies) Require that subdivisions include multiple and adequate ingress and egress routes for evacuation.
   g. Gap: Code requires stormwater retention on site for one-hour, 10-year storm.
   h. Opportunity:
      - Cluster development to conserve green space – non structural stormwater mitigation
   i. Gap: Does not include requirements for subdivisions that are within special flood hazard areas
   j. Opportunity:
      - Include building, structure, drainage, higher elevation and flood proofing for buildings in SFHA
      - Include requirements for floodable open space areas in subdivision within SFHA

[2] Massachusetts Government Smart Growth / Smart Energy Toolkit Modules -Transfer of Development Rights (TDR). https://www.mass.gov/service-details/smart-growth-smart-energy-toolkit-modules-transfer-of-development-rights-tdr

4. Land use plans: Hawaii County General Plan (GP), 2005; Draft Update (est. 2019) Hawaii County General Plan Element Compilation Rationale

   a. Gap: 2005 General Plan recognizes that certain areas susceptible to natural hazards may need to be kept open and not utilized for buildings, structures or other economic development purposes. The "open" district of County Zoning Code, intended for open type uses does permit golf courses, with a use permit, some recreational facilities, and various public and utility-type facilities.
   b. Opportunities: Reduce developments in identified high risk hazard areas;

      - (from Draft 2019 GP Update) Actions – (i)Adopt natural hazard overlay zones and set appropriate conditions for land use, siting, and design within high risk zones; (ii) Identify redevelopment opportunities within or adjacent to Urban Growth Areas but outside of high risk hazard areas; (iii) Update existing, or map new potential, hazard areas for consideration in long term planning decisions.
      - (from Draft 2019 GP Update) - Coastal High Hazard Area is the area including tsunami inundation, sea level rise and special flood hazard areas. The Coastal High Hazard Area shall be shown on the Future Land Use Map.
      - (from Draft 2019 GP Update) Discourage infrastructure investments in high risk hazard areas and incentivize infrastructure expenditures outside high risk hazard areas.
      - (From 2015 HMP) – propose a new policy to "Amend the Zoning Code to create a category for lands that should be kept in a largely natural state, but that may not be in the Conservation District, such as certain important view planes, buffer areas, and very steep slopes."

   c. Gap: High risk hazard sending areas and low risk hazard receiving areas not identified for a Transfer of Development Rights (TDR) program
   d. Opportunity:

      - Identify specific sending (e.g. natural hazard overlay districts) and receiving districts (e.g. areas within or adjacent to Urban Growth Areas) and incentives such as density, intensity of use, floor space, and portion of lot covered.

   e. Gap: 2005 GP devotes Entire section to Flood and Natural Disaster Risks but does not integrate into other sectors.
   f. Opportunity:

      - (From 2015 HMP) – Integrate Hazard information into all chapters and resource areas, including Chapter 2 Economics, Chapter 3 Energy, Chapter 5 integrate executive summary from 2015 HMP, Chapter 9 Housing, Chapter 10 Public Facilities, Chapter 11 Public Utilities, Chapter 13 Transportation, Chapter 14 Land use.
      - Chapter 3 – Energy: Include high wind vulnerability of transmission and distribution of energy, and fuel tank farm vulnerability to tsunami.
      - Chapter 5 - Housing: Include hazard mitigation and protection of property as an objective, not just reduction of regulations affecting availability.
      - Chapter 10 – Public Facilities: Introduce and define Critical Facilities and Infrastructure, necessary for community disaster response and recovery.
      - Chapter 11 – Public Utilities: Introduce Critical Infrastructure, necessary for community disaster response and recovery, e.g., that are "too important to fail". Include policy to discourage infrastructure in natural hazard areas especially high risk hazards such as high risk lava zones.

  - Chapter 13 – Transportation: Include policy for design for seismic effects and protection from rockfalls, especially bridges. Include policy for identifying alternative routes for evacuation in the event of volcanic eruption or other high risk hazard event.
  - Chapter 14 – Land Use: Acknowledge design for enhanced resilience as being a valid mitigation in a hazard zone.

g. Gap: (from Draft 2019 GP Update) There are gaps and outdated flood data around the island and recent flooding events particularly damaging and life-threatening in urban areas.
h. Opportunity:

  - Prioritize drainage and flood studies for high risk urban areas within the Urban Growth Area

5. Community Development Plans (CDPs): Kona, Puna, North Kohala, South Kohala, Kaʻu, Hamakua, Hilo

a. Gaps: CDPs recognize most hazards as threats, with one CDP recognizing future SLR as threat (S. Kohala).
b. Opportunities:

  - Reduce development in identified high risk hazard areas, including SLR-XA3 or Coastal High Hazard Area.
  - (from Draft 2019 GP Update) Actions – (i)Adopt natural hazard overlay zones and set appropriate conditions for land use, siting, and design within high risk zones; (ii) Identify redevelopment opportunities within or adjacent to Urban Growth Areas but outside of high risk hazard areas; (iii) Update existing, or map new potential, hazard areas for consideration in long term planning decisions.
  - (from Draft 2019 GP Update) Discourage infrastructure investments in high risk hazard areas and incentivize infrastructure expenditures outside high risk hazard areas.

c. Gaps: Only Puna CDP calls on identifying alternative routes in case of emergency
d. Opportunity:

  - Recommend all CDPs to identify alternative routes in case of disaster event or emergency for evacuation.

e. Gap: Present or historic wetlands are not mapped and identified
f. Opportunity:

  - Identify and map any present-day or historical wetlands in the CDP, where appropriate.
  - Identify overlaps with future sea level rise exposure areas. These areas might present opportunities for wetland restoration.

6. Housing Policy and plans: Chapter 11 – Affordable Housing, H.C.C. last updated 2016; Affordable Rental Housing 10-year Report; Consolidated Plan 2015-2019, 2015; C.o.H Housing

[3] Hawaiʻi Climate Change Mitigation and Adaptation Commission. 2017. *HI SLR Report*.; Pacific Islands Ocean Observing System. 2018. "Sea Level Rise: Hawaiʻi Sea Level Rise Viewer." https://www.pacioos.hawaii.edu/shoreline/slr-hawaii/

Planning Study 2011; Hawaii State, Housing Planning Study 2011; 2005 General Plan and 2019 General Plan Draft Update Housing Elements

a. Gap: in Affordable Housing policy (Chapter 11, H.C.C.) objectives has no mention of high hazard areas.
b. Opportunity:

   - Consider including in affordable housing objectives: "to promote and assist housing for seniors and persons with disabilities with consideration of high hazard areas," and "require residential developers include affordable housing in their projects or off site with consideration of hazard areas."

c. Gap: Integration of high volcanic hazard risk, sea level rise data and other high hazard data into assessment for the construction of new affordable housing including rentals into housing plans.
d. Opportunity:

   - Do not allow new affordable housing or rental housing in identified high risk hazard areas.

e. Gap: There is existing housing in high risk hazard areas
f. Opportunity:

   - (From 2019 General Plan Draft Update) pg. 21 Hazard -Action -"93.7 Assess the feasibility of hazard mitigation strategies such as impact fees, TDR, tax incentive, evacuation rate-based build-out, portable housing, zoning and overlay zones, acquisition during updates to the Multi-Hazard Mitigation Plan. "

7. Drainage:

a. Gap: (from 2015 HMP) Drainage standards based on 10 year storm, need to be reevaluated to better account for cumulative upslope development
b. Opportunity

   - Drainage standards to account for cumulative upslope development

c. Gap: (from Draft 2019 GP Update; Hamakua CDP Policy 95; Kona CDP Action ENV 1.7) Drainage Master Plan does not recognize corridors or take a watershed approach
d. Opportunity

   - Identify flood corridors as per Kona CDP Action ENV 1.7
   - Include the new studies and provide a watershed perspective in managing floods using both structural and non-structural methods (from Draft 2019 GP Update)

8. Coastal zone management (County Planning Department)

a. Gap: Shoreline setback line (Rule 11 of County Rules) is based on HRS §205A minimum of 40ft from shoreline.
b. Opportunity

   - Update setback policy to redefine setback line based on historical erosion rates and future rates based on 3.2‘ of sea level rise.
   - Fund shoreline change study (current County proposal)

c. Gap: 3.2 feet of Sea level rise not recognized as important constraint when reviewing applications for new subdivisions, commercial areas, hotels, and other development activities in shoreline management area.
d. Opportunity:

- Update boundaries of Shoreline Management Area (SMA) to coincide with 3.2 feet of sea level rise (or SLR-XA) (from Hawaii Sea Level Rise Vulnerability and Adaptation Report).

9. Capital Improvement Plan

a. Gap: Projects eligible for funding do not require an in-depth analysis of high risk hazards.
b. Opportunities:

- Consider requiring an in-depth analysis of high risk volcanic hazards and other high risk hazards where data is available for project eligibility and prioritization.
- Consider requiring an in-depth analysis of sea level rise impacts based on elevation, tolerance for risk, and lifetime of the structure (from Hawaii Sea Level Rise Vulnerability and Adaptation Report, 2017).

Transportation

1. Transportation Plans: County of Hawaii Transit and Multi-Modal Master Plan, 2018; Puna Regional Circulation Plan.

a. Gap: COH multi-modal Master Plan identifies the impact that lava flow can have on the transit system, specifically in the Puna District. Acknowledges other hazards can have on transit system (e.g. hurricane impacts);
b. Opportunities:

- (From General Plan Draft Update 2019) Mass Transit –Policy- “The County’s public transit system accommodates redeployment for emergency evacuations.”

c. Gap: Redundancy in transportation network. (From 2015 HMP) “lack of redundancy in the highway system on the Island of Hawaii, road closures due to rockfalls, landslides or embankment slope instability can have a significant effect on emergency response and economic recovery efforts” p. 18-30. “…scarcity of access roads creates a problem should lava flows, storms or earthquakes, sever these roads” p.18-31.
d. Opportunities:
e. (From 2015 HMP) “Future updates to this plan will identify critical road segments [for evacuation] that require hardening or an emergency bypass” p. 8-31).

- Propose alternative circulation routes and alternatives in case of emergency (similar to Puna Plan – see next)
- Expand Puna Regional Circulation Plan - addresses future automobile, bicycle, pedestrian, and transit corridors of the Puna District. Proposes future transportation corridors in Puna till year 2030, includes proposed circulation routes and alternatives in case of emergency.
- (From Hāmākua CDP, p 69 and General Plan Draft Update 2019) Improving Transportation Systems -Action-"173.2 Develop a roads-in-limbo improvement and adoption process according to population, usage, alternative route/connectivity needs, and safety assessments.

f. Gap: Need systems in place to ensure transportation systems functions under disaster conditions and allows for evacuation, e.g. MOU between agencies for sharing data, alternative communications systems
g. Opportunities:

- MOU between agencies for sharing data and information before, during, and after a disaster
- Establish interoperable communication systems (e.g., for communication between transportation entities and first responders)

Other Infrastructure Lifeline Facilities & Systems:

energy (electrical, fuel, gas), communication (wired/cabled telecommunication, wireless), water, wastewater

1. Gap: Policy in place critical lifeline transportation facilities (airport, harbors) from hazard events and locate outside of high hazard areas.
2. Opportunity:

- (From General Plan Draft Update 2019) pg. 52 Airports and Harbors- Agency Collaboration & Advocacy- "220.2.4 Encourage the modernization and maximized use/capacity of airports and harbors, including resistance to damage from natural hazards and disasters and separation of cargo and passenger uses."

Climate Change

Sustainability

Natural Resource Protection Plans

Three Mountain Alliance (TMA) Watershed Plan, December 2007; Kohala Watershed Alliance (KWA) Watershed Plan, 2007; Mauna Kea Alliance Watershed Plan, April 2010

1. All plans include goals and strategies to minimize wildfires, flood impacts and erosion/landslides
2. Opportunities:

- Continue to work/coordinate with large land owners to develop wildfire protection plans

Cultural Resource Protection

1. Gap: (From General Plan Draft Update 2019, Policy 543 and Action 543.1) Wahi Pana designation needed and criteria needed for designating special places as Wahi Pana
2. Opportunity:

- Amend zoning code and rules to develop a regulatory provision for Special Area Plans for natural resource protection for areas designated as Wahi Pana

Economic Development

Emergency Management

1. Gap: Debris Management Plan
2. Opportunity:

   - Consider developing a County Debris Management Plan

County of Hawai‘i Multi-Hazard Mitigation Plan

Appendix E. Hazard Mapping Data Sources and Methods

E. HAZARD MAPPING DATA SOURCES AND METHODS

The following risk-area data sources were used for project mapping and to update the Hazus inventory for the Level 2 analyses conducted for the risk assessment.

DAM FAILURE

Dam failure inundation area data was provided by the Pacific Disaster Center. Original Individual Assessment Reports and accompanying data were prepared under contract for DLNR. The dam break scenarios depicted in the reports utilized the Danish Hydrological Institute's MIKE 21 model. Using the inundation area boundaries and U.S. Geological Survey (USGS) 10-meter DEM data, inundation depth grids were generated and integrated into the Hazus model. Depth grids were generated for dam failure inundation areas that contain buildings as follows:

- Pūnāwai Reservoir
- Pu'ukapu Watershed Retarding Dam R-1
- Pu'u Pūlehu Reservoir
- Waikoloa Reservoir No. 1/2/3
- Waimea 60 Mg Reservoir

EARTHQUAKE

Earthquake ShakeMap and probabilistic data prepared by the USGS were used for the analysis of this hazard. National Earthquake Hazard Reduction Program (NEHRP) soils data provided by AECOM and landslide susceptibility data provided by the Pacific Disaster Center were also integrated into the Hazus model.

FLOOD

The effective Digital Flood Insurance Rate Maps (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance flood event. The DFIRM is effective as of September 29, 2017. Using the DFIRM floodplain boundaries, National Oceanic and Atmospheric Administration (NOAA) 3-meter coastal digital elevation model (DEM), and USGS 10-meter DEM data, flood depth grids were generated and integrated into the Hazus model.

TROPICAL CYCLONE

Category 4 wind field import files provided by the Pacific Disaster Center were used for the analysis of this hazard. The wind field files were created for the Hawai'i Catastrophic Hurricane Plan. Storm surge vulnerability was estimated using the coastal flood analysis.

CLIMATE CHANGE/SEA LEVEL RISE

Sea level rise data compiled for the Hawai'i Sea Level Rise Vulnerability and Adaptation Report was used for the exposure analyses. The Sea Level Rise Exposure Area (SLR-XA) 3.2ft scenario represents future chronic coast flooding. The 1%-Annual-Chance Coastal Flood Zone (1%CFZ) + 3.2ft SLR scenario represents event-based coastal flooding plus sea level rise.

HIGH WIND STORM

Straight line wind awareness areas data was provided by Hawaiʻi County. These areas were delineated by the County for the purposes of this plan.

LANDSLIDE

Landslide susceptibility data for Hawaiʻi County was provided by the Pacific Disaster Center. This data is attributed for use in Hazus, susceptibility type values range from 1 (least susceptible) to 10 (most susceptible).

TROPICAL CYCLONE (STORM SURGE)

SLOSH (Sea, Lake, and Overland Surges from Hurricane) data provided by NOAA was used for the exposure analysis. The data is the maximum of maximums for a Category 4 tropical cyclone. This data was created by running multiple analysis runs for hurricanes approaching from different directions and retaining the highest value at a given location. The storm surge inundation is from wave action and does not include freshwater inundation.

TSUNAMI

Tsunami inundation area data was provided by Hawaiʻi County. The data was created for the 2009 Hawaiʻi Tsunami Mapping Project. The maximum inundation limit was computed from the 1946 Aleutian, 1952 Kamchatka, 1957 Aleutian, 1960 Chile and 1964 Alaskan Tsunamis simulated at both mean-sea-level (MSL) and high tide conditions.

The data and its interpretations are intended for emergency management personnel reference and evacuation zone development and are not intended for land-use planning and coastal infrastructure design. The project utilizes the latest bathymetry and topography, two-dimensional numerical models, and Geographical Information System (GIS) and Google Map technologies. The mapping effort considered the five most destructive tsunamis affecting Hawaiʻi during the last century. Reconstruction of these tsunamis using a two-dimensional long-wave model determines the inundation limits of the last 100 years that provides a basis for the evacuation map update. The historical run-up records provide data for model and procedure calibration and assure the quality of the data products. Comparisons between the updated and current inundation limits show good agreement in areas with straight and open coastlines. The updated inundation limits generally show more severe inundation in flat areas adjacent to steep slopes and embayments, where the one-dimensional model used in the previous inundation mapping cannot adequately describe the complex flow pattern.

VOLCANIC ERUPTION

Buffered lava flow hazard zones 1 and 2, and historic lava flows data were used for the exposure analysis. The lava flow hazard zones and historic lava flows data was provided by the USGS. Lava flow hazard zone 1 includes the summits and rift zones of Kīlauea and Mauna Loa, where vents have been repeatedly active in historical time; lava zone 2 includes areas adjacent to and downslope of lava zone 1, with 15 to 25% of lava zone 2 being covered by lava since 1800. The zone boundaries are approximate and gradational. A 1,000-foot buffer was added to each lava zone to account for the uncertainty of the location of the zone boundaries. The historic lava flows data delineates eruptions during the period from 1790 to 2018.

WILDFIRE

Communities at Risk from Wildfire data was provided by the Hawaiʻi Wildfire Management Organization. The data was categorized as high, medium and low fire risk ratings using the Communities at Risk from Wildfire map produced by Hawaiʻi Department of Land and Natural Resources' Division of Forestry and Wildlife (DOFAW) and Hawaiʻi Wildfire Management Organization. High and medium categories were used for the exposure analysis.

County of Hawai‘i Multi-Hazard Mitigation Plan

Appendix F. Detailed Risk Assessment Results

Risk Assessment Results		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	39	0	0	3	581	0	1,168	346	88	**2,225**
	Population Exposed (3)	110	0	0	3	1,231	0	2,607	540	262	**4,754**
	% of Population Exposed	1.5%	0.0%	0.0%	0.0%	2.8%	0.0%	5.0%	3.3%	2.5%	**2.5%**
	Value Structure in $ Exposed (2)	$5,640,653	$0	$0	$621,054	$188,833,379	$0	$5,247,826,849	$187,781,332	$16,488,171	**$5,647,191,438**
	Value Contents in $ Exposed (2)	$3,003,813	$0	$0	$566,240	$125,839,190	$0	$5,154,934,934	$102,086,164	$8,461,034	**$5,394,891,374**
	Value (Structure and contents in $) Exposed (2)	$8,644,466	$0	$0	$1,187,294	$314,672,568	$0	$10,402,761,782	$289,867,496	$24,949,205	**$11,042,082,811**
	% of Total Value Exposed	0.9%	0.0%	0.0%	0.1%	2.3%	0.0%	39.5%	4.1%	1.6%	**19.0%**
Economic Impact	Structure Debris (Tons) (4)	3	0	0	0	8	0	640	119	5	**775**
	Displaced Population (5)	4	0	0	0	22	0	230	53	10	**319**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	8	1	0	**9**
	Buildings Impacted (6)	10	0	0	0	141	0	281	190	9	**631**
	Value Structure in $ Damaged (6)	$527,711	$0	$0	$0	$8,826,152	$0	$10,314,321	$12,506,049	$95,614	**$32,269,847**
	Value Contents in $ Damaged (6)	$288,851	$0	$0	$0	$9,574,861	$0	$6,530,920	$7,543,410	$60,090	**$23,998,131**
	Total Value (Structure and Contents in $) Damaged (6)	$816,563	$0	$0	$0	$18,401,013	$0	$16,845,240	$20,049,458	$155,704	**$56,267,978**
	% of Total Value Damaged	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.3%	0.0%	**0.1%**
	Acres of Floodplain	921	154	0	203	1,030	335	2,391	1,519	868	**7,421**
Number of Structures in Floodplain (2)	Residential	37	0	0	1	509	0	916	326	86	**1,875**
	Commercial	2	0	0	2	57	0	241	13	2	**317**
	Industrial	0	0	0	0	3	0	1	0	0	**4**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	10	0	9	6	0	**25**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	2	0	1	1	0	**4**
	Total	39	0	0	3	581	0	1168	346	88	**2225**

Sources
(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Probability Factor (3,2,1,0)	3	3	3	3	3	3	3	3	3	**3**
Impact on People	% Population Exposed	1.47%	0.00%	0.00%	0.04%	2.80%	0.00%	4.99%	3.26%	2.46%	**2.48%**
	Impact (High, Medium, Low, None)	Low	None	None	Low	Low	None	Low	Low	Low	**Low**
	Impact Factor	1	0	0	1	1	0	1	1	1	**1**
	Weighted Impact Factor	3	0	0	3	3	0	3	3	3	**3**
Impact on Property	% of Total Value Exposed	0.90%	0.00%	0.00%	0.13%	2.31%	0.00%	39.53%	4.13%	1.65%	**18.98%**
	Impact (High, Medium, Low, None)	Low	None	None	Low	Low	None	High	Low	Low	**Medium**
	Impact Factor	1	0	0	1	1	0	3	1	1	**2**
	Weighted Impact Factor	2	0	0	2	2	0	6	2	2	**4**
Impact on Economy	% of Total Value Damaged	0.08%	0.00%	0.00%	0.00%	0.13%	0.00%	0.06%	0.29%	0.01%	**0.10%**
	Impact (High, Medium, Low, None)	Low	None	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	1	0	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	1	0	0	0	1	0	1	1	1	**1**
Ranking	Risk Ranking Score	18	0	0	15	18	0	30	18	18	**24**
	Hazard Risk Rating	Medium	Low	Low	Medium	Medium	Low	High	Medium	Medium	**Medium**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	0	5	0	0	216	13	326	5	23	**588**
	Population Exposed (3)	0	6	0	0	474	31	754	7	70	**1,342**
	% of Population Exposed	0.0%	0.1%	0.0%	0.0%	1.1%	0.1%	1.4%	0.0%	0.7%	**0.7%**
	Value Structure in $ Exposed (2)	$0	$2,326,151	$0	$0	$85,635,570	$2,298,698	$179,201,148	$3,393,747	$3,510,932	**$276,366,246**
	Value Contents in $ Exposed (2)	$0	$2,151,853	$0	$0	$56,856,738	$1,149,349	$122,690,664	$1,991,292	$1,755,466	**$186,595,362**
	Value (Structure and contents in $) Exposed (2)	$0	$4,478,004	$0	$0	$142,492,308	$3,448,047	$301,891,812	$5,385,040	$5,266,397	**$462,961,608**
	% of Total Value Exposed	0.0%	0.4%	0.0%	0.0%	1.0%	0.1%	1.1%	0.1%	0.3%	**0.8%**
Economic Impact	Structure Debris (Tons) (4)	0	0	0	0	1	0	0	0	0	**1**
	Displaced Population (5)	0	0	0	0	18	2	160	0	1	**181**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	17	0	0	**17**
	Buildings Impacted (6)	0	3	0	0	85	1	53	2	13	**157**
	Value Structure in $ Damaged (6)	$0	$226,028	$0	$0	$13,077,068	$36,925	$3,139,089	$1,285,426	$803,948	**$18,568,483**
	Value Contents in $ Damaged (6)	$0	$930,415	$0	$0	$8,160,152	$17,512	$7,525,828	$642,713	$398,404	**$17,675,024**
	Total Value (Structure and Contents in $) Damaged (6)	$0	$1,156,443	$0	$0	$21,237,220	$54,437	$10,664,917	$1,928,139	$1,202,353	**$36,243,508**
	% of Total Value Damaged	0.0%	0.1%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.1%	**0.1%**
	Acres of Floodplain	1,734	6,121	0	3,013	4,036	4,776	1,335	1,746	3,778	**26,538**
Number of Structures in Floodplain (2)	Residential	0	3	0	0	196	13	265	4	23	**504**
	Commercial	0	2	0	0	20	0	60	1	0	**83**
	Industrial	0	0	0	0	0	0	1	0	0	**1**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	0	0	**0**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	0	5	0	0	216	13	326	5	23	**588**

Sources
(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Probability Factor (3,2,1,0)	3	3	3	3	3	3	3	3	3	**3**
Impact on People	% Population Exposed	0.00%	0.08%	0.00%	0.00%	1.08%	0.07%	1.44%	0.04%	0.66%	**0.70%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	Low	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	1	1	1	1	**1**
	Weighted Impact Factor	0	3	0	0	3	3	3	3	3	**3**
Impact on Property	% of Total Value Exposed	0.00%	0.39%	0.00%	0.00%	1.04%	0.05%	1.15%	0.08%	0.35%	**0.80%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	Low	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	1	1	1	1	**1**
	Weighted Impact Factor	0	2	0	0	2	2	2	2	2	**2**
Impact on Economy	% of Total Value Damaged	0.00%	0.10%	0.00%	0.00%	0.16%	0.00%	0.04%	0.03%	0.08%	**0.06%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	1	0	0	1	0	1	1	1	**1**
Ranking	Risk Ranking Score	0	18	0	0	18	15	18	18	18	**18**
	Hazard Risk Rating	Low	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium	**Medium**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	12	6	0	0	955	14	1,128	345	83	**2,543**
	Population Exposed (4)	36	8	0	0	2,105	31	2,186	552	253	**5,170**
	% of Population Exposed	0.48%	0.10%	0.00%	0.00%	4.78%	0.07%	4.18%	3.33%	2.37%	**2.70%**
	Value Structure in $ Exposed (2)	1,357,277	2,781,469	0	0	391,127,897	3,020,624	5,518,626,158	194,854,985	14,873,237	**6,126,641,646**
	Value Contents in $ Exposed (2)	678,639	2,379,512	0	0	237,104,606	1,637,047	5,397,683,482	100,325,504	7,436,618	**5,747,245,409**
	Value (Structure and contents in $) Exposed (2)	2,035,916	5,160,981	0	0	628,232,503	4,657,672	10,916,309,640	295,180,489	22,309,855	**11,873,887,056**
	% of Total Value	0.21%	0.45%	0.00%	0.00%	4.60%	0.07%	41.48%	4.20%	1.47%	**20.40%**
Number of Structures in Hazard Area (2)	Residential	12	4	0	0	870	13	768	333	83	**2,083**
	Commercial	0	2	0	0	72	1	355	10	0	**440**
	Industrial	0	0	0	0	4	0	2	0	0	**6**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	7	0	3	2	0	**12**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	2	0	0	0	0	**2**
	Total	12	6	0	0	955	14	1,128	345	83	**2,543**

Sources:
(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) 1%-Annual-Chance Coastal Flood Zone (1%CFZ) + 3.2ft SLR from the 2017 Hawaii Sea Level Rise Vulnerability and Adaptation Report.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	0.48%	0.10%	0.00%	0.00%	4.78%	0.07%	4.18%	3.33%	2.37%	**2.70%**
	Impact (High, Medium, Low, None)	Low	Low	None	None	Low	Low	Low	Low	Low	**Low**
	Impact Factor	1	1	0	0	1	1	1	1	1	**1**
	Weighted Impact Factor	3	3	0	0	3	3	3	3	3	**3**
Impact on Property	% of Total Value Exposed	0.21%	0.45%	0.00%	0.00%	4.60%	0.07%	41.48%	4.20%	1.47%	**20.40%**
	Impact (High, Medium, Low, None)	Low	Low	None	None	Low	Low	High	Low	Low	**Medium**
	Impact Factor	1	1	0	0	1	1	3	1	1	**2**
	Weighted Impact Factor	2	2	0	0	2	2	6	2	2	**4**
Impact on Economy	% of Total Value Damaged	0.21%	0.45%	0.00%	0.00%	4.60%	0.07%	41.48%	4.20%	1.47%	**20.40%**
	Impact (High, Medium, Low, None)	Low	Low	None	None	Low	Low	High	Low	Low	**High**
	Impact Factor	1	1	0	0	1	1	3	1	1	**3**
	Weighted Impact Factor	1	1	0	0	1	1	3	1	1	**3**
Ranking	Risk Ranking Score	12	12	0	0	12	12	24	12	12	**20**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Medium	Low	Low	**Medium**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	0	2	0	0	4	0	7	26	1	**40**
	Population Exposed (4)	0	0	0	0	10	0	17	38	3	**68**
	% of Population Exposed	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.03%	0.23%	0.03%	**0.04%**
	Value Structure in $ Exposed (2)	0	1,977,555	0	0	3,100,878	0	2,283,668	93,203,177	158,540	**100,723,818**
	Value Contents in $ Exposed (2)	0	1,977,555	0	0	1,550,439	0	1,684,785	47,243,706	79,270	**52,535,755**
	Value (Structure and contents in $) Exposed (2)	0	3,955,110	0	0	4,651,316	0	3,968,454	140,446,883	237,810	**153,259,573**
	% of Total Value	0.00%	0.34%	0.00%	0.00%	0.03%	0.00%	0.02%	2.00%	0.02%	**0.26%**
Number of Structures in Hazard Area (2)	Residential	0	0	0	0	4	0	6	23	1	**34**
	Commercial	0	2	0	0	0	0	1	2	0	**5**
	Industrial	0	0	0	0	0	0	0	0	0	**0**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	1	0	**1**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	0	2	0	0	4	0	7	26	1	**40**

Sources:
(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Sea Level Rise Exposure Area (SLR-XA) 3.2ft from the 2017 Hawaii Sea Level Rise Vulnerability and Adaptation Report.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.03%	0.23%	0.03%	**0.04%**
	Impact (High, Medium, Low, None)	None	None	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	0	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	0	0	0	3	0	3	3	3	**3**
Impact on Property	% of Total Value Exposed	0.00%	0.34%	0.00%	0.00%	0.03%	0.00%	0.02%	2.00%	0.02%	**0.26%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	2	0	0	2	0	2	2	2	**2**
Impact on Economy	% of Total Value Damaged	0.00%	0.34%	0.00%	0.00%	0.03%	0.00%	0.02%	2.00%	0.02%	**0.26%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	1	0	0	1	0	1	1	1	**1**
Ranking	Risk Ranking Score	0	6	0	0	12	0	12	12	12	**12**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	1	4	0	0	896	3	1,061	592	5	**2,562**
	Population Exposed (4)	3	4	0	0	1,967	7	2,260	933	15	**5,190**
	% of Population Exposed	0.04%	0.05%	0.00%	0.00%	4.47%	0.02%	4.32%	5.62%	0.14%	**2.71%**
	Value Structure in $ Exposed (2)	114,689	2,219,333	0	0	382,549,116	422,327	964,092,478	414,966,056	881,683	**1,765,245,684**
	Value Contents in $ Exposed (2)	57,344	2,098,444	0	0	241,755,237	211,164	851,253,329	215,329,289	440,842	**1,311,145,649**
	Value (Structure and contents in $) Exposed (2)	172,033	4,317,778	0	0	624,304,354	633,491	1,815,345,807	630,295,346	1,322,525	**3,076,391,333**
	% of Total Value	0.02%	0.37%	0.00%	0.00%	4.57%	0.01%	6.90%	8.98%	0.09%	**5.29%**
Number of Structures in Hazard Area (2)	Residential	1	2	0	0	813	3	794	563	5	**2,181**
	Commercial	0	2	0	0	70	0	257	27	0	**356**
	Industrial	0	0	0	0	4	0	3	0	0	**7**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	7	0	7	2	0	**16**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	2	0	0	0	0	**2**
	Total	1	4	0	0	896	3	1,061	592	5	**2,562**

Sources:
(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) 2009 Hawaii Tsunami Mapping Project data provided by Hawaii County.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	0.04%	0.05%	0.00%	0.00%	4.47%	0.02%	4.32%	5.62%	0.14%	**2.71%**
	Impact (High, Medium, Low, None)	Low	Low	None	None	Low	Low	Low	Low	Low	**Low**
	Impact Factor	1	1	0	0	1	1	1	1	1	**1**
	Weighted Impact Factor	3	3	0	0	3	3	3	3	3	**3**
Impact on Property	% of Total Value Exposed	0.02%	0.37%	0.00%	0.00%	4.57%	0.01%	6.90%	8.98%	0.09%	**5.29%**
	Impact (High, Medium, Low, None)	Low	Low	None	None	Low	Low	Low	Low	Low	**Low**
	Impact Factor	1	1	0	0	1	1	1	1	1	**1**
	Weighted Impact Factor	2	2	0	0	2	2	2	2	2	**2**
Impact on Economy	% of Total Value Damaged	0.02%	0.37%	0.00%	0.00%	4.57%	0.01%	6.90%	8.98%	0.09%	**5.29%**
	Impact (High, Medium, Low, None)	Low	Low	None	None	Low	Low	Medium	Medium	Low	**Medium**
	Impact Factor	1	1	0	0	1	1	2	2	1	**2**
	Weighted Impact Factor	1	1	0	0	1	1	2	2	1	**2**
Ranking	Risk Ranking Score	12	12	0	0	12	12	14	14	12	**14**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Estimated Exposure	Estimated Population (1)	7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
	% Population Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
	Total Number of Buildings (2)	2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
	Total Building Value (Structure and contents in $) (2)	$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
	% of Total Value Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
Economic Impact	Structure Debris (x 1,000 Tons) (3)	2.73	18.81	2.14	1.62	122.19	73.28	196.99	20.30	14.34	**452.39**
	Number of Displaced Households (3)	4	80	4	1	309	232	243	27	51	**953**
	People Requiring Short-Term Shelter (3)	3	59	2	1	178	173	183	15	34	**647**
	Total Value (Structure and Contents in $) Damaged (4)	$75,502,990	$189,523,838	$23,737,719	$29,062,559	$1,144,160,127	$991,243,505	$3,644,020,279	$495,080,532	$129,057,443	**6,721,388,993**
	% of Total Value Damaged	7.8%	16.4%	7.4%	3.1%	8.4%	15.7%	13.8%	7.1%	8.5%	**11.6%**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(3) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	9	9	9	9	9	9	9	9	9	**9**
Impact on Property	% of Total Value Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	6	6	6	6	6	6	6	6	6	**6**
Impact on Economy	% of Total Value Damaged	7.82%	16.43%	7.39%	3.06%	8.38%	15.72%	13.85%	7.05%	8.53%	**11.55%**
	Impact (High, Medium, Low, None)	Medium	High	Medium	Low	Medium	High	High	Medium	Medium	**High**
	Impact Factor	2	3	2	1	2	3	3	2	2	**3**
	Weighted Impact Factor	2	3	2	1	2	3	3	2	2	**3**
Ranking	Risk Ranking Score	34	36	34	32	34	36	36	34	34	**36**
	Hazard Risk Rating	High	High	High	High	High	High	High	High	High	**High**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Estimated Exposure	Estimated Population (1)	7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
	% Population Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
	Total Number of Buildings (2)	2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
	Total Building Value (Structure and contents in $) (2)	$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
	% of Total Value Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
Economic Impact	Structure Debris (x 1,000 Tons) (3)	1.69	0.09	0.11	6.11	117.52	0.18	7.88	63.37	0.61	**197.56**
	Number of Displaced Households (3)	0	0	0	0	71	0	1	95	0	**167**
	People Requiring Short-Term Shelter (3)	0	0	0	0	41	0	1	51	0	**93**
	Total Value (Structure and Contents in $) Damaged (4)	$142,316,776	$19,868,550	$19,695,883	$140,758,472	$907,381,187	$3,387,045	$981,523,986	$1,237,135,832	$9,366,010	**3,461,433,741**
	% of Total Value Damaged	14.7%	1.7%	6.1%	14.8%	6.6%	0.1%	3.7%	17.6%	0.6%	**5.9%**

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(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(3) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	9	9	9	9	9	9	9	9	9	**9**
Impact on Property	% of Total Value Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	6	6	6	6	6	6	6	6	6	**6**
Impact on Economy	% of Total Value Damaged	14.75%	1.72%	6.13%	14.83%	6.65%	0.05%	3.73%	17.62%	0.62%	**5.95%**
	Impact (High, Medium, Low, None)	High	Low	Medium	High	Medium	Low	Low	High	Low	**Medium**
	Impact Factor	3	1	2	3	2	1	1	3	1	**2**
	Weighted Impact Factor	3	1	2	3	2	1	1	3	1	**2**
Ranking	Risk Ranking Score	36	32	34	36	34	32	32	36	32	**34**
	Hazard Risk Rating	High	High	High	High	High	High	High	High	High	**High**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Estimated Exposure	Estimated Population (1)	7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
	% Population Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
	Total Number of Buildings (2)	2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
	Total Building Value (Structure and contents in $) (2)	$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
	% of Total Value Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
Economic Impact	Structure Debris (x 1,000 Tons) (3)	0.05	2.38	0.07	0.02	0.47	26.72	37.83	0.16	0.20	**67.90**
	Number of Displaced Households (3)	0	0	0	0	0	12	19	0	0	**32**
	People Requiring Short-Term Shelter (3)	0	0	0	0	0	10	15	0	0	**24**
	Total Value (Structure and Contents in $) Damaged (4)	$814,430	$57,156,526	$1,591,255	$224,008	$6,911,511	$343,039,837	$2,258,922,222	$6,787,119	$2,383,255	**2,677,830,163**
	% of Total Value Damaged	0.1%	5.0%	0.5%	0.0%	0.1%	5.4%	8.6%	0.1%	0.2%	**4.6%**

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(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(3) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	9	9	9	9	9	9	9	9	9	**9**
Impact on Property	% of Total Value Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	6	6	6	6	6	6	6	6	6	**6**
Impact on Economy	% of Total Value Damaged	0.08%	4.95%	0.50%	0.02%	0.05%	5.44%	8.58%	0.10%	0.16%	**4.60%**
	Impact (High, Medium, Low, None)	Low	Low	Low	Low	Low	Medium	Medium	Low	Low	**Low**
	Impact Factor	1	1	1	1	1	2	2	1	1	**1**
	Weighted Impact Factor	1	1	1	1	1	2	2	1	1	**1**
Ranking	Risk Ranking Score	32	32	32	32	32	34	34	32	32	**32**
	Hazard Risk Rating	High	High	High	High	High	High	High	High	High	**High**

Risk Assessment Results

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Estimated Exposure	Estimated Population (1)	7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
	% Population Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
	Total Number of Buildings (2)	2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
	Total Building Value (Structure and contents in $) (2)	$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
	% of Total Value Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
Economic Impact	Structure Debris (x 1,000 Tons) (3)	0.40	13.59	1.02	0.05	3.33	17.51	58.99	0.95	2.16	**98.01**
	Number of Displaced Households (3)	0	6	0	0	0	4	27	0	2	**39**
	People Requiring Short-Term Shelter (3)	0	4	0	0	0	3	20	0	1	**29**
	Total Value (Structure and Contents in $) Damaged (4)	$7,580,361	$213,931,406	$3,529,884	$711,789	$57,014,193	$303,352,212	$2,494,967,597	$85,619,144	$16,992,816	**3,183,699,401**
	% of Total Value Damaged	0.8%	18.5%	1.1%	0.1%	0.4%	4.8%	9.5%	1.2%	1.1%	**5.5%**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(3) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	9	9	9	9	9	9	9	9	9	**9**
Impact on Property	% of Total Value Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	6	6	6	6	6	6	6	6	6	**6**
Impact on Economy	% of Total Value Damaged	0.79%	18.54%	1.10%	0.07%	0.42%	4.81%	9.48%	1.22%	1.12%	**5.47%**
	Impact (High, Medium, Low, None)	Low	High	Low	Low	Low	Low	Medium	Low	Low	**Medium**
	Impact Factor	1	3	1	1	1	1	2	1	1	**2**
	Weighted Impact Factor	1	3	1	1	1	1	2	1	1	**2**
Ranking	Risk Ranking Score	32	36	32	32	32	32	34	32	32	**34**
	Hazard Risk Rating	High	High	High	High	High	High	High	High	High	**High**

Risk Assessment Results—Landslide Susceptibility Category X

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	20	407	32	2	75	4	1,889	20	46	**2,495**
	Population Exposed (4)	59	747	55	5	179	9	4,500	32	131	**5,718**
	% of Population Exposed	0.8%	9.4%	3.3%	0.1%	0.4%	0.0%	8.6%	0.2%	1.2%	**3.0%**
	Value Structure in $ Exposed (2)	$4,573,344	$79,892,544	$6,628,795	$382,858	$18,028,596	$538,025	$1,711,829,523	$7,610,306	$11,123,755	**$1,840,607,743**
	Value Contents in $ Exposed (2)	$2,286,672	$49,846,567	$3,464,029	$191,429	$9,300,375	$269,012	$1,932,866,852	$3,993,581	$6,434,718	**$2,008,653,234**
	Value (Structure and contents in $) Exposed (2)	$6,860,015	$129,739,111	$10,092,824	$574,286	$27,328,971	$807,037	$3,644,696,375	$11,603,886	$17,558,472	**$3,849,260,978**
	% of Total Value	0.7%	11.2%	3.1%	0.1%	0.2%	0.0%	13.8%	0.2%	1.2%	**6.6%**
Number of Structures in Zone (2)	Residential	20	368	31	2	74	4	1,581	19	43	**2,142**
	Commercial	0	33	1	0	1	0	277	1	3	**316**
	Industrial	0	0	0	0	0	0	1	0	0	**1**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	2	0	0	0	0	18	0	0	**20**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	4	0	0	0	0	12	0	0	**16**
	Total	20	407	32	2	75	4	1,889	20	46	**2,495**

Risk Assessment Results—Landslide Susceptibility Category IX

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	2,338	57	410	1,935	32	702	7,254	3,534	0	**16,262**
	Population Exposed (4)	6,629	110	714	4,915	68	1,514	20,131	5,519	0	**39,600**
	% of Population Exposed	89.1%	1.4%	43.0%	75.7%	0.2%	3.4%	38.5%	33.3%	0.0%	**20.7%**
	Value Structure in $ Exposed (2)	$543,132,250	$10,853,504	$90,422,468	$425,072,029	$8,400,768	$186,087,833	$1,919,124,075	$1,252,074,021	$0	**$4,435,166,948**
	Value Contents in $ Exposed (2)	$339,370,893	$6,099,534	$48,160,095	$239,895,265	$6,121,627	$128,293,645	$1,189,429,255	$841,162,024	$0	**$2,798,532,339**
	Value (Structure and contents in $) Exposed (2)	$882,503,144	$16,953,038	$138,582,563	$664,967,293	$14,522,394	$314,381,479	$3,108,553,331	$2,093,236,045	$0	**$7,233,699,287**
	% of Total Value	91.5%	1.5%	43.2%	70.1%	0.1%	5.0%	11.8%	29.8%	0.0%	**12.4%**
Number of Structures in Zone (2)	Residential	2,237	54	403	1,860	28	642	7,072	3,329	0	**15,625**
	Commercial	91	1	6	60	3	38	142	181	0	**522**
	Industrial	3	0	0	2	0	3	10	3	0	**21**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	7	2	1	9	1	4	21	9	0	**54**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	4	0	15	9	12	0	**40**
	Total	2,338	57	410	1,935	32	702	7,254	3,534	0	**16,262**

Risk Assessment Results—Landslide Susceptibility Category VIII

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$7	**$56,678,566,200**
Estimated Exposure	Estimated Buildings Exposed (2)	15	1	19	11	44	1	241	9	23	**364**
	Population Exposed (4)	44	2	34	29	106	2	686	15	67	**986**
	% of Population Exposed	0.6%	0.0%	2.0%	0.4%	0.2%	0.0%	1.3%	0.1%	0.6%	**0.5%**
	Value Structure in $ Exposed (2)	$2,814,207	$54,533	$3,656,261	$4,752,411	$10,293,394	$374,425	$68,373,210	$2,211,157	$4,402,180	**$96,931,778**
	Value Contents in $ Exposed (2)	$1,407,103	$27,267	$1,828,131	$2,376,206	$5,146,697	$187,212	$34,186,605	$1,105,578	$2,331,943	**$48,596,742**
	Value (Structure and contents in $) Exposed (2)	$4,221,310	$81,800	$5,484,392	$7,128,617	$15,440,090	$561,637	$102,559,815	$3,316,735	$6,734,123	**$145,528,520**
	% of Total Value	0.4%	0.0%	1.7%	0.8%	0.1%	0.0%	0.4%	0.0%	96201752.8%	**0.3%**
Number of Structures in Zone (2)	Residential	15	1	19	11	44	1	241	9	22	**363**
	Commercial	0	0	0	0	0	0	0	0	1	**1**
	Industrial	0	0	0	0	0	0	0	0	0	**0**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	0	0	**0**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	15	1	19	11	44	1	241	9	23	**364**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) 2009 Landslide susceptibility data provided by the Pacific Disaster Center.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking—Landslide Susceptibility Categories IX and X

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Probability Factor (3,2,1,0)	3	3	3	3	3	3	3	3	3	**3**
Impact on People	% Population Exposed	89.88%	10.79%	46.27%	75.81%	0.56%	3.44%	47.11%	33.45%	1.23%	**23.67%**
	Impact (High, Medium, Low, None)	High	Medium	High	High	Low	Low	High	High	Low	**Medium**
	Impact Factor	3	2	3	3	1	1	3	3	1	**2**
	Weighted Impact Factor	9	6	9	9	3	3	9	9	3	**6**
Impact on Property	% of Total Value Exposed	92.16%	12.71%	46.31%	70.11%	0.31%	5.00%	25.66%	29.98%	1.16%	**19.05%**
	Impact (High, Medium, Low, None)	High	Medium	High	High	Low	Low	High	High	Low	**Medium**
	Impact Factor	3	2	3	3	1	1	3	3	1	**2**
	Weighted Impact Factor	6	4	6	6	2	2	6	6	2	**4**
Impact on Economy	% of Total Value Damaged	23.04%	3.18%	11.58%	17.53%	0.08%	1.25%	6.42%	7.50%	0.29%	**4.76%**
	Impact (High, Medium, Low, None)	High	Low	High	High	Low	Low	Medium	Medium	Low	**Low**
	Impact Factor	3	1	3	3	1	1	2	2	1	**1**
	Weighted Impact Factor	3	1	3	3	1	1	2	2	1	**1**
Ranking	Risk Ranking Score	54	33	54	54	18	18	51	51	18	**33**
	Hazard Risk Rating	High	High	High	High	Medium	Medium	High	High	Medium	**High**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Estimated Exposure	Estimated Population (1)	7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
	% Population Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
	Total Number of Buildings (2)	2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
	Total Building Value (Structure and contents in $) (2)	$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
	% of Total Value Exposed	100%	100%	100%	100%	100%	100%	100%	100%	100%	**100%**
Economic Impact	Structure Debris (Tons) (3)	59,079.99	13,328.32	14,431.94	63,099.32	500,155.99	459.94	15,959.68	308,411.62	51,035.17	**1,025,962.00**
	Number of Displaced Households (3)	1,803	389	436	1,520	8,875	3	285	5,093	1,580	**19,985**
	People Requiring Short-Term Shelter (3)	1,154	284	255	1,023	5,192	2	209	2,862	1,051	**12,032**
	Value Structure in $ Damaged (3)	$405,468,552	$114,529,864	$104,486,238	$383,295,638	$3,501,377,413	$15,905,656	$157,092,795	$2,370,127,195	$388,469,552	**$7,440,752,904**
	Value Contents in $ Damaged (3)	$213,511,994	$46,924,250	$48,161,393	$187,663,400	$1,788,846,447	$6,427,837	$56,718,611	$1,224,953,175	$191,034,489	**$3,764,241,595**
	Total Value (Structure and Contents in $) Damaged (3)	$618,980,547	$161,454,114	$152,647,631	$570,959,038	$5,290,223,859	$22,333,493	$213,811,406	$3,595,080,370	$579,504,041	**11,204,994,498**
	% of Total Value Damaged	64.1%	14.0%	47.5%	60.1%	38.8%	0.4%	0.8%	51.2%	38.3%	**19.3%**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	TOTAL
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	9	9	9	9	9	9	9	9	9	**9**
Impact on Property	% of Total Value Exposed	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	**100.00%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Impact Factor	3	3	3	3	3	3	3	3	3	**3**
	Weighted Impact Factor	6	6	6	6	6	6	6	6	6	**6**
Impact on Economy	% of Total Value Damaged	64.14%	13.99%	47.55%	60.15%	38.77%	0.35%	0.81%	51.21%	38.30%	**19.26%**
	Impact (High, Medium, Low, None)	High	High	High	High	High	Low	Low	High	High	**High**
	Impact Factor	3	3	3	3	3	1	1	3	3	**3**
	Weighted Impact Factor	3	3	3	3	3	1	1	3	3	**3**
Ranking	Risk Ranking Score	36	36	36	36	36	32	32	36	36	**36**
	Hazard Risk Rating	High	High	High	High	High	High	High	High	High	**High**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	0	3	0	0	86	0	324	239	2	**654**
	Population Exposed (4)	0	2	0	0	152	0	561	360	6	**1,081**
	% of Population Exposed	0.00%	0.03%	0.00%	0.00%	0.35%	0.00%	1.07%	2.17%	0.06%	**0.56%**
	Value Structure in $ Exposed (2)	0	2,084,373	0	0	53,907,426	0	537,337,339	156,350,696	291,219	**749,971,054**
	Value Contents in $ Exposed (2)	0	2,030,964	0	0	31,942,144	0	488,693,167	83,429,636	145,610	**606,241,521**
	Value (Structure and contents in $) Exposed (2)	0	4,115,337	0	0	85,849,571	0	1,026,030,505	239,780,333	436,829	**1,356,212,574**
	% of Total Value	0.00%	0.36%	0.00%	0.00%	0.63%	0.00%	3.90%	3.42%	0.03%	**2.33%**
Number of Structures in Hazard Area (2)	Residential	0	1	0	0	63	0	197	217	2	**480**
	Commercial	0	2	0	0	21	0	125	20	0	**168**
	Industrial	0	0	0	0	1	0	1	0	0	**2**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	1	0	1	2	0	**4**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	0	3	0	0	86	0	324	239	2	**654**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Category 4 hurricane storm surge data provided by the National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center, Storm Surge Unit in 2018.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	0.00%	0.03%	0.00%	0.00%	0.35%	0.00%	1.07%	2.17%	0.06%	**0.56%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	3	0	0	3	0	3	3	3	**3**
Impact on Property	% of Total Value Exposed	0.00%	0.36%	0.00%	0.00%	0.63%	0.00%	3.90%	3.42%	0.03%	**2.33%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	2	0	0	2	0	2	2	2	**2**
Impact on Economy	% of Total Value Damaged	0.00%	0.36%	0.00%	0.00%	0.63%	0.00%	3.90%	3.42%	0.03%	**2.33%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	None	Low	Low	Low	**Low**
	Impact Factor	0	1	0	0	1	0	1	1	1	**1**
	Weighted Impact Factor	0	1	0	0	1	0	1	1	1	**1**
Ranking	Risk Ranking Score	0	12	0	0	12	0	12	12	12	**12**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	2,614	1,300	961	489	0	0	1,188	10,435	0	**16,987**
	Population Exposed (4)	7,438	2,526	1,659	1,287	0	0	3,274	16,592	0	**32,776**
	% of Population Exposed	99.96%	31.81%	99.89%	19.83%	0.00%	0.00%	6.26%	99.99%	0.00%	**17.12%**
	Value Structure in $ Exposed (2)	597,467,994	254,868,457	208,368,613	169,934,912	0	0	281,344,433	4,380,695,665	0	**5,892,680,075**
	Value Contents in $ Exposed (2)	366,900,422	141,367,950	112,345,517	87,780,836	0	0	161,544,067	2,639,282,253	0	**3,509,221,044**
	Value (Structure and contents in $) Exposed (2)	964,368,416	396,236,407	320,714,130	257,715,748	0	0	442,888,500	7,019,977,917	0	**9,401,901,119**
	% of Total Value	99.93%	34.34%	99.90%	27.15%	0.00%	0.00%	1.68%	100.00%	0.00%	**16.16%**
Number of Structures in Hazard Area (2)	Residential	2,510	1,244	937	487	0	0	1,150	10,008	0	**16,336**
	Commercial	92	46	19	2	0	0	32	378	0	**569**
	Industrial	5	0	1	0	0	0	2	6	0	**14**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	7	4	4	0	0	0	4	19	0	**38**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	6	0	0	0	0	0	24	0	**30**
	Total	2,614	1,300	961	489	0	0	1,188	10,435	0	**16,987**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Straight line wind hazard awareness areas provided by Hawaii County in 2019.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Probability Factor (3,2,1,0)	3	3	3	3	3	3	3	3	3	**3**
Impact on People	% Population Exposed	99.96%	31.81%	99.89%	19.83%	0.00%	0.00%	6.26%	99.99%	0.00%	**17.12%**
	Impact (High, Medium, Low, None)	High	High	High	Medium	None	None	Low	High	None	**Medium**
	Impact Factor	3	3	3	2	0	0	1	3	0	**2**
	Weighted Impact Factor	9	9	9	6	0	0	3	9	0	**6**
Impact on Property	% of Total Value Exposed	99.93%	34.34%	99.90%	27.15%	0.00%	0.00%	1.68%	100.00%	0.00%	**16.16%**
	Impact (High, Medium, Low, None)	High	High	High	High	None	None	Low	High	None	**Medium**
	Impact Factor	3	3	3	3	0	0	1	3	0	**2**
	Weighted Impact Factor	6	6	6	6	0	0	2	6	0	**4**
Impact on Economy	% of Total Value Damaged	9.99%	3.43%	9.99%	2.71%	0.00%	0.00%	0.17%	10.00%	0.00%	**1.62%**
	Impact (High, Medium, Low, None)	Medium	Low	Medium	Low	None	None	Low	Medium	None	**Low**
	Impact Factor	2	1	2	1	0	0	1	2	0	**1**
	Weighted Impact Factor	2	1	2	1	0	0	1	2	0	**1**
Ranking	Risk Ranking Score	51	48	51	39	0	0	18	51	0	**33**
	Hazard Risk Rating	High	High	High	High	Low	Low	Medium	High	Low	**High**

Risk Assessment Results—Lava Hazard Zone 1

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	0	54	0	0	0	920	0	0	0	**974**
	Population Exposed (4)	0	110	0	0	0	2,154	0	0	0	**2,263**
	% of Population Exposed	0.0%	1.4%	0.0%	0.0%	0.0%	4.9%	0.0%	0.0%	0.0%	**1.2%**
	Value Structure in $ Exposed (2)	$0	$7,261,772	$0	$0	$0	$168,946,464	$0	$0	$0	**$176,208,235**
	Value Contents in $ Exposed (2)	$0	$3,630,886	$0	$0	$0	$87,296,018	$0	$0	$0	**$90,926,904**
	Value (Structure and contents in $) Exposed (2)	$0	$10,892,657	$0	$0	$0	$256,242,481	$0	$0	$0	**$267,135,139**
	% of Total Value	0.0%	0.9%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	**0.5%**
Number of Structures in Zone (2)	Residential	0	54	0	0	0	913	0	0	0	**967**
	Commercial	0	0	0	0	0	5	0	0	0	**5**
	Industrial	0	0	0	0	0	1	0	0	0	**1**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	1	0	0	0	**1**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	0	54	0	0	0	920	0	0	0	**974**

Risk Assessment Results—Lava Hazard Zone 2

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	0	1,847	0	0	0	3,603	1	0	1,104	**6,555**
	Population Exposed (4)	0	3,710	0	0	0	8,272	3	0	3,330	**15,315**
	% of Population Exposed	0.0%	46.7%	0.0%	0.0%	0.0%	18.7%	0.0%	0.0%	31.2%	**8.0%**
	Value Structure in $ Exposed (2)	$0	$301,452,614	$0	$0	$0	$658,114,575	$30,359	$0	$206,062,378	**$1,165,659,926**
	Value Contents in $ Exposed (2)	$0	$157,459,867	$0	$0	$0	$365,411,698	$15,179	$0	$106,241,841	**$629,128,584**
	Value (Structure and contents in $) Exposed (2)	$0	$458,912,481	$0	$0	$0	$1,023,526,273	$45,538	$0	$312,304,219	**$1,794,788,511**
	% of Total Value	0.0%	39.8%	0.0%	0.0%	0.0%	16.2%	0.0%	0.0%	20.6%	**3.1%**
Number of Structures in Zone (2)	Residential	0	1,827	0	0	0	3,507	1	0	1,092	**6,427**
	Commercial	0	18	0	0	0	77	0	0	9	**104**
	Industrial	0	0	0	0	0	0	0	0	3	**3**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	2	0	0	0	10	0	0	0	**12**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	9	0	0	0	**9**
	Total	0	1,847	0	0	0	3,603	1	0	1,104	**6,555**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Lava flow hazard zones data provided by the Hawaii Statewide GIS Program.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking—Lava Hazard Zones 1 & 2

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	0.00%	48.10%	0.00%	0.00%	0.00%	23.51%	0.01%	0.00%	31.21%	**9.18%**
	Impact (High, Medium, Low, None)	None	High	None	None	None	Medium	None	None	High	**Low**
	Impact Factor	0	3	0	0	0	2	0	0	3	**1**
	Weighted Impact Factor	0	9	0	0	0	6	0	0	9	**3**
Impact on Property	% of Total Value Exposed	0.00%	40.72%	0.00%	0.00%	0.00%	20.29%	0.00%	0.00%	20.64%	**3.54%**
	Impact (High, Medium, Low, None)	None	High	None	None	None	Medium	None	None	Medium	**Low**
	Impact Factor	0	3	0	0	0	2	0	0	2	**1**
	Weighted Impact Factor	0	6	0	0	0	4	0	0	4	**2**
Impact on Economy	% of Total Value Damaged	0.00%	10.18%	0.00%	0.00%	0.00%	5.07%	0.00%	0.00%	5.16%	**0.89%**
	Impact (High, Medium, Low, None)	None	High	None	None	None	Medium	None	None	Medium	**Low**
	Impact Factor	0	3	0	0	0	2	0	0	2	**1**
	Weighted Impact Factor	0	3	0	0	0	2	0	0	2	**1**
Ranking	Risk Ranking Score	0	36	0	0	0	24	0	0	30	**12**
	Hazard Risk Rating	Low	High	Low	Low	Low	Medium	Low	Low	High	**Low**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	0	217	0	0	591	1,507	767	0	33	**3,115**
	Population Exposed (4)	0	439	0	0	1,403	3,533	2,180	0	101	**7,656**
	% of Population Exposed	0.00%	5.52%	0.00%	0.00%	3.19%	7.97%	4.17%	0.00%	0.94%	**4.00%**
	Value Structure in $ Exposed (2)	0	34,827,225	0	0	166,082,985	248,102,063	204,170,103	0	5,787,798	**658,970,174**
	Value Contents in $ Exposed (2)	0	17,540,384	0	0	87,345,612	125,862,130	102,149,668	0	2,893,899	**335,791,693**
	Value (Structure and contents in $) Exposed (2)	0	52,367,609	0	0	253,428,597	373,964,193	306,319,772	0	8,681,697	**994,761,867**
	% of Total Value	0.00%	4.54%	0.00%	0.00%	1.86%	5.93%	1.16%	0.00%	0.57%	**1.71%**
Number of Structures in Hazard Area (2)	Residential	0	216	0	0	580	1,498	766	0	33	**3,093**
	Commercial	0	1	0	0	9	4	1	0	0	**15**
	Industrial	0	0	0	0	0	1	0	0	0	**1**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	2	4	0	0	0	**6**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	0	217	0	0	591	1,507	767	0	33	**3,115**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Historical lava flow areas data provided by the U.S. Geological Survey.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	**Medium**
	Probability Factor (3,2,1,0)	2	2	2	2	2	2	2	2	2	**2**
Impact on People	% Population Exposed	0.00%	5.52%	0.00%	0.00%	3.19%	7.97%	4.17%	0.00%	0.94%	**4.00%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	Low	Low	None	Low	**Low**
	Impact Factor	0	1	0	0	1	1	1	0	1	**1**
	Weighted Impact Factor	0	3	0	0	3	3	3	0	3	**3**
Impact on Property	% of Total Value Exposed	0.00%	4.54%	0.00%	0.00%	1.86%	5.93%	1.16%	0.00%	0.57%	**1.71%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	Low	Low	None	Low	**Low**
	Impact Factor	0	1	0	0	1	1	1	0	1	**1**
	Weighted Impact Factor	0	2	0	0	2	2	2	0	2	**2**
Impact on Economy	% of Total Value Damaged	0.00%	4.54%	0.00%	0.00%	1.86%	5.93%	1.16%	0.00%	0.57%	**1.71%**
	Impact (High, Medium, Low, None)	None	Low	None	None	Low	Medium	Low	None	Low	**Low**
	Impact Factor	0	1	0	0	1	2	1	0	1	**1**
	Weighted Impact Factor	0	1	0	0	1	2	1	0	1	**1**
Ranking	Risk Ranking Score	0	12	0	0	12	14	12	0	12	**12**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results—High Risk Level

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	15	3,612	0	324	12,777	0	0	4,809	787	**22,324**
	Population Exposed (4)	44	7,142	0	854	28,549	0	0	7,807	2,366	**46,762**
	% of Population Exposed	0.6%	89.9%	0.0%	13.2%	64.8%	0.0%	0.0%	47.0%	22.2%	**24.4%**
	Value Structure in $ Exposed (2)	$2,224,845	$653,032,141	$0	$108,652,585	$5,858,652,511	$0	$0	$1,656,255,031	$152,959,740	**$8,431,776,853**
	Value Contents in $ Exposed (2)	$1,112,423	$361,759,125	$0	$54,457,145	$4,354,400,346	$0	$0	$905,006,113	$79,677,177	**$5,756,412,329**
	Value (Structure and contents in $) Exposed (2)	$3,337,268	$1,014,791,266	$0	$163,109,731	$10,213,052,856	$0	$0	$2,561,261,144	$232,636,917	**$14,188,189,182**
	% of Total Value	0.3%	88.0%	0.0%	17.2%	74.8%	0.0%	0.0%	36.5%	15.4%	**24.4%**
Number of Structures in Zone (2)	Residential	15	3,517	0	323	11,801	0	0	4,709	776	**21,141**
	Commercial	0	79	0	1	895	0	0	82	8	**1,065**
	Industrial	0	0	0	0	17	0	0	3	3	**23**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	8	0	0	34	0	0	6	0	**48**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	8	0	0	30	0	0	9	0	**47**
	Total	15	3,612	0	324	12,777	0	0	4,809	787	**22,324**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Communities at Risk from Wildfire data provided by the Hawaii Wildfire Management Organization (HWMO).
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Risk Assessment Results—Medium Risk Level

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Exposure	Estimated Buildings Exposed (2)	793	276	288	0	1,734	701	243	2,151	818	**7,004**
	Population Exposed (4)	2,305	552	492	0	3,917	1,646	655	3,460	2,275	**15,303**
	% of Population Exposed	31.0%	7.0%	29.6%	0.0%	8.9%	3.7%	1.3%	20.9%	21.3%	**8.0%**
	Value Structure in $ Exposed (2)	$156,861,421	$61,666,471	$62,396,468	$0	$839,807,299	$101,792,399	$50,874,223	$1,170,863,782	$291,646,244	**$2,735,908,305**
	Value Contents in $ Exposed (2)	$82,338,313	$32,229,378	$33,581,514	$0	$478,642,614	$51,419,706	$28,704,304	$629,556,091	$213,937,294	**$1,550,409,214**
	Value (Structure and contents in $) Exposed (2)	$239,199,734	$93,895,849	$95,977,982	$0	$1,318,449,913	$153,212,105	$79,578,526	$1,800,419,873	$505,583,538	**$4,286,317,520**
	% of Total Value	24.8%	8.1%	29.9%	0.0%	9.7%	2.4%	0.3%	25.6%	33.4%	**7.4%**
Number of Structures in Zone (2)	Residential	778	272	278	0	1,619	698	230	2,087	746	**6,708**
	Commercial	12	3	9	0	109	2	10	62	62	**269**
	Industrial	2	1	1	0	0	0	0	0	0	**4**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	1	0	0	0	4	1	3	2	4	**15**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	2	0	0	0	6	**8**
	Total	793	276	288	0	1,734	701	243	2,151	818	**7,004**

Risk Ranking—High and Medium Risk Levels

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	High	High	High	High	High	High	High	High	High	**High**
	Probability Factor (3,2,1,0)	3	3	3	3	3	3	3	3	3	**3**
Impact on People	% Population Exposed	31.58%	96.88%	29.64%	13.15%	73.70%	3.71%	1.25%	67.90%	43.50%	**32.41%**
	Impact (High, Medium, Low, None)	High	High	High	Medium	High	Low	Low	High	High	**High**
	Impact Factor	3	3	3	2	3	1	1	3	3	**3**
	Weighted Impact Factor	9	9	9	6	9	3	3	9	9	**9**
Impact on Property	% of Total Value Exposed	25.13%	96.09%	29.89%	17.18%	84.50%	2.43%	0.30%	62.13%	48.79%	**31.75%**
	Impact (High, Medium, Low, None)	High	High	High	Medium	High	Low	Low	High	High	**High**
	Impact Factor	3	3	3	2	3	1	1	3	3	**3**
	Weighted Impact Factor	6	6	6	4	6	2	2	6	6	**6**
Impact on Economy	% of Total Value Damaged	2.51%	9.61%	2.99%	1.72%	8.45%	0.24%	0.03%	6.21%	4.88%	**3.17%**
	Impact (High, Medium, Low, None)	Low	Medium	Low	Low	Medium	Low	Low	Medium	Low	**Low**
	Impact Factor	1	2	1	1	2	1	1	2	1	**1**
	Weighted Impact Factor	1	2	1	1	2	1	1	2	1	**1**
Ranking	Risk Ranking Score	48	51	48	33	51	18	18	51	48	**48**
	Hazard Risk Rating	High	High	High	High	High	Medium	Medium	High	High	**High**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	0	0	0	10	0	0	0	0	0	**10**
	Population Exposed (3)	0	0	0	26	0	0	0	0	0	**26**
	% of Population Exposed	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
	Value Structure in $ Exposed (2)	$0	$0	$0	$4,037,299	$0	$0	$0	$0	$0	**$4,037,299**
	Value Contents in $ Exposed (2)	$0	$0	$0	$2,018,649	$0	$0	$0	$0	$0	**$2,018,649**
	Value (Structure and contents in $) Exposed (2)	$0	$0	$0	$6,055,948	$0	$0	$0	$0	$0	**$6,055,948**
	% of Total Value Exposed	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
Economic Impact	Structure Debris (Tons) (4)	0	0	0	0	0	0	0	0	0	**0**
	Displaced Population (5)	0	0	0	0	0	0	0	0	0	**0**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	0	0	0	**0**
	Buildings Impacted (6)	0	0	0	10	0	0	0	0	0	**10**
	Value Structure in $ Damaged (6)	$0	$0	$0	$152,079	$0	$0	$0	$0	$0	**$152,079**
	Value Contents in $ Damaged (6)	$0	$0	$0	$99,104	$0	$0	$0	$0	$0	**$99,104**
	Total Value (Structure and Contents in $) Damaged (6)	$0	$0	$0	$251,183	$0	$0	$0	$0	$0	**$251,183**
	% of Total Value Damaged	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
	Acres of Floodplain	0	0	0	192	0	0	0	0	0	**192**
Number of Structures in Zone (2)	Residential	0	0	0	10	0	0	0	0	0	**10**
	Commercial	0	0	0	0	0	0	0	0	0	**0**
	Industrial	0	0	0	0	0	0	0	0	0	**0**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	0	0	**0**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	0	0	0	10	0	0	0	0	0	**10**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**
	Probability Factor (3,2,1,0)	1	1	1	1	1	1	1	1	1	**1**
Impact on People	% Population Exposed	0.00%	0.00%	0.00%	0.41%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.01%**
	Impact (High, Medium, Low, None)	None	None	None	Low	None	None	None	None	None	**Low**
	Impact Factor	0	0	0	1	0	0	0	0	0	**1**
	Weighted Impact Factor	0	0	0	3	0	0	0	0	0	**3**
Impact on Property	% of Total Value Exposed	0.00%	0.00%	0.00%	0.64%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.01%**
	Impact (High, Medium, Low, None)	None	None	None	Low	None	None	None	None	None	**Low**
	Impact Factor	0	0	0	1	0	0	0	0	0	**1**
	Weighted Impact Factor	0	0	0	2	0	0	0	0	0	**2**
Impact on Economy	% of Total Value Damaged	0.00%	0.00%	0.00%	0.03%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
	Impact (High, Medium, Low, None)	None	None	None	Low	None	None	None	None	None	**None**
	Impact Factor	0	0	0	1	0	0	0	0	0	**0**
	Weighted Impact Factor	0	0	0	1	0	0	0	0	0	**0**
Ranking	Risk Ranking Score	0	0	0	6	0	0	0	0	0	**5**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	0	0	0	0	0	0	0	247	0	**247**
	Population Exposed (3)	0	0	0	0	0	0	0	260	0	**260**
	% of Population Exposed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.6%	0.0%	**0.1%**
	Value Structure in $ Exposed (2)	$0	$0	$0	$0	$0	$0	$0	$324,461,298	$0	**$324,461,298**
	Value Contents in $ Exposed (2)	$0	$0	$0	$0	$0	$0	$0	$302,391,865	$0	**$302,391,865**
	Value (Structure and contents in $) Exposed (2)	$0	$0	$0	$0	$0	$0	$0	$626,853,164	$0	**$626,853,164**
	% of Total Value Exposed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.9%	0.0%	**1.1%**
Economic Impact	Structure Debris (Tons) (4)	0	0	0	0	0	0	0	109	0	**109**
	Displaced Population (5)	0	0	0	0	0	0	0	58	0	**58**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	0	3	0	**3**
	Buildings Impacted (6)	0	0	0	0	0	0	0	125	0	**125**
	Value Structure in $ Damaged (6)	$0	$0	$0	$0	$0	$0	$0	$2,148,690	$0	**$2,148,690**
	Value Contents in $ Damaged (6)	$0	$0	$0	$0	$0	$0	$0	$2,114,109	$0	**$2,114,109**
	Total Value (Structure and Contents in $) Damaged (6)	$0	$0	$0	$0	$0	$0	$0	$4,262,799	$0	**$4,262,799**
	% of Total Value Damaged	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.0%**
	Acres of Floodplain	0	0	0	0	0	0	0	1,446	0	**1,446**
Number of Structures in Zone (2)	Residential	0	0	0	0	0	0	0	157	0	**157**
	Commercial	0	0	0	0	0	0	0	81	0	**81**
	Industrial	0	0	0	0	0	0	0	1	0	**1**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	6	0	**6**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	2	0	**2**
	Total	0	0	0	0	0	0	0	247	0	**247**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**
	Probability Factor (3,2,1,0)	1	1	1	1	1	1	1	1	1	**1**
Impact on People	% Population Exposed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.57%	0.00%	**0.14%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	Low	None	**Low**
	Impact Factor	0	0	0	0	0	0	0	1	0	**1**
	Weighted Impact Factor	0	0	0	0	0	0	0	3	0	**3**
Impact on Property	% of Total Value Exposed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.93%	0.00%	**1.08%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	Low	None	**Low**
	Impact Factor	0	0	0	0	0	0	0	1	0	**1**
	Weighted Impact Factor	0	0	0	0	0	0	0	2	0	**2**
Impact on Economy	% of Total Value Damaged	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	**0.01%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	Low	None	**None**
	Impact Factor	0	0	0	0	0	0	0	1	0	**0**
	Weighted Impact Factor	0	0	0	0	0	0	0	1	0	**0**
Ranking	Risk Ranking Score	0	0	0	0	0	0	0	6	0	**5**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	12	0	0	0	0	0	0	14	0	**26**
	Population Exposed (3)	36	0	0	0	0	0	0	23	0	**59**
	% of Population Exposed	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.0%**
	Value Structure in $ Exposed (2)	$3,007,994	$0	$0	$0	$0	$0	$0	$2,780,584	$0	**$5,788,578**
	Value Contents in $ Exposed (2)	$1,503,997	$0	$0	$0	$0	$0	$0	$1,390,292	$0	**$2,894,289**
	Value (Structure and contents in $) Exposed (2)	$4,511,991	$0	$0	$0	$0	$0	$0	$4,170,876	$0	**$8,682,867**
	% of Total Value Exposed	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	**0.0%**
Economic Impact	Structure Debris (Tons) (4)	6	0	0	0	0	0	0	4	0	**11**
	Displaced Population (5)	4	0	0	0	0	0	0	1	0	**5**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	0	0	0	**0**
	Buildings Impacted (6)	6	0	0	0	0	0	0	1	0	**7**
	Value Structure in $ Damaged (6)	$140,428	$0	$0	$0	$0	$0	$0	$8,425	$0	**$148,853**
	Value Contents in $ Damaged (6)	$86,173	$0	$0	$0	$0	$0	$0	$5,460	$0	**$91,633**
	Total Value (Structure and Contents in $) Damaged (6)	$226,601	$0	$0	$0	$0	$0	$0	$13,885	$0	**$240,486**
	% of Total Value Damaged	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
	Acres of Floodplain	855	0	0	0	0	0	0	45	0	**900**
Number of Structures in Zone (2)	Residential	12	0	0	0	0	0	0	14	0	**26**
	Commercial	0	0	0	0	0	0	0	0	0	**0**
	Industrial	0	0	0	0	0	0	0	0	0	**0**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	0	0	**0**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	12	0	0	0	0	0	0	14	0	**26**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**
	Probability Factor (3,2,1,0)	1	1	1	1	1	1	1	1	1	**1**
Impact on People	% Population Exposed	0.48%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.14%	0.00%	**0.03%**
	Impact (High, Medium, Low, None)	Low	None	None	None	None	None	None	Low	None	**Low**
	Impact Factor	1	0	0	0	0	0	0	1	0	**1**
	Weighted Impact Factor	3	0	0	0	0	0	0	3	0	**3**
Impact on Property	% of Total Value Exposed	0.47%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.06%	0.00%	**0.01%**
	Impact (High, Medium, Low, None)	Low	None	None	None	None	None	None	Low	None	**Low**
	Impact Factor	1	0	0	0	0	0	0	1	0	**1**
	Weighted Impact Factor	2	0	0	0	0	0	0	2	0	**2**
Impact on Economy	% of Total Value Damaged	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
	Impact (High, Medium, Low, None)	Low	None	None	None	None	None	None	None	None	**None**
	Impact Factor	1	0	0	0	0	0	0	0	0	**0**
	Weighted Impact Factor	1	0	0	0	0	0	0	0	0	**0**
Ranking	Risk Ranking Score	6	0	0	0	0	0	0	5	0	**5**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	0	0	0	0	0	0	0	513	0	**513**
	Population Exposed (3)	0	0	0	0	0	0	0	652	0	**652**
	% of Population Exposed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	0.0%	**0.3%**
	Value Structure in $ Exposed (2)	$0	$0	$0	$0	$0	$0	$0	$444,693,694	$0	**$444,693,694**
	Value Contents in $ Exposed (2)	$0	$0	$0	$0	$0	$0	$0	$379,954,811	$0	**$379,954,811**
	Value (Structure and contents in $) Exposed (2)	$0	$0	$0	$0	$0	$0	$0	$824,648,505	$0	**$824,648,505**
	% of Total Value Exposed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.7%	0.0%	**1.4%**
Economic Impact	Structure Debris (Tons) (4)	0	0	0	0	0	0	0	427	0	**427**
	Displaced Population (5)	0	0	0	0	0	0	0	276	0	**276**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	0	17	0	**17**
	Buildings Impacted (6)	0	0	0	0	0	0	0	216	0	**216**
	Value Structure in $ Damaged (6)	$0	$0	$0	$0	$0	$0	$0	$8,839,023	$0	**$8,839,023**
	Value Contents in $ Damaged (6)	$0	$0	$0	$0	$0	$0	$0	$10,759,612	$0	**$10,759,612**
	Total Value (Structure and Contents in $) Damaged (6)	$0	$0	$0	$0	$0	$0	$0	$19,598,635	$0	**$19,598,635**
	% of Total Value Damaged	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	**0.0%**
	Acres of Floodplain	0	0	0	0	0	0	0	1,610	0	**1,610**
Number of Structures in Zone (2)	Residential	0	0	0	0	0	0	0	393	0	**393**
	Commercial	0	0	0	0	0	0	0	104	0	**104**
	Industrial	0	0	0	0	0	0	0	1	0	**1**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	7	0	**7**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	8	0	**8**
	Total	0	0	0	0	0	0	0	513	0	**513**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**
	Probability Factor (3,2,1,0)	1	1	1	1	1	1	1	1	1	**1**
Impact on People	% Population Exposed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.93%	0.00%	**0.34%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	Low	None	**Low**
	Impact Factor	0	0	0	0	0	0	0	1	0	**1**
	Weighted Impact Factor	0	0	0	0	0	0	0	3	0	**3**
Impact on Property	% of Total Value Exposed	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	11.75%	0.00%	**1.42%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	Medium	None	**Low**
	Impact Factor	0	0	0	0	0	0	0	2	0	**1**
	Weighted Impact Factor	0	0	0	0	0	0	0	4	0	**2**
Impact on Economy	% of Total Value Damaged	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.28%	0.00%	**0.03%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	Low	None	**Low**
	Impact Factor	0	0	0	0	0	0	0	1	0	**1**
	Weighted Impact Factor	0	0	0	0	0	0	0	1	0	**1**
Ranking	Risk Ranking Score	0	0	0	0	0	0	0	8	0	**6**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Risk Assessment Results

Jurisdiction		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Estimated Population (1)		7,441	7,942	1,661	6,490	44,049	44,350	52,286	16,594	10,669	**191,482**
Total Number of Buildings (2)		2,615	4,015	962	2,544	19,394	19,245	19,923	10,436	3,662	**82,796**
Total Number of Residential Buildings (2)		2,511	3,911	938	2,456	18,208	18,802	18,368	10,009	3,499	**78,702**
Total Building Value (Structure and contents in $) (2)		$965,000,890	$1,153,799,589	$321,051,028	$949,266,941	$13,646,633,094	$6,306,660,548	$26,316,068,455	$7,020,085,649	$1,512,982,374	**$58,191,548,568**
Estimated Building Exposure	Buildings Exposed (2)	3	0	0	0	0	0	0	0	0	**3**
	Population Exposed (3)	9	0	0	0	0	0	0	0	0	**9**
	% of Population Exposed	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
	Value Structure in $ Exposed (2)	$450,872	$0	$0	$0	$0	$0	$0	$0	$0	**$450,872**
	Value Contents in $ Exposed (2)	$225,436	$0	$0	$0	$0	$0	$0	$0	$0	**$225,436**
	Value (Structure and contents in $) Exposed (2)	$676,307	$0	$0	$0	$0	$0	$0	$0	$0	**$676,307**
	% of Total Value Exposed	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
Economic Impact	Structure Debris (Tons) (4)	5	0	0	0	0	0	0	0	0	**5**
	Displaced Population (5)	3	0	0	0	0	0	0	0	0	**3**
	People Requiring Short-Term Shelter (5)	0	0	0	0	0	0	0	0	0	**0**
	Buildings Impacted (6)	1	0	0	0	0	0	0	0	0	**1**
	Value Structure in $ Damaged (6)	$20,122	$0	$0	$0	$0	$0	$0	$0	$0	**$20,122**
	Value Contents in $ Damaged (6)	$12,186	$0	$0	$0	$0	$0	$0	$0	$0	**$12,186**
	Total Value (Structure and Contents in $) Damaged (6)	$32,308	$0	$0	$0	$0	$0	$0	$0	$0	**$32,308**
	% of Total Value Damaged	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**
	Acres of Floodplain	294	0	0	0	0	0	0	59	0	**353**
Number of Structures in Zone (2)	Residential	3	0	0	0	0	0	0	0	0	**3**
	Commercial	0	0	0	0	0	0	0	0	0	**0**
	Industrial	0	0	0	0	0	0	0	0	0	**0**
	Agriculture	0	0	0	0	0	0	0	0	0	**0**
	Religion	0	0	0	0	0	0	0	0	0	**0**
	Government	0	0	0	0	0	0	0	0	0	**0**
	Education	0	0	0	0	0	0	0	0	0	**0**
	Total	3	0	0	0	0	0	0	0	0	**3**

(1) 2015 Census Block Groups with population figures from American Community Survey 5-year estimates. Downloaded from Hawaii Statewide GIS Program Geospatial Data Portal.
(2) Values based off of 2019 parcel and real property data provided by Hawaii County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Risk Ranking

		HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Probability	Probability (High, Medium, Low, None)	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**
	Probability Factor (3,2,1,0)	1	1	1	1	1	1	1	1	1	**1**
Impact on People	% Population Exposed	0.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
	Impact (High, Medium, Low, None)	Low	None	None	None	None	None	None	None	None	**None**
	Impact Factor	1	0	0	0	0	0	0	0	0	**0**
	Weighted Impact Factor	3	0	0	0	0	0	0	0	0	**0**
Impact on Property	% of Total Value Exposed	0.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
	Impact (High, Medium, Low, None)	Low	None	None	None	None	None	None	None	None	**None**
	Impact Factor	1	0	0	0	0	0	0	0	0	**0**
	Weighted Impact Factor	2	0	0	0	0	0	0	0	0	**0**
Impact on Economy	% of Total Value Damaged	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
	Impact (High, Medium, Low, None)	None	None	None	None	None	None	None	None	None	**None**
	Impact Factor	0	0	0	0	0	0	0	0	0	**0**
	Weighted Impact Factor	0	0	0	0	0	0	0	0	0	**0**
Ranking	Risk Ranking Score	5	0	0	0	0	0	0	0	0	**0**
	Hazard Risk Rating	Low	Low	Low	Low	Low	Low	Low	Low	Low	**Low**

Land Use in SLR Event-Based Coastal Flood

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	7	0	0	7
Conservation	481	328	1	35	137	117	87	0	32	1,217
Extensive Agriculture	663	177	0	1	1	253	52	0	20	1,168
High Density Urban	0	0	0	0	0	0	89	0	0	89
Important Ag. Lands	131	13	0	6	0	113	2	0	0	266
Industrial	0	0	0	0	94	0	164	51	0	310
Low Density Urban	0	0	0	11	7	222	164	104	0	507
Medium Density Urban	0	0	0	0	21	0	31	19	0	70
Open Area	418	1,432	106	555	1,392	1,141	765	1,218	827	7,853
Orchards	0	0	0	0	0	0	0	0	1	1
Ponds	0	0	0	0	0	0	1	0	0	1
Resort Node	0	0	0	0	146	0	0	64	0	210
Resort	0	25	0	0	0	0	76	0	0	100
Rural	0	0	4	0	0	5	0	0	0	8
Urban Expansion	0	0	0	0	15	99	0	121	0	235
University Use	0	0	0	0	0	0	0	0	0	0
Total	1,693	1,974	111	609	1,813	1,949	1,438	1,578	879	12,044

Land Use in SLR Future Chronic Coastal Flood

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	3	0	0	3
Conservation	2	113	1	7	25	19	79	0	7	253
Extensive Agriculture	13	2	0	0	0	6	5	0	0	26
High Density Urban	0	0	0	0	0	0	4	0	0	4
Important Ag. Lands	0	0	0	0	0	4	0	0	0	5
Industrial	0	0	0	0	0	0	7	1	0	7
Low Density Urban	0	0	0	2	0	52	5	11	0	71
Medium Density Urban	0	0	0	0	0	0	0	0	0	1
Open Area	296	357	87	271	353	480	259	176	243	2,521
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	7	0	0	10	0	18
Resort	0	1	0	0	0	0	9	0	0	10
Rural	0	0	3	0	0	0	0	0	0	3
Urban Expansion	0	0	0	0	0	14	0	0	0	15
University Use	0	0	0	0	0	0	0	0	0	0
Total	311	473	90	279	386	575	370	198	251	2,935

Land Use in Combined Dam Inundation Areas

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	15	4	0	15	0	0	0	43	0	77
Extensive Agriculture	176	395	0	212	0	0	0	737	0	1,519
High Density Urban	0	0	0	0	0	0	0	0	0	0
Important Ag. Lands	787	718	0	247	0	0	0	338	0	2,090
Industrial	0	0	0	0	0	0	0	0	0	0
Low Density Urban	15	0	0	17	0	0	0	417	0	449
Medium Density Urban	0	0	0	0	0	0	0	223	0	223
Open Area	10	5	0	25	0	0	0	27	0	67
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	0	0	0	12	0	12
Resort	0	0	0	0	0	0	0	0	0	0
Rural	0	0	0	0	0	0	0	57	0	57
Urban Expansion	0	0	0	0	0	0	0	265	0	265
University Use	0	0	0	0	0	0	0	0	0	0
Total	1,003	1,122	0	515	0	0	0	2,119	0	4,758

Land Use in NEHRP Soils D and E

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	20,980	18,458	969	566	77	1,328	4,904	97	0	47,380
Extensive Agriculture	1,253	3,593	664	62	59	310	124	2,548	0	8,615
High Density Urban	0	0	0	0	0	0	178	0	0	178
Important Ag. Lands	501	15,452	0	0	0	0	4,915	2,689	0	23,557
Industrial	0	32	0	0	0	0	0	82	0	114
Low Density Urban	0	240	0	0	0	0	1,208	76	0	1,525
Medium Density Urban	0	43	0	0	0	0	338	143	0	524
Open Area	195	873	0	28	21	0	123	97	0	1,338
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	0	0	3	0	0	3
Resort	0	0	0	0	0	0	0	0	0	0
Rural	0	0	0	0	0	22	6	0	0	28
Urban Expansion	0	0	0	0	0	0	2	0	0	2
University Use	0	0	0	0	0	0	0	0	0	0
Total	22,929	38,692	1,634	656	158	1,661	11,800	5,733	0	83,263

Land Use in FEMA 100-year Riverine Flood Zone

Land Use Category	Designated Area (acres)									
	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	273	24	0	2	36	13	291	0	5	642
Extensive Agriculture	481	40	0	0	29	61	350	6	255	1,221
High Density Urban	0	0	0	0	0	0	60	0	0	60
Important Ag. Lands	128	8	0	162	100	32	759	268	401	1,858
Industrial	0	0	0	0	37	0	49	7	0	93
Low Density Urban	23	0	0	31	54	43	535	250	26	962
Medium Density Urban	13	0	0	0	102	0	64	51	12	242
Open Area	4	78	0	9	325	101	141	773	137	1,568
Orchards	0	0	0	0	3	0	0	0	26	28
Ponds	0	0	0	0	0	0	13	0	0	13
Resort Node	0	0	0	0	36	0	0	26	0	62
Resort	0	5	0	0	0	0	11	0	3	19
Rural	0	0	0	0	5	0	65	0	2	71
Urban Expansion	0	0	0	0	302	26	0	136	0	464
University Use	0	0	0	0	0	0	53	0	0	53
Total	921	154	0	203	1,028	275	2,391	1,518	868	7,357

Land Use in FEMA 100-year Coastal Flood Zone

Land Use Category	Designated Area (acres)									
	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	1	0	0	1
Conservation	44	244	0	1	10	87	72	0	21	478
Extensive Agriculture	99	99	0	1	0	60	1	0	1	261
High Density Urban	0	0	0	0	0	0	24	0	0	24
Important Ag. Lands	0	0	0	5	0	34	0	0	0	40
Industrial	0	0	0	0	0	0	68	0	0	68
Low Density Urban	0	0	0	11	1	116	62	4	0	195
Medium Density Urban	0	0	0	0	0	0	15	0	0	15
Open Area	237	1,268	0	508	620	892	445	199	577	4,746
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	13	0	0	0	0	13
Resort	0	9	0	0	0	0	56	0	0	65
Rural	0	0	0	0	0	4	0	0	0	4
Urban Expansion	0	0	0	0	0	6	0	0	0	6
University Use	0	0	0	0	0	0	0	0	0	0
Total	380	1,620	0	527	644	1,199	743	203	599	5,915

Land Use in Straight Line Wind Awareness Areas

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	96,768	6,837	56,633	324	15,809	0	51,783	2,099	0	230,253
Extensive Agriculture	23,430	27,074	11,212	14,717	16,231	0	8,853	61,297	0	162,814
High Density Urban	0	0	0	0	0	0	0	0	0	0
Important Ag. Lands	70,404	20,779	21,635	17,334	0	0	12,210	45,980	0	188,341
Industrial	132	29	30	0	0	0	20	1,873	0	2,083
Low Density Urban	2,298	434	618	885	0	0	817	5,116	0	10,168
Medium Density Urban	294	267	70	17	10	0	77	1,284	0	2,019
Open Area	794	2,584	435	1,149	253	0	353	14,096	0	19,664
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	0	0	0	3,218	0	3,218
Resort	0	24	0	47	0	0	0	0	0	71
Rural	47	1,125	72	74	0	0	0	1,927	0	3,244
Urban Expansion	0	325	62	258	0	0	0	12,287	0	12,932
University Use	0	0	0	0	0	0	0	0	0	0
Total	194,166	59,478	90,766	34,806	32,303	0	74,113	149,175	0	634,807

Land Use in Landslide Susceptibility Categories 9 and 10

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	41,979	60,111	21,123	1,109	12,995	7,588	12,069	5,694	172	162,839
Extensive Agriculture	70,307	9,456	30,463	3,825	3,300	1,542	16,010	13,448	1,342	149,694
High Density Urban	8	0	0	0	0	0	326	0	0	335
Important Ag. Lands	67,980	26,253	12,636	37,276	178	5,674	25,574	45,307	89	220,966
Industrial	108	32	25	40	0	53	93	387	0	738
Low Density Urban	2,136	253	159	1,528	72	622	5,495	2,219	16	12,499
Medium Density Urban	278	43	0	122	5	195	648	209	3	1,502
Open Area	248	1,218	128	539	22	0	365	856	0	3,376
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	1	0	0	1
Resort Node	0	0	0	0	0	0	4	0	0	4
Resort	0	0	0	0	0	0	0	0	0	0
Rural	36	112	46	350	15	177	78	390	0	1,204
Urban Expansion	0	0	0	0	0	0	51	0	0	51
University Use	0	0	48	0	22	367	2	520	0	959
Total	183,079	97,478	64,629	44,789	16,608	16,217	60,716	69,030	1,621	554,168

Land Use in Category 4 Hurricane Storm Surge Inundation Area

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	7	0	0	7
Conservation	26	77	0	21	89	14	22	0	7	256
Extensive Agriculture	0	9	0	0	0	10	3	0	0	23
High Density Urban	0	0	0	0	0	0	53	0	0	53
Important Ag. Lands	0	0	0	0	0	18	0	0	0	18
Industrial	0	0	0	0	0	0	63	47	0	110
Low Density Urban	0	0	0	1	1	88	26	76	0	194
Medium Density Urban	0	0	0	0	11	0	34	15	0	60
Open Area	30	368	26	129	684	273	400	371	224	2,505
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	1	0	0	1
Resort Node	0	0	0	0	47	0	0	38	0	85
Resort	0	3	0	0	0	0	40	0	0	42
Rural	0	0	2	0	0	0	0	0	0	2
Urban Expansion	0	0	0	0	15	21	0	0	0	35
University Use	0	0	0	0	0	0	0	0	0	0
Total	57	457	29	151	847	424	649	547	231	3,392

Land Use in Tsunami Inundation

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	3	0	0	3
Conservation	10	1	0	0	219	4	32	0	2	269
Extensive Agriculture	133	12	0	0	0	401	7	0	0	553
High Density Urban	0	0	0	0	0	0	74	0	0	74
Important Ag. Lands	26	0	0	0	0	117	0	0	0	144
Industrial	0	0	0	0	0	0	185	63	0	248
Low Density Urban	0	0	0	0	0	65	195	116	0	376
Medium Density Urban	0	0	0	0	33	0	38	20	0	92
Open Area	78	167	10	0	713	484	547	660	68	2,728
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	222	0	0	163	0	385
Resort	0	9	0	0	0	0	74	0	0	83
Rural	0	0	0	0	0	1	0	0	0	1
Urban Expansion	0	0	0	0	0	3	0	0	0	3
University Use	0	0	0	0	0	0	0	0	0	0
Total	247	189	10	0	1,189	1,076	1,156	1,022	70	4,958

Land Use in Combined Historic Lava Flow Areas and Buffered Lava Zones 1 and 2

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	30,687	261,505	69,370	0	31,141	80,364	60,668	0	32,969	566,703
Extensive Agriculture	0	55,463	2,642	0	12,707	36,442	3,880	0	49,156	160,290
High Density Urban	0	0	0	0	0	0	0	0	0	0
Important Ag. Lands	0	3,139	0	0	382	19,839	73	0	19,088	42,522
Industrial	0	0	0	0	1,658	0	0	0	0	1,658
Low Density Urban	0	0	0	0	210	4,531	505	0	0	5,246
Medium Density Urban	0	0	0	0	0	487	78	0	0	566
Open Area	0	1,807	0	0	1,097	1,604	3	0	1,541	6,052
Orchards	0	0	0	0	0	0	0	0	0	0
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	466	0	0	0	0	466
Resort	0	0	0	0	0	0	0	0	0	0
Rural	0	11,986	0	0	0	3,371	357	0	31	15,745
Urban Expansion	0	273	0	0	15	556	0	0	0	845
University Use	0	0	0	0	0	0	52	0	0	52
Total	30,687	334,174	72,012	0	47,677	147,194	65,615	0	102,786	800,144

Land Use in Communities at Risk from Wildfire Areas – Medium and High Risk Levels

	Designated Area (acres)									
Land Use Category	HAMAKUA	KAU	NORTH HILO	NORTH KOHALA	NORTH KONA	PUNA	SOUTH HILO	SOUTH KOHALA	SOUTH KONA	Total
Breakwater	0	0	0	0	0	0	0	0	0	0
Conservation	2,530	9,852	140	26	2,186	2,830	0	0	11,158	28,723
Extensive Agriculture	2,136	18,070	0	1,557	2,720	8,271	0	2,026	21,323	56,103
High Density Urban	0	0	0	0	459	0	0	0	0	459
Important Ag. Lands	9,735	8,794	1,735	0	6,359	2,209	272	4,270	9,535	42,909
Industrial	7	62	30	0	3,333	0	0	574	0	4,005
Low Density Urban	663	1,080	168	712	3,486	654	124	3,245	125	10,258
Medium Density Urban	33	354	0	17	1,386	0	21	856	43	2,711
Open Area	115	467	126	405	3,562	553	42	1,689	2,001	8,960
Orchards	0	0	0	0	409	0	0	0	465	874
Ponds	0	0	0	0	0	0	0	0	0	0
Resort Node	0	0	0	0	1,715	0	0	1,892	0	3,607
Resort	0	29	0	0	0	0	0	0	25	54
Rural	47	13,111	71	74	858	562	0	954	31	15,708
Urban Expansion	0	419	62	0	8,674	0	0	867	0	10,022
University Use	0	0	0	0	0	0	0	0	0	0
Total	15,266	52,237	2,332	2,791	35,147	15,079	460	16,373	44,707	184,392

County of Hawai‘i Multi-Hazard Mitigation Plan

Appendix G. Hazard Mitigation Plan Approval and Adoption Resolution

Harry Kim
Mayor

Roy Takemoto
Managing Director

Barbara J. Kossow
Deputy Managing Director

County of Hawaiʻi
Office of the Mayor

25 Aupuni Street, Suite 2603 • Hilo, Hawaiʻi 96720 • (808) 961-8211 • Fax (808) 961-6553
KONA: 74-5044 Ane Keohokālole Hwy., Bldg C • Kailua-Kona, Hawaiʻi 96740
(808) 323-4444 • Fax (808) 323-4440

September 14, 2020

RE: Adoption of the County of Hawaiʻi Multi-Hazard Mitigation Plan Update

The County of Hawaiʻi-- due to its active volcanoes, varied topography, and easternmost exposure—is uniquely exposed to all major natural disasters. This island has historically experienced property damage and loss of life from tsunamis, lava flows, earthquakes, hurricanes, floods, and wildfires. It is with this awareness to prepare and mitigate risks with a comprehensive multi-hazard strategy that I hereby approve and adopt this update of the County of Hawaiʻi Multi-Hazard Mitigation Plan in compliance with the Disaster Mitigation Act of 2000 (Public Law 106-390). This plan updates the previous plan adopted in 2015.

With the adoption of this plan update, this County is positioned to apply or compete for various hazard funding in coordination with the State's multi-hazard mitigation plan and federal requirements, as well as prioritizing and leveraging County resources. This update involved the many agencies and the public engaged in expanding awareness and implementing the actions set forth in the plan.

The County is committed to be as best prepared as possible, proactively mitigating risks, and continually improving its knowledge and systems.

Approved:

Harry Kim
Mayor

U.S. Department of Homeland Security
1111 Broadway, Suite 1200
Oakland, CA. 94607-4052

FEMA

September 15, 2020

Talmadge Magno
Civil Defense Administrator
County of Hawaii Civil Defense Agency
920 Ululani Street
Hilo HI 96720

Dear Mr. Magno:

We have completed our final review of the *County of Hawaii Multi-Hazard Mitigation Plan Update, 2020*, officially adopted by the County of Hawaii on September 15, 2020, and found the plan to be in conformance with Title 44 Code of Federal Regulations (CFR) Part 201.6 *Local Mitigation Plans.*

The approval of this plan ensures the County of Hawaii's continued eligibility for project grants under FEMA's Hazard Mitigation Assistance programs, including the Hazard Mitigation Grant Program, Building Resilient Infrastructure and Communities Program, and Flood Mitigation Assistance Program. All requests for funding, however, will be evaluated individually according to the specific eligibility, and other requirements of the particular program under which applications are submitted.

Also, approved hazard mitigation plans may be eligible for points under the National Flood Insurance Program's Community Rating System (CRS). Additional information regarding the CRS can be found at https://www.fema.gov/national-flood-insurance-program-community-rating-system or through your local floodplain manager.

FEMA's approval of the *County of Hawaii Multi-Hazard Mitigation Plan Update, 2020* is for a period of five years, effective starting the date of this letter. Prior to September 15, 2025, County of Hawaii is required to review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval in order to continue to be eligible for mitigation project grant funding. The enclosed plan review tool provides additional recommendations to incorporate into the plan when County of Hawaii undertakes its identified plan maintenance process.

If you have any questions regarding the planning or review processes, please contact the FEMA Region IX Hazard Mitigation Planning Team at fema-r9-mitigation-planning@fema.dhs.gov.

Sincerely,

for Alison Kearns
Risk Analysis Branch Chief
Mitigation Division
FEMA, Region IX

Enclosure

cc: Savanna Holloway-Ledo, Grant Coordinator, Hawai'i Emergency Management Agency
Larry Kanda, State Hazard Mitigation Officer, Hawai'i Emergency Management Agency