Public Review Draft:
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DRAFT STATE OF HAWAIʻI HAZARD MITIGATION PLAN

Prepared for:
The Hawaiʻi Emergency Management Agency

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DRAFT 2018 STATE OF HAWAI'I HAZARD MITIGATION PLAN UPDATE
PUBLIC REVIEW: JUNE 28 TO JULY 13, 2018

Thank you for taking the time to review and provide feedback on the Draft 2018 State of Hawaii's Hazard Mitigation Plan Update (2018 HMP Update). The 2018 HMP Update represents a significant revision to the 2013 HMP. The State of Hawaii's HMP continues to be a 'living document' that will evolve over time to reflect new or additional information, support relationship building, promote resiliency and sustainability, aid in consistent evaluation, and provide a means to reduce the costs associated with response and recovery.

All comments received will be reviewed by the Hawai'i Emergency Management Agency (HI-EMA) Mitigation Section and addressed appropriately at the sole discretion of the State. Comments will be accepted through the end of the day July 13, 2018 through this comment form:

https://www.surveymonkey.com/r/HIStateHMPReview

The State of Hawai'i appreciates your interest and input to this planning process. Thank you!

The 2018 HMP Update released for public review is considered a draft document. Public review is concurrent with State subject-matter expert review. Therefore, the contents of the draft HMP Update are subject to change after all comments are reviewed and considered by the HI-EMA Mitigation Section.

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SECTION 1. INTRODUCTION

1.1 Overview

The State of Hawaiʻi has experienced a range of climate, hydrological, seismic, geological and technological hazard events that have resulted in great costs to lives, property and the economy of the State. To reduce disaster risks in the State requires an integrated, multi-level, multi-sector, collaborative approach to risk reduction with additional emphasis on building community resilience.

Key Terms

Hazard Mitigation *- Sustained action to reduce or eliminate the long-term risk to human life and property from hazards.*

State Hazard Mitigation Plan *– Demonstrates the State's commitment to reduce risks from natural hazards and serves as a guide for decision makers for reducing the effects of natural hazards as resources are committed.*

Source: FEMA State Mitigation Plan Review Guide, effective March 2016.

Mitigation is the effort to reduce loss of life and property by lessening the impacts of disasters. It creates safer communities and helps maintain the quality of life. To be effective, we must understand all risks and invest in long-term community well-being through the implementation of short- and long-term strategies before the next disaster (FEMA 2018).

The purpose of mitigation planning is to identify hazards that impact the State, identify actions and activities to reduce losses from those hazards, and to establish a coordinated process to implement the plan [44CFR 201.1 (b)]. On October 27, 2004, the State of Hawaii's first approved Multi-Hazard Mitigation Plan went into effect. The 2010 revision became effective on October 4, 2010. The 2013 update became effective on October 3, 2013. The State is committed to updating and implementing its long-term strategy for reducing the risks of hazards as documented in the 2018 State of Hawaiʻi Hazard Mitigation Plan Update (2018 HMP Update). The Federal Emergency Management Agency (FEMA) approval and State adoption of the 2018 HMP Update qualify the State of Hawaiʻi to obtain federal assistance for hazard mitigation, and for the repair and replacement of infrastructure damaged in natural disasters.

The 2018 HMP Update demonstrates the State of Hawaii's commitment to:

- Reduce risks from hazards;
- Serve as a guide for both State and local decision makers as they commit resources to reducing the effects of hazards on lives and property;
- Provide assurances that the State will comply with all applicable Federal statutes and regulations during the periods for which it receives grant funding, in compliance with the Code of Federal Regulations [***44 CFR 13.11(c)***];
- Maintain its eligibility to participate in all FEMA funding programs;
- Amend the HMP whenever necessary to reflect changes in State or Federal laws and statutes as required in ***44 CFR 13.11(d)***.

1.2 Authority, Assurances and References

44 CFR §201.4(c)(2)(ii): The plan must include assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, including 2 CFR parts 200 and 3002. The State will amend its plan whenever necessary to reflect changes in State or Federal statutes and regulations.

Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance, 42 U.S.C., Section 322, as amended.
- Code of Federal Regulations (CFR), Title 44, Parts 79.4, 201 and 206.
- Disaster Mitigation Act (DMA) of 2000, Public Law 106-390, as amended.

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), Public Law 100-707, signed into law in 1988 amended the Disaster Relief Act of 1974 (Public Law 93-288). The act constitutes the statutory authority for most Federal disaster response activities.

The DMA 2000 is the current federal regulation addressing hazard mitigation planning. It amended the Stafford Act to require the preparation of hazard mitigation plans by state and local governments emphasizing planning for disasters before they occur. The requirement for a state HMP is continued as a condition for disaster assistance.

The State of Hawaiʻi will continue to comply with all applicable federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c), and will amend its plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).

The following Federal Emergency Management Agency (FEMA) guides and reference documents were used to prepare the 2018 HMP Update. Refer to the References section for a complete list of resources used to prepare the plan.

- State Mitigation Plan Review Guide, March 2015
- State Mitigation Planning Key Topics Bulletins: Planning Process, July 2016
- State Mitigation Planning Key Topics Bulletins: Risk Assessment, June 2016
- State Mitigation Planning Key Topics Bulletins: Mitigation Capabilities, September 2016
- State Mitigation Planning Key Topics Bulletins: Mitigation Strategy, October 2016
- Plan Integration: Linking Local Planning Efforts, July 2015
- Hazard Mitigation Assistance Guidance, February 2015
- Integrating Disaster Data into Hazard Mitigation Planning: A State and Local Mitigation Planning How-to-Guide, February 2015
- Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials, March 2013
- Local Mitigation Planning Handbook, March 2013
- Mitigation Ideas. A Resource for Reducing Risk to Natural Hazards, January 2013
- Climate Change Adaptation Policy, January 2012

- Local Mitigation Plan Review Guide, October 1, 2011

1.3 Organization of the Plan

The 2018 HMP Update represents a significant revision to the 2013 HMP. The State of Hawaii's HMP continues to be a 'living document' that supports relationship building, promotes resiliency and sustainability, aids in consistent evaluation, and provides a means to reduce the costs associated with response and recovery.

An updated outline of the 2018 HMP Update is presented below with a brief summary of each section's contents.

- **Section 1: Introduction**—This section defines mitigation and the planning requirements for the State of Hawai'i HMP. It also discusses the 2018 HMP Update organization and a summary of changes made during the 2018 HMP update.
- **Section 2: Planning Process**—This section documents the planning process, the agencies, stakeholders and subject-matter experts (SMEs) involved, and the manner of their involvement. It highlights the extended outreach efforts conducted to encourage participation and increased involvement during this 2018 HMP update. This section also describes how the planning process has been integrated into ongoing federal and state programs and initiatives.
- **Section 3: State Profile**—This section provides a description of the State of Hawaii's physical setting, demographics, economy, state assets and critical facilities, cultural assets, natural resources and land use and development.
- **Section 4: Risk Assessment**—
  - **Section 4.1: Overview**—This section provides an overview of the risk assessment including the identification of hazards and update process, the asset inventories collected and utilized and the hazard-specific data and methodologies used in the vulnerability assessment.
  - **Sections 4.2 through 4.15: Risk Assessment for each Hazard**—The risk assessment for each hazard is divided into two parts: (1) hazard profile and (2) vulnerability assessment. The vulnerability assessment now follows the hazard profile, so that all information about a particular hazard is found in one concise section.
    - All hazard profiles and vulnerability assessments have been updated and enhanced to include more detailed and current technical information. The hazard profile includes a hazard description, location, extent, warning time, previous occurrences and losses, discussions on each hazard's probability of future occurrence and potential effects of climate change.
    - The vulnerability assessment includes qualitative and quantitative assessments to state assets and counties including state buildings, state roads, critical facilities, population, the built environment, land use, environmental resources, cultural assets and projected development.
  - **Section 4.16: Vulnerability Summary—**A hazard ranking methodology was developed to rank all hazards, both statewide and for each county. The methodology was expanded beyond an examination of impacts to include hazard event probability, warning time, spatial extent, duration, adaptive capacity, and future conditions.

- **Section 5: Capability Assessment—**This section provides a comprehensive review and evaluation of state and local capabilities used to support and facilitate mitigation activities and describes the process utilized by the State of Hawai'i to support, promote and coordinate mitigation planning at the county level.
- **Section 6: Mitigation Strategy**—This section provides a description of the review and update of the State's goals and mitigation actions. Previously identified mitigation actions were updated by each lead agency, and new actions were developed to enhance the State's resiliency to disasters.
- **Section 7: Plan Maintenance—**This section describes the 2018 implementation process. For the 2018 HMP Update, changes to this section are based on an evaluation of the effectiveness of the plan maintenance strategy in the 2013 HMP.
- **Appendices:**
  - Appendix X – Capability Assessment
  - Appendix X – Mitigation Strategy

1.4 Overview of Changes from the 2013 HMP to 2018 HMP Update

The HI-EMA State Hazard Mitigation Officer's vision for the 2018 HMP Update is to streamline the plan resulting in a practical and more readable document for the public, and an implementable document for the State to support future risk reduction. In addition, the 2018 HMP Update will serve as a technical reference for the next round of local HMP updates with a robust risk assessment that expands the assets assessed and integrates best available climate science.

With that in mind, the 2018 HMP Update included a comprehensive update to the 2013 HMP risk assessment. The 2018 HMP Update has been reformatted and organized to be more readable while paralleling the structure of the requirements outlined in 44CFR 201.4 and FEMA's State Mitigation Review Guide (March 2015) and State Mitigation Planning Key Topics Bulletins: Planning Process (July 2016); Risk Assessment (June 2016; Mitigation Capabilities (September 2016) and Mitigation Strategy (October 2016). Highly technical information has been simplified, with lengthy tables, maps and support text moved to the appendices.

The 2018 HMP Update includes references to the CFR throughout to provide the reader context. Where possible, these provide specific section and subsection notations. When citing the CFR for state hazard mitigation planning, it is located in the light blue text boxes as seen below:

44 CFR 201.4(c)(4)(ii): [The State Plan must include a] …description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan.

Table 1.4-1 crosswalks the section changes from the 2013 HMP to the 2018 HMP Update.

Table 1.4-1. Crosswalk of Section Changes to the 2018 HMP Update

2013 HMP	Location in the 2018 HMP
Chapter 1 - Introduction	Section 1 - Introduction
Chapter 2 – Mitigation Planning	Section 2 – Planning Process
Chapter 3 – Land Use and Development	Section 3 – State Profile
Chapters 4 through 18	Sections 4.1 through 4.15 – Risk Assessment

2013 HMP	Location in the 2018 HMP
	Section 5 – Capability Assessment
Chapter 19 – Risk Assessment	Sections 4.1 through 4.15 – Overview and Hazard Sections Section 4.16 – Vulnerability Overview
Chapter 20 – Mitigation Strategy	Section 6 – Mitigation Strategy
Chapter 21 – Planning Processes and Update Procedures	Section 7 – Plan Maintenance

Source: State of Hawaii HMP 2013

At the beginning of each section, there is a bulleted summary of changes made. The following highlights the significant changes and enhancements made for the 2018 HMP Update organized by key topic.

Planning Process

- One of the HI-EMA's priorities for the 2018 HMP Update was to ensure increased outreach and collaboration among various sectors to ensure a comprehensive update. The following sectors were engaged throughout the planning process: emergency management, economic development, land use and development, housing, health and social services, infrastructure, natural and cultural resources, academia and the private sector.

Risk Assessment

- **State Buildings**—An enhancement to the 2018 HMP Update was utilizing the complete State Risk Management Office's database of state-owned and leased buildings (referred to as state buildings). Through increased interagency coordination between the HI-EMA and the State Risk Management Office, this dataset was made available to utilize in the 2018 risk assessment update. A state building dataset was not available for the 2013 HMP; therefore, changes in risk and vulnerability of these facilities over the performance period of the plan cannot be assessed.
- **Critical Facilities**—Another enhancement to the 2018 HMP Update risk assessment is the updated definition of a critical facility and the utilization of a more robust critical facility and infrastructure dataset. The 2013 HMP included 274 critical structures in the risk analyses. The 2013 HMP indicated that because the State was involved with the local HMPs, the counties included State critical facilities and lifeline structures in their local risk assessments. For the 2018 HMP Update, the definition and identification of critical facilities as a result of a collaborative planning effort conducted with county, state, federal, private sector and non-governmental organizations was utilized as reported in the Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report.
- **Sea Level Rise**—The 2018 HMP Update was enhanced to include quantified losses to the sea level rise hazard.
    - The 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* quantified the potential area and assets exposed to sea level rise impacts, mapped vulnerability zones, and formulated a comprehensive adaptation strategy. The sea level rise spatial data developed for this effort was used for the climate change and chronic coastal flood risk assessments and adaptation strategies integrated into the updated mitigation strategy in the 2018 HMP Update.
    - A coastal flood zone was modeled that included flood extents and wave heights for wave-generating events with 3.2 feet of sea level rise. This area, referred to as the 1-percent annual chance coastal

flood zone with sea level rise (1%CFZ-3.2) was utilized to examine potential impacts to event-based flooding with sea level rise (Section 4.2 – Climate Change and Sea Level Rise).

- **Local Vulnerability**—The enhanced risk assessment not only evaluates state assets, but also evaluates each county's vulnerability to the identified hazards so that results may be integrated into upcoming local HMP updates. Each section discusses potential impacts to population, the built environment and economy, land use, environmental resources, cultural assets and projected development.

Capabilities

- State and local capabilities have been comprehensively reviewed, updated and reformatted. The following plan elements have been consolidated into a single section: State Capability Assessment, Effectiveness of Local Mitigation Capabilities, and Coordination of Local Mitigation Planning.

Mitigation Strategy

- The 2013 HMP mitigation actions, updated risk assessment, updated capability assessment, and county local HMP actions were used to identify mitigation actions for the 2018 HMP Update. Each identified mitigation action now includes detailed implementation information as well as a clearly articulated and uniformly applied prioritization scheme.

SECTION 2. PLANNING PROCESS

This section outlines the process the State of Hawaiʻi followed to update the HMP and demonstrates their ongoing commitment to ensuring a robust planning process. The following sections describe how the 2018 HMP Update was prepared, which agencies and stakeholders participated in the planning process, and how each section was reviewed, analyzed and revised.

2.1 Description of the Planning Process

44 CFR 201.4(c)(4)(ii): "[The State plan must include a description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated."

The 2018 HMP Update was led by the HI-EMA and developed and updated in accordance with the planning requirement outlined in Section 404 of the Robert T. Stafford Act as amended by the Disaster Mitigation Act of 2000 and in accordance with Chapter 44 of the Code of Federal Regulations (CFR), Sections 201.4(b) and 201.4(c) of the Standard State Hazard Mitigation Plan criteria. The State of Hawaiʻi HMP will continue to serve as a guide for State decision-makers in the allocation of resources in the effort to reduce the effects of natural hazards on people and infrastructure.

The State of Hawaiʻi Multi-Hazard Mitigation Plan was first approved in 2004 and previously updated in 2007, 2010 and 2013. The monitoring, evaluation and update process outlined in the 2013 HMP was well-intended; however, it was not fully actualized. The HI-EMA recognizes that the Mitigation Section is limited in staffing capacity as discussed further in Section 5 (Capability Assessment) and that Hawaiʻi State Hazard Mitigation Forum (Forum) involvement has been sporadic since the adoption of the 2013 HMP update. Additionally, the frequency of hazard events combined with the State's necessity to redirect attention to disaster response and recovery diverted attention and resources away from the outlined 2013 HMP maintenance process. Section 7 (Plan Maintenance) further details the challenges and successes of maintaining the 2013 HMP.

In mid-2016 the State applied for a FEMA 2016 Pre-Disaster Mitigation (PDM) grant to update the 2013 HMP. The State was awarded the grant on March 15, 2017. In early 2017, the HI-EMA appointed a new State Hazard Mitigation Officer (SHMO) to lead the Mitigation Section. The SHMO's vision for the 2018 HMP Update is to streamline the plan resulting in a practical and implementable document, increase collaboration across a broader range of stakeholders to maximize the state planning efforts, and to inspire continued collaboration and implementation beyond the 2018 HMP Update. In September 2017, the State secured planning consulting services to facilitate with 2018 HMP Update with a schedule to submit the updated plan to FEMA Region IX by the summer of 2018.

The HI-EMA Mitigation Section, under leadership of the SHMO, led the 2018 HMP Update. The team met bi-weekly with the planning consultant throughout the planning process. The HI-EMA and the planning consultant met and/or communicated regularly with members of the Forum (individually and as a whole), as well as key stakeholders and subject-matter experts (SME), to identify hazards; assess risks; update capabilities; assist in updating and developing new mitigation goals and strategies; and provide continuity through the process. The role of the Forum, stakeholders, subject-matter experts and the public are discussed later in this section. FEMA Region IX was also consulted throughout the entire planning process and invited to concurrent HMP and Forum update meetings.

Due to the State's unique geography, convening in-person meetings on a regular basis proves challenging; both in time and resources. Therefore, in addition to the in-person meetings held, there was a great deal of communication between the HI-EMA, Forum members, SMEs and stakeholders through individual meetings, electronic mail (email), and by teleconference. Early in the planning process, Forum members were provided a roadmap of the planning process outlining projected major milestones throughout the planning process.

Table 2.1-1 summarizes the key milestone meetings held during the 2018 HMP Update planning process with supporting documentation in Appendix X (Planning Process Documentation). Table 2.1-2 lists the SME's identified and consulted in the 2018 HMP Update planning process. Following Table 2.1-2 is a summary of how key elements of the planning process were conducted. These summaries do not reflect all planning activities conducted in association with the 2018 HMP Update but rather the highlights of the process.

Table 2.1-1. Key 2018 HMP Update Planning Meetings

Date	Meeting and Planning Milestone
August 8, 2017	FEMA Mitigation Program Annual Consultation
October 10, 2017	HI-EMA Project Kick-Off with Mitigation Plan Consultant • Review of 2013 HMP; reorganization and streamlining of content • Organization of the planning team • Outreach strategy • Changes and enhancements to state inventories and risk assessment
October 20, 2017	HI-EMA/FEMA Region IX HMP Update Meeting • New HMP guidance and bulletins • Schedule for FEMA review

October 23, 2017	State Hazard Mitigation Planning Meeting
	• Organization of the planning partnership
	• Risk assessment
	  o Hazards of concern
	  o Critical facility definition
	• Capability Assessment/Plan Integration Exercise

October 2017 to January 2018	Meetings with State Agencies, Stakeholders and Subject-Matter Experts • 2013 Previous Mitigation Strategy Progress • Data collection (events/losses, spatial data, capabilities) • Risk assessment methodology development
January 9, 2018	State Hazard Mitigation Planning Meeting • Review goals • Review capability assessment • Review risk assessment and ranking methodology criteria • 2013 previous mitigation strategy progress
January 2018 to June 2018	Meetings with State Agencies, Stakeholders and Subject-Matter Experts • Data collection (capabilities and risk assessment) • 2013 previous mitigation strategy progress • Updated mitigation strategy
February 21 to 22, 2018	Hazard Mitigation Workshop • Subject-matter experts share best practices in mitigation • Mitigation action development

Date	Meeting and Planning Milestone
	• Focus areas: power, telecommunications and building protection
March 28, 2018	State Hazard Mitigation Planning Meeting • Risk assessment review • Risk ranking review • Mitigation toolbox • Mitigation brainstorming and problem-statement development focused on risk
	Public Meeting • Overview of plan and risk assessment results
April 25, 2018	State Hazard Mitigation Planning Meeting • Review capability assessment • Problem-statement development focused on capabilities • Updated mitigation strategy development
June 9 to 15, 2018	Distribution of Draft 2018 HMP Update Sections to Lead Reviewers
June 27, 2018	State Hazard Mitigation Planning Meeting • Plan maintenance • Review draft 2018 HMP Update procedures
	Draft 2018 HMP Update posted on the project website for public review and comment
	City and County of Honolulu public meeting to discuss the draft 2018 HMP Update
July 3, 2018*	County of Kauaʻi public meeting to discuss the draft 2018 HMP Update
July 6, 2018*	County of Maui public meeting to discuss the draft 2018 HMP Update
August 2018	Submit to FEMA for review

Notes:
FEMA Federal Emergency Management Agency
HI-EMA Hawaiʻi Emergency Management Agency
HMP Hazard Mitigation Plan
**Due to the volcanic hazard event taking place, no public meeting is scheduled in the County of Hawaiʻi at this time. However, the draft plan is available electronically for review and comments via the link on the HI-EMA website. In addition, two Forum members are from the County of Hawaiʻi, and two of the subject-matter experts are from the county. The HI-EMA's Mitigation Section staff had various conversations with County of Hawaiʻi agency staff about the plan update as well as the connection to the county's local hazard mitigation plan, to be updated in 2018-2019.*

Numerous individual meetings with federal and state agencies, academia and stakeholders took place throughout the planning process to ensure a robust risk assessment, thorough collection and update of capabilities and mitigation progress and a comprehensive updated mitigation strategy. There is an abundance of natural hazard subject-matter experts in the State that were willing to participate in the 2018 HMP Update, including providing spatial data, guiding the vulnerability assessment methodology and reviewing the draft Section 4 (Risk Assessment) of this plan. These SMEs were consulted from the beginning stages of the planning process to ensure the best available spatial and natural hazard data and methodologies were utilized to assess the State of Hawaii's risk. Table 2.1-2 summarizes the SME's identified and consulted.

Table 2.1-2. Geospatial and Natural Hazard Subject-Matter Experts

Agency	Name	Area of Expertise
Administrative Services Office, Risk Management Office	Tracy Kitaoka	State assets; State building loss exposure
Department of Defense	Alexa Jacroux Briggs	Geospatial data
Pacific Disaster Center	Doug Baush	Hazus-MH
State of Hawaiʻi Historic Preservation	Michael Wahl	Cultural resources

Agency	Name	Area of Expertise
University of Hawaiʻi School of Ocean and Earth Science and Technology; State Department of Land and Natural Resources, Office of Conservation & Coastal Lands; Tetra Tech, Inc.	Chip Fletcher, Ph.D.; Bradley Romine, Ph.D.; Kitty Courtney, Ph.D.	Climate change and sea level rise
University of Hawaiʻi School of Ocean and Earth Science and Technology; State Department of Land and Natural Resources, Office of Conservation & Coastal Lands	Chip Fletcher, Ph.D.; Brad Romine, Ph.D.	Coastal erosion
State Department of Land and Natural Resources	Edwin Matsuda	Dam failure
State Department of Land and Natural Resources, Commission on Water Resource Management	Neal D. Fujii	Drought
United States Geological Survey, Hawaiian Volcano Observatory	Paul Okubo, Ph.D.	Earthquake
State Department of Land and Natural Resources, Engineering Division, Flood Control and Dam Safety	Edwin Matsuda	Flood
State Department of Health	Judy Kern; Craig (Addison) Houston	Hazardous materials
State Department of Health	Judy Kern; Craig (Addison) Houston	Health risks
FEMA Region IX HLT, Central Pacific Hurricane Center; State Climatologist, University of Hawaiʻi	Victor Dejesus; Pao-shin Chu, Ph.D.	High wind storms
University of Hawaiʻi , Department of Geology & Geophysics	Steve Martel, Ph.D.	Landslide and rock falls
FEMA Region IX HLT, Central Pacific Hurricane Center; State Climatologist, University of Hawaiʻi	Victor Dejesus; Pao-shin Chu, Ph.D.	Tropical cyclones
University of Hawaiʻi	Gerard Fryer, Ph.D.	Tsunami
University of Hawaiʻi, Hawaiʻi Institute of Geophysics & Planetology	Donald Thomas, Ph.D.	Volcanic hazards (lava flow, VOG)
State Department of Land and Natural Resources, Division of Forestry & Wildlife	Dietra A. Myers Tremblay	Wildfire

Notes:
FEMA — *Federal Emergency Management Agency*
Hazus-MH — *Hazards-U.S. Multi-Hazard*
HLT — *Hurricane Liaison Team*
VOG — *Volcanic gas*

When the draft 2018 HMP Update was completed in June 2018, the SHMO identified a lead reviewer per plan section to ensure the first-round of review was conducted by a SME. The lead reviewers are listed in Table 2.1-3. The draft 2018 HMP Update sections were distributed to the lead reviewers via email or posted on the project Sharepoint site depending upon individual needs. All comments received from the SMEs were considered by the HI-EMA Mitigation Section and incorporated into the draft, where appropriate.

Table 2.1-3. Lead Draft 2018 HMP Update Reviewers

Section	Agency	Name
Section 1 – Introduction	HI-EMA Mitigation Section	David Kennard
Section 2 – Planning Process	HI-EMA Mitigation Section	David Kennard
Section 3 – State Profile	HI-EMA Mitigation Section	David Kennard
Section 4.0 – Methodology*	HI-EMA Mitigation Section	David Kennard
Section 4.1 – Climate Change	University of Hawaiʻi Sea Grant Program; State DLNR, Office of Conservation and Coastal Lands	Bradley Romine, Ph.D.
Section 4.2 – Chronic Coastal Flood	State DLNR, Engineering Division, Flood Control and Dam Safety	Edwin Matsuda and Jesse Colandrea
Section 4.3 – Dam Failure	State DLNR, Engineering Division, Flood Control and Dam Safety	Edwin Matsuda and Jesse Colandrea
Section 4.4 – Drought	Drought and Water Conservation Coordinator Hawaiʻi Department of Land and Natural Resources	Neal Fujii
Section 4.5 – Earthquake	United States Geological Survey, Hawaiian Volcano Observatory	Paul Okubo, Ph.D.
Section 4.6 – Event-based Flood	State DLNR, Engineering Division, Flood Control and Dam Safety	Edwin Matsuda and Jesse Colandrea
Section 4.7 – Hazardous Materials	Hawaiʻi Department of Public Health, Public Health Preparedness Branch	Craig “Addison” Houston
Section 4.8 – Health Risks	Hawaiʻi Department of Public Health, Public Health Preparedness Branch	Craig “Addison” Houston
Section 4.9 – High Wind Storm	State Climatologist, University of Hawaiʻi	Pao-Shin Chu, Ph.D.
Section 4.10 – Hurricane	State Climatologist, University of Hawaiʻi	Pao-Shin Chu, Ph.D.
Section 4.11 – Landslide	University of Hawaiʻi, Department of Geology & Geophysics	Steve Martel, Ph.D.
Section 4.12 – Tsunami	Geophysicist, Pacific Tsunami Warning Center	Gerard Fryer, Ph.D.
Section 4.13 – Volcanic	Center for the Study of Active Volcanos	Don Thomas, Ph.D.
Section 4.14 – Wildfire	DLNR, Division of Forestry and Wildlife	Dietra A. Myers Tremblay
Section 4.15 – Risk Ranking	HI-EMA Mitigation Section	David Kennard
Section 5 – Capability Assessment**	HI-EMA Mitigation Section	David Kennard
Section 6 – Mitigation Strategy**	HI-EMA Mitigation Section	David Kennard
Section 7 – Plan Maintenance	HI-EMA Mitigation Section	David Kennard
Appendices	HI-EMA Mitigation Section	David Kennard

Notes:
** The risk assessment methodology was discussed with subject-matter experts listed in Table 2-3 at the beginning stages of the 2018 HMP Update.*
***The State Hazard Mitigation Forum members and State agencies were consulted throughout the planning process, both at in-person meetings and via email and telephone to update their agency-specific information and contribute to each of these sections.*
DLNR Department of Land and Natural Resources
HI-EMA Hawaiʻi Emergency Management Agency
HMP Hazard Mitigation Plan

2.2 Coordination Among Agencies

44 CFR 201.4(b): "The [State] mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and…"

One of the HI-EMA's priorities for the 2018 HMP Update was to ensure increased outreach and collaboration among various sectors to ensure a comprehensive update. The following describes how other agencies and stakeholders were involved in the 2018 HMP Update process and were provided the opportunity to provide input on the plan's content.

State Hazard Mitigation Forum

The Hawaiʻi State Hazard Mitigation Forum serves in an advisory capacity relative to the incorporation of hazard mitigation in policy in Hawaiʻi.

2.2.1 State Hazard Mitigation Forum

The former State Civil Defense established the Hawaiʻi State Hazard Mitigation Forum (Forum) in 1998 (bylaws in Appendix X). Forum members come from a broad spectrum of State and County agencies, and the private sector. The Forum also includes ex officio representatives from all four county emergency management agencies, HI-EMA, additional State agencies and FEMA (Table 2.2-1). The primary functions of the Forum are:

1. Coordinate hazard mitigation activities in the State
2. Recommend and prioritize project nominations for the Hazard Mitigation Grant Program (HMGP)
3. Conduct a statewide public awareness campaign
4. Assist in obtaining funds for mitigation projects
5. Develop a hazard migiation strategy for the State

Table 2.2-1. State Hazard Mitigation Forum Members

Agency	Name
Members	
Maui County Department of Planning	James Buika*
Kauaʻi County Department of Public Works	Doug Haigh
Hawaiʻi State Department of Business, Economic Development & Tourism	Mark Want
Hawaiʻi County Mayor's Office	Roy Takemoto
Retired	Ann Ogata-Deal
University of Hawaiʻi Department of Urban & Regional Planning	Daniele Spiradelli
University of Hawaiʻi Sea Grant Program, State DLNR Office of Conservation & Coastal Lands	Bradley Romine, Ph.D.
Hawaiʻi State DLNR Division of Forestry & Wildlife	Dietra A. Myers Tremblay
Hawaiʻi State Office of Planning, Coastal Zone Management	Sandy Ma
Honolulu Office of Climate Change, Sustainability & Resiliency	Justin Gruenstein
Bank of Hawaiʻi	Ray Trombley
Hawaiʻi State Department of Transportation	George Abcede
Hawaiʻi State Climatologist, Professor of Meteorology University of Hawaiʻi	Pao-Shin Chu, Ph.D.
Ex Officio Members	
City & County of Honolulu Department of Emergency Management, Director	Melvin Kaku
City & County of Honolulu Department of Emergency Management (Alternate)	Crystal Van Beelen

Agency	Name
Kauaʻi County Emergency Management Agency, Administrator	Elton Ushio
Kauaʻi County Emergency Management Agency (Alternate)	Chelsie Sakai
Maui County Emergency Management Agency, Administrator	Herman Andaya
Maui County Emergency Management Agency (Alternate)	Keanu LauHee
Hawaiʻi County Civil Defense Agency, Administrator	Talmadge Magno
FEMA Region IX Pacific Area Office	Lorena Willes
FEMA Region IX Pacific Area Office, Director of Readiness	Colby Stanton
Hawaiʻi Emergency Management Agency (HI-EMA)	
HI-EMA – Preparedness Branch Chief	Jennifer Walter
HI-EMA – State Hazard Mitigation Officer	David Kennard
HI-EMA – Hazard Mitigation Planner	Havinne Okamura
HI-EMA – Disaster Assistance Mitigation Officer	Larry Kanda
HI-EMA – Natural Hazards Planner	Kevin Richards
HI-EMA – Population Protection Planner	Steve Yoshimura
HI-EMA – Citizen Corps Volunteer Coordinator	Marsha Tamura
HI-EMA – Critical Systems Planner	David Lopez
HI-EMA – Hazard Mitigation Clerk Typist	Carmela Vigue
Hawaiʻi State Department of Defense, Hawaiʻi Army National Guard	Alexa Jacroux Biggs
Department of Land and Natural Resources (DLNR)	
Hawaiʻi State DLNR, Engineering Division	Edwin Matsuda
Hawaiʻi State DLNR, Engineering Division	Jesse Colandrea
Alternates	
Central Pacific Bank	Michael Shibata
Hawaiʻi State Office of Planning, Coastal Zone Management	Justine W. Nihipali
Honolulu Office of Climate Change, Sustainability and Resiliency	Uyen Vong

Notes:
The State Hazard Mitigation Forum members listed in this table are current as of March 2018.
**State Hazard Mitigation Forum Chair*
DLNR Department of Land and Natural Resources
FEMA Federal Emergency Management Agency
HI-EMA Hawaiʻi Emergency Management Agency

In the development of the 2018 HMP Update, the HI-EMA regularly engaged the Forum throughout the planning process. As described in Table 2-1, the HI-EMA scheduled regular HMP update meetings from October 2017 to June 2018. These meeting dates coincided with regular Forum meetings to facilitate participation from members. The Forum provided a variety of expertise to the planning process including emergency management, natural hazards, land use planning, building codes, transportation and infrastructure from both state and county perspectives. The Forum was included on all aspects of the planning process, encouraged to provide data and information to support the update, and review interim and draft plan deliverables as outlined further in this section.

2.2.2 State Agencies and Stakeholders

The National Mitigation Framework emphasizes the valuable role of collaboration among sectors to ensure mitigation capabilities continually develop and that comprehensive mitigation includes strategies for all community systems. In addition to collaborating with the Forum, the HI-EMA Mitigation Section coordinated with additional federal and state agencies and stakeholders throughout the 2018 HMP Update. The following sectors were engaged throughout the planning process and were provided opportunities to provide plan input.

A summary of the various sectors engaged in the update process are summarized in Table 2.2-2 below, along with a brief description of their involvement. Note that Forum members and hazard-specific SMEs already captured in Tables 2.1-1 and 2.1-2 earlier are not included in the table below. Refer to Appendix X (Planning Process Documentation) that contains further details on coordination with other agencies and stakeholders.

Table 2.2-2. Sectors Engaged in the 2018 HMP Update

Agency	Involvement
Emergency Management	
FEMA Region IX Pacific Area Office	Invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
FEMA Region IX	Invited to and attended Forum meetings; regular calls with HI-EMA Mitigation Section regarding 2018 HMP Update progress
HI-EMA	The Mitigation Section led the 2018 HMP Update; additional sections and SMEs were invited to and attended Forum meetings as noted in the Forum member table (Table 2-4 above)
City and County of Honolulu Office of Climate Change, Sustainability and Resiliency*	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
County Emergency Management Agencies	Members of the Forum include county emergency management agency representatives; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
California Governor's Office of Emergency Services	Speaker at the Mitigation Workshop in February 2018 and invited to review the draft 2018 HMP Update
Economic Development	
State Department of Business, Economic Development and Tourism	Member of the Forum; Invited to and attended Forum meetings to provide input on all aspects of the plan update
State Department of Accounting and General Services - State of Hawaiʻi Risk Management Office	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies; provided state building database for the risk assessment
Land Use and Development	
University of Hawaiʻi Department of Urban and Regional Planning, University of Hawaiʻi Sea Grant Program**	Invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
Hawaiʻi State Office of Planning, Coastal Zone Management	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
Housing	
Department of Human Services and Hawaiʻi Public Housing Authority	The HI-EMA met with the Department of Human Services and Hawaiʻi Public Housing Authority to discuss the 2018 HMP Update including the capability assessment, risk assessment results and vulnerability of their state buildings and to develop mitigation actions
Heath and Social Issues	
State Department of Health	Invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update; SME review of the health risks and vulnerability risk assessment (Section 4.8); contributed mitigation strategies
Infrastructure	

Agency	Involvement
State Department of Transportation – Harbors Division	Invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update; the HI-EMA coordinates with the Harbors Division regarding their Master Plan Update
State Department of Transportation – Highways Division	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update; contributed mitigation strategies
Hawaiian Electric Company	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
University of Hawaiʻi Energy Program	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
Public Utility Commission	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
Kauaʻi Island Utility Cooperative	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
Department of Energy	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
Natural and Cultural Resources	
Department of Land and Natural Resources, Hawaiʻi State Historic Preservation Division	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update; data request for cultural resource information
Department of Land and Natural Resources, Division of Forestry & Wildlife	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
University of Hawaiʻi Sea Grant Program**	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update; SME reviewer for Climate Change risk assessment section
Academia and Subject-Matter Experts* **	
University of Hawaiʻi Energy Sector School of Ocean and Earth Science and Technology	Invited to the Mitigation Workshop in February 2018
University of Puerto Rico	
Western States Seismic Policy Council	
Private Sector	
Central Pacific Bank	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
Bank of Hawaiʻi	Member of the Forum; invited to and attended Forum meetings to provide input on all aspects of the 2018 HMP Update
Building Industry Association and Builders	Invited to the Mitigation Workshop in February 2018 and invited to submit mitigation strategies
Structural Engineer Association	
Food Distribution Warehouse	
Architect Association	
Tesla (Solar Energy)	

Notes:
** Resiliency is included under Emergency Management*
*** May also be listed under academia*
**** Hazard-specific subject-matter experts not listed in Table 2-4*
FEMA Federal Emergency Management Agency
HI-EMA Hawaiʻi Emergency Management Agency
HMP Hazard Mitigation Plan
SME Subject-matter expert

2.2.3 Public

In October 2017, a dedicated website was developed and deployed to keep the public informed on the 2018 HMP Update planning process. On March 27, 2018, a public meeting was held at HI-EMA to provide a status update on the 2018 HMP Update, present the risk assessment results and hazard ranking and discuss potential mitigation strategies. The meeting was publicly advertised and noticed, compliant with State of Hawaiʻi requirements.

The HI-EMA Mitigation Section scheduled three public meetings to discuss the 2018 HMP Update. These meetings were held in the City and County of Honolulu (June 27, 2018), County of Kauaʻi (July 3, 2018) and County of Maui (July 6, 2018). Due to the volcanic hazard event taking place, there is no public meeting scheduled in the County of Hawaiʻi at this time. However, the draft 2018 HMP Update is available electronically for review and comments via the link on the HI-EMA website. In addition, two Forum members and two of the SMEs are from the County of Hawaiʻi. The HI-EMA's Mitigation Section staff had various conversations with County of Hawaiʻi agency staff about the 2018 HMP Update as well as the connection to the county's local hazard mitigation plan, to be updated in 2018-2019.

On June 27, 2018, the HI-EMA was interviewed live on camera by KHON news at the Blaisdell Arena to preview the State of Hawaiʻi Hazard Mitigation Plan public meeting later that afternoon. In addition, the SHMO is scheduled to participate in an interview on Hawaiʻi Public Radio regarding the 2018 HMP Update and its release for public review.

On June 28, 2018, the HI-EMA released the plan for public review and comment. The public comment period is open through July 13, 2018. A link to the draft plan is posted on the project website (http://www.statehawaiihmp.com) as well as the HI-EMA website (http://dod.hawaii.gov/hiema/sert-resources/hazard-mitigation/). The public is encouraged to submit comments through an online comment form. All comments received by July 13, 2018 will be reviewed and taken into consideration by the HI-EMA Mitigation Section. Applicable and appropriate comments will be summarized by section or theme in Appendix X.

Figure 2.2-1. The News Release Announcing the March 28, 2018 Public Meeting

Home » Latest News » NEWS RELEASE: Hawaii Emergency Management Agency hosts public forum to gather input on State Multi-Hazard Mitigation Plan

NEWS RELEASE: HAWAII EMERGENCY MANAGEMENT AGENCY HOSTS PUBLIC FORUM TO GATHER INPUT ON STATE MULTI-HAZARD MITIGATION PLAN

Posted on Mar 15, 2018 in Latest News

HONOLULU – The Hawai'i Emergency Management Agency (HI-EMA) is inviting the community to a public forum as it updates the **Hawai'i State Multi-Hazard Mitigation Plan,** which addresses ways to reduce the impact of natural hazards on the State. The forum will be held on **March 28, 2018** from **3-5 pm on** at the HI-EMA Operational Support Center at Diamond Head.

HI-EMA 's forum will discuss the planning process and findings to date as it relates to natural hazards which may pose risk to the State of Hawai`i. Participants will also have an opportunity to ask HI-EMA representatives questions regarding the proposed project.

Hawaii's Multi-Hazard Mitigation Plan, last updated in 2013, lays out the State's blueprint for sustained actions to reduce or eliminate the long-term risks to people and property from natural hazards such as hurricanes, tsunamis, earthquakes, severe flooding, wildfires and drought. A current, approved plan is among the conditions of eligibility for some Federal Emergency Management Agency (FEMA) disaster assistance programs. Federal regulations require states to review and update their Plans at least every five years and to submit the Plan updates to FEMA for approval and to the Governor for adoption.

HI-EMA is currently evaluating the State's vulnerability to natural hazards. This risk analysis is key to developing a strategy with potential hazard mitigation actions to reduce the impact of future natural disasters.

To register or for more information, please visit Eventbrite, https://www.eventbrite.com/e/hawaii-state-multi-hazard-mitigation-plan-public-forum-tickets-43867687434

Source: https://governor.hawaii.gov/newsroom/latest-news/news-release-hawaii-emergency-management-agency-hosts-public-forum-to-gather-input-on-state-multi-hazard-mitigation-plan/

Figure 2.2-2. Social Media Announcement for the March 28, 2018 Public Meeting

Source: Facebook

Figure 2.2-3. The HI-EMA Announcement of the Public Meetings in June and July 2018 and Draft 2018 HMP Update Available for Review

Home » Latest News » Hawaii Emergency Management Agency Hosts Three Open Houses

HAWAII EMERGENCY MANAGEMENT AGENCY HOSTS THREE OPEN HOUSES

Posted on Jun 25, 2018 in Latest News

TO GATHER INPUT ON STATE MULTI-HAZARD MITIGATION PLAN UPDATE

HONOLULU – The Hawai'i Emergency Management Agency (HI-EMA) is inviting the community to three open houses as it updates the Hawai'i State Multi-Hazard Mitigation Plan, which addresses ways to reduce the impact of natural hazards on the State. The open houses will be held on:

· **Wednesday, June 27, 2018 from 4:00 – 6:00 pm** in partnership with the City and County of Honolulu Department of Emergency Management at the Neal Blaisdell Center Hawaii Suites, 777 Ward Avenue, Honolulu
· **Tuesday, July 3, 2018 from 5:00 – 7:00 pm** in partnership with the Kauai Emergency Management Agency at the Moikeha Conference Room, 4444 Rice Street, Lihu'e
· **Friday, July 6, 2018 from 1:00 – 3:00 pm** in partnership with the Maui Emergency Management Agency at the Maui Planning Commission Room, 250 South High Street, Wailuku

HI-EMA 's open houses will give the public an opportunity to hear about the planning process and the draft findings to date as they relate to natural hazards which may pose risk to the State of Hawai`i. Participants will also have an opportunity to ask HI-EMA representatives questions regarding the proposed update.

Hawaii's Multi-Hazard Mitigation Plan, last updated in 2013, lays out the State's blueprint for sustained actions to reduce or eliminate the long-term risks to people and property from natural hazards such as hurricanes, tsunamis, earthquakes, severe flooding, wildfires and drought. A current, approved plan is among the conditions of eligibility for some Federal Emergency Management Agency (FEMA) disaster assistance programs. Federal regulations require states to review and update their Plans at least every five years and to submit the Plan updates to FEMA for approval and to the Governor for adoption.

To view the current Multi-Hazard Mitigation Plan, and after June 27 the DRAFT Plan Update, please visit the HI-EMA site:

https://dod.hawaii.gov/hiema/files/2017/03/2013-Hawaii-State-Mitigation-Plan-FEMA-Review-COMPLETE.pdf

Public comments can be submitted at:

https://www.surveymonkey.com/r/HIStateHMPReview

Source: https://governor.hawaii.gov/newsroom/latest-news/hawaii-emergency-management-agency-hosts-three-open-houses/

Figure 2.2-4. News Broadcast and Article on the 2018 Draft HMP Update

khon2

NEWS WEATHER WAKE UP 2DAY SPORTS LIVING808 REPORT IT TRAFFIC CW

Local Kilauea Eruption Always Investigating Business Matters INspirational People Action Line Kupun

Local News

HI-EMA to host open houses to gather input on State Multi-Hazard Mitigation Plan updates

By: Web Staff

Posted: Jun 27, 2018 06:57 AM HST
Updated: Jun 27, 2018 07:02 AM HST

HONOLULU (KHON2) -

The Hawai'i Emergency Management Agency is hosting the community to three open houses as it updates the Hawai'i State Multi-Hazard Mitigation Plan, which addresses ways to reduce the impact of natural hazards on the State.

The open houses will be held on:

- June 27 from 4:00 - 6:00 p.m. in partnership with the City and County of Honolulu Department of Emergency Management at the Neal Blaisdell Center Hawaii Suites
- July 3 from 5:00 - 7:00 p.m. in partnership with the Kauai Emergency Management

Source: KHON2.com

2.3 Program Integration

44 CFR 201.4(b): "[The State] mitigation planning process should…be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives."

Mitigation plan implementation is most effective when mitigation planning efforts are integrated and coordinated with other state and federal programs and initiatives. A vision of the 2018 HMP Update was to enhance coordination among sectors, as discussed previously, and integrate the HMP with other planning efforts. The integration of mitigation into other programs and progress on 2013 HMP mitigation actions that addressed integration into other planning mechanisms and/or encourage collaborative planning are discussed further in Section 5 (Capability Assessment), Section 6 (Mitigation Strategy) and Appendix X (Capability Assessment).

2.3.1 State Mitigation Programs and Initiatives

Within the State of Hawaiʻi, there are several State programs and initiatives that foster HMP integration and coordination. These programs and initiatives are summarized below with further details discussed in Section 5 (Capability Assessment) and Appendix X (Capability Assessment). As part of the 2018 HMP Update planning process, the HI-EMA used the update of the plan as an opportunity to further promote integration. In addition, numerous plans were reviewed and integrated into the 2018 HMP Update as documented in the References section. The following highlights integration opportunities during the planning process as well as a sampling of plans that were integrated into the risk assessment.

- **Broad SME and County Collaboration on the Risk Assessment**—SMEs from state and federal agencies, and academia were consulted during the data collection phase and risk assessment methodology development for the 2018 HMP Update through one-on-one meetings as well as phone and email outreach. Further, these and additional SMEs were requested to conduct a technical review of Section 4. Refer to Table 2-3 above for a list of these SMEs. Additional input from SMEs are summarized in Section 4.0 (Risk Assessment Overview).
- **Expansion of Forum Representation**
  - **Climate Change**—The City and County of Honolulu's Office of Climate Change, Sustainability and Resiliency (CCSR) was established by City Charter in 2016 to seek local information from scientists and track climate change science and potential impacts on city facilities, coordinating actions and policies of departments within the city to increase community preparedness, protect economic activity, protect the coastal areas and beaches, and develop resilient infrastructure in response to the effects from climate change. The CCSR was invited to become a Forum member in February 2018 and participated throughout the 2018 HMP Update planning process.
  - **Planning**—In February 2018 the Hawaiʻi Department of Planning and Permitting and the University of Hawaiʻi Department of Urban and Regional Planning were invited to become Forum members. These two stakeholders participated throughout the 2018 HMP Update planning process by attending Forum meetings, and contributing to the risk assessment, capability assessment and mitigation strategy.
  - **Transportation**—In February 2018 the State of Hawaiʻi Department of Transportation was invited to become a Forum member and participated throughout the 2018 HMP Update planning process by

attending Forum meetings, and contributing to the risk assessment, capability assessment and mitigation strategy.

- **Local HMPs**—The local HMPs were reviewed and data and information were integrated as possible including hazards of concern and potential new development. Goals identified in local HMPs were used to inform the development of goals for the 2018 HMP Update. County leaders worked with the State in goal development and all aspects of plan development through their involvement on the Forum.
- **HI-EMA Strategic Plan Update (Fall 2018)** – HI-EMA will review and updated the existing 2004-2008 State Civil Defense Strategic Plan during the Fall of 2018. Mitigation as one of the four Phases of Emergency Management (Preparedness, Response, Recovery and Mitigation) is a key element of the HI-EMA Strategic Plan and the 2018 State Hazard Mitigation Plan update will support and be integrated into this overdue review.
- **Forum Meetings Discussing FEMA HMGP Projects**—The Forum met throughout the 2013 HMP performance period to identify and rank FEMA DR HMGP projects for DR-4194 (March 2015) and DR-4201 (May 2015).
- **Pacific Disaster Center**—The HI-EMA coordinated with the Pacific Disaster Center to leverage inventory data (enhanced Hazus version 4.2 buildings), hazard data and risk assessment results generated for the earthquake, landslide, tsunami and wind hazards. Details regarding the data are described in Section 4.0.
- **Mitigation Workshop**—In February 2018, the State hosted a Hazard Mitigation Workshop as part of ongoing emergency management conversations about improving the State's ability to withstand the impacts of natural hazards. After presentations and discussions on impacts and lessons learned in Puerto Rico from Hurricanes Irma and Maria, the primary focus was to develop potential mitigation projects in the power and telecommunications sectors and in strengthening the general building stock. Workshop attendees included federal representatives, government representatives from Hawai'i, California and Puerto Rico, hazard-specific committee members, academia and the private sector. Refer to Appendix X (Planning Process Documentation) for further details on meeting topics covered and attendees.
- **2015 Hawai'i Catastrophic Hurricane Plan**—To align with the *2015 Hawai'i Catastrophic Hurricane Plan* the statewide and four county-specific hurricane scenario events were evaluated for the 2018 HMP Update.
- **Threat and Hazard Identification and Risk Assessment (THIRA) and State Preparedness Report (SPR)**—The HI-EMA and Planning Consultant met with the Executive Officer at HI-EMA leading the THIRA update to discuss the THIRA and Strategic Plan updates, 2018 HMP Update risk assessment methodology, and to review the THIRA risk ranking. The results of the THIRA capability assessment were integrated into the adaptive capacity component to the hazard ranking methodology as outlined in Section 4.16 (Vulnerability Overview). Similarly, when the HI-EMA begins the 2018 State of Hawai'i THIRA and SPR preparation under the new FEMA guidance, the 2018 HMP Update will be integrated into the 2018 THIRA and SPR.
- **Annual Consultation**—The FEMA Region IX annual consultation summary was reviewed and used to identify challenges and opportunities as documented in Section 5 (Capability Assessment).
- **Statewide Highway Shoreline Protection Study 2018**—The State Department of Transportation is a member on the Forum and provided the Statewide Highway Shoreline Protection Study for review. It was used to develop a mitigation action to mitigate prioritized flooded roadways in the State.
- **Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report**—In 2017, the HI-EMA led a collaborative planning effort with county, state, federal, private sector and non-governmental organizations to address temporary emergency power planning requirements outlined in the *2015 Hawai'i Catastrophic Hurricane Plan*. The results of this effort were memorialized in the *Makani Pahili 2017 Emergency Power*

Prioritization Workshop Series Report and included the definition and identification of critical facilities within the State. This robust critical facility inventory was utilized for the 2018 HMP Update risk assessment.

- **Naval Post Graduate School Center for Homeland Defense and Security Pacific Executive Leaders Program (PELP)**—The HI-EMA Mitigation Section participated in the Naval Post Graduate School PELP meetings (spring 2017 and spring 2018) to evaluate the risk to the State of Hawaiʻi harbors and critical systems, focusing on restoration of Honolulu Harbor (and other Neighboring Island harbors).
- **Pacific Risk Management Ohana (PRiMO)** —The HI-EMA Mitigation Section participated in PRiMO meetings in 2017 and 2018.
- **State Climate Commission**—A HI-EMA representative is an alternate for TAG at State Climate Commission meetings and advises TAG on mitigation options.
- **Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report (2017)**—The 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* quantified the potential area and assets exposed to sea level rise impacts, mapped vulnerability zones, and formulated comprehensive adaptation strategy. The sea level rise spatial data developed for this effort was used for the climate change and chronic coastal flood risk assessments and adaptation strategies integrated into the updated mitigation strategy in the 2018 HMP Update.
- **Hawaiʻi Drought Plan 2017 Update and 2003 Drought Risk and Vulnerability Assessment and Geographic Information System (GIS) Mapping Project**—Information from these two plans were used to support the drought risk assessment.
- **Communities at Risk from Wildfire (CARW)**—CARW data was provided by the Hawaiʻi Wildfire Management Organization (HWMO). **Community Wildfire Protection Plans (CWPPs)** were reviewed and integrated into the wildfire risk assessment.
- **Climate Change Impacts in Hawaiʻi, 2014**—Local impacts of climate change to the State of Hawaiʻi was integrated into the risk assessment update.
- **State of Hawaiʻi Databook**—The State of Hawaiʻi Databook was utilized to report current and projected population and development statistics in the Section 3 (State Profile) and support the hazard-specific analyses on projected changes in development in the risk assessment.
- **Hawaiʻi Earthquake and Tsunami Advisory Committee (HETAC)**—Several members of the HETAC are SMEs and draft plan reviewers for the 2018 HMP Update: earthquake, landslide, tsunami, volcanic hazards. The HI-EMA Mitigation Section regularly attends quarterly HETAC meetings, updates members on mitigation, and provides the 2018 HMP Update status.
- **State Building Code Council**—The HI-EMA Mitigation Section attends State Building Code Council meetings. The HI-EMA is working with the SBCC and the Department of Accounting and General Services (DAGS), which houses the SBCC, to implement a Hazard Mitigation Grant Program project, funded under an earlier disaster, to update the State Building Code to the most current IBC model code and to adopt high wind amendments.
- **Legislative Briefings**—The HI-EMA Mitigation Section attended numerous legislative briefings on pending legislation during the 2018 cycle (January to May 2018).
- **Hawaiʻi Statewide GIS Program, Office of Planning and Hawaiʻi National Guard**—Much of the spatial data used for the 2018 HMP Update was facilitated through the Office of Planning (geospatial data portal) and the Hawaiʻi National Guard.
- **March 2018 FEMA Annual Hazard Mitigation Stakeholder Workshop**—The SHMO participated in the FEMA-hosted “Building Tomorrow’s Resilient Communities” workshop to further enhance the 2018 HMP Update.

- **Meeting with the State National Flood Insurance Program (NFIP) Coordinator**—The HI-EMA and Planning Consultant met with the State NFIP Coordinator to discuss recent flood events, the update of the 2013 HMP mitigation strategy and capability assessment, and to identify mitigation actions for the 2018 HMP Update.
- **State Agency Meetings**—The HI-EMA Mitigation Section attended meetings with state agency representatives and legislators on various issues, including recovery from recent landslides and flooding, and the Waimānalo watershed.

SECTION 3. STATE PROFILE

2018 HMP UPDATE CHANGES

- The 2013 HMP did not include a State Profile section. Information from several sections of the 2013 HMP was aggregated into the new State Profile including portions of the 2013 HMP Land Use and Development Chapter and Risk Assessment Chapter.
- All data presented was updated as appropriate including demographic information and land use and development statistics.
- Sections were added and expanded to provide additional context for understanding mitigation and risk within the State and to frame the Risk Assessment presented in Section 4 of the 2018 HMP Update.
- All mapping was updated using the best available data.

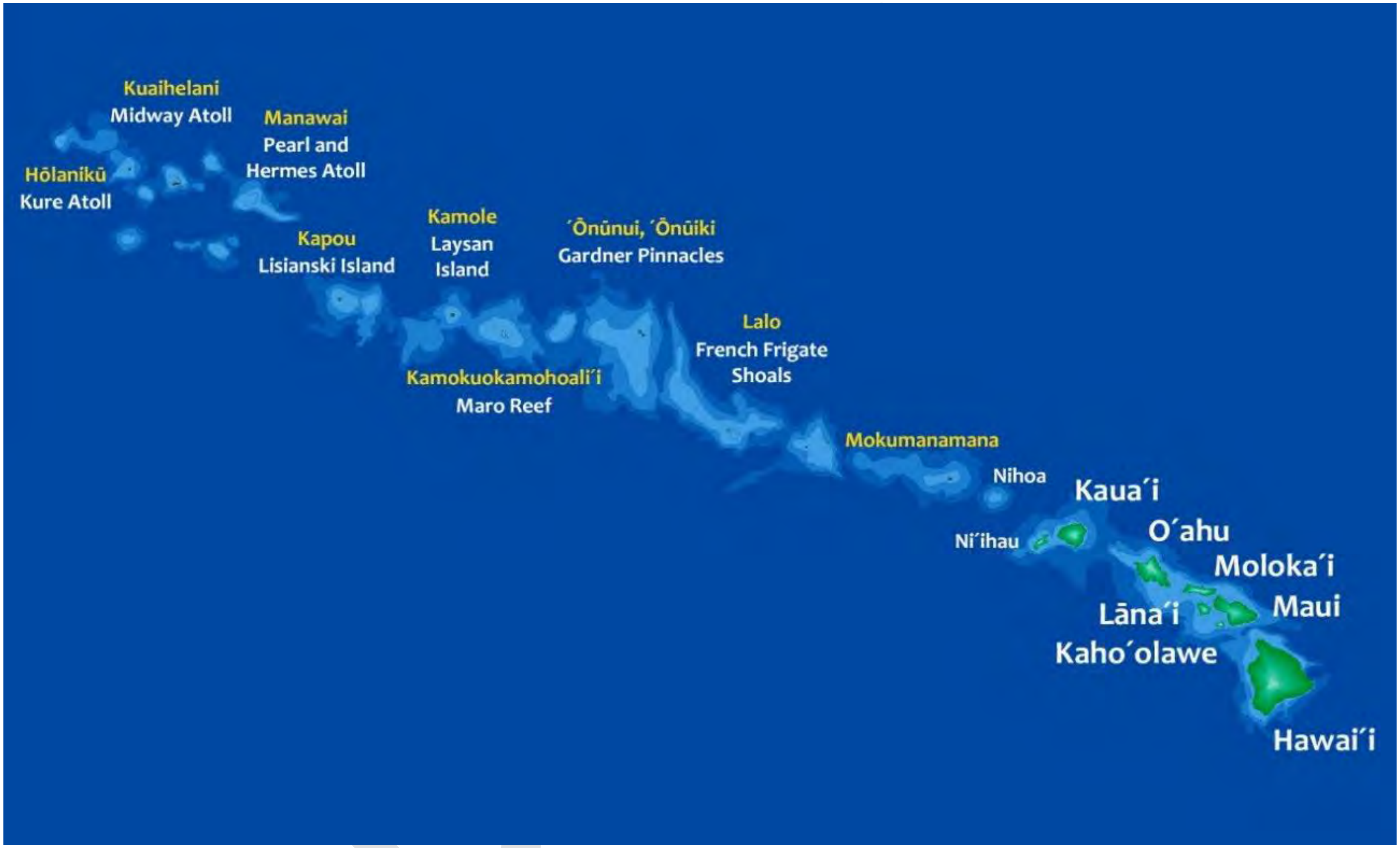
3.1 Geographic Overview

The Hawaiian Archipelago, located about 2,400 miles southwest of the continental Unites States, is comprised of 132 volcanic islands, atolls, reef, and shoals extending in an east-to-west direction across the northern Pacific Ocean between 19 and 22 degrees north latitude (Juvik and Juvic 1998, as cited in the 2013 HMP). The Hawaiian Islands cover 10,932 square miles, with eight main islands located at the southeastern end of the island chain: Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, Kahoʻolawe, Maui, and Hawaiʻi. The remaining islands, atolls, and shoals are known as the Northwestern Hawaiian Islands and form part of the Papahānaumokuākea Marine National Monument created in June 2006 (State of Hawaiʻi HMP 2013). The general features of the State can be seen in Figure 3.2-1 3-1.

3.2 Historic Overview

The Hawaiian Islands were first settled approximately 1,500 years ago when Polynesians traveled more than 2,000 miles by canoe, from the Marquesas Islands to the Island of Hawaiʻi (Hawaiʻi Tourism Authority 2018). Hawaiian society was highly stratified with the mōʻī, or king, acting as the highest authority and aliʻi, or chiefs, below this highest level. Ancient Hawaiians divided land using the ahupuaʻa system, a complex land division system where whole islands, or mokupuni, were divided into smaller, wedge-shaped segments running from the mountain crest to the shore (HawaiʻiHistory.org 2018). The first westerners to arrive in the Islands was Captain James Cook and his crew in 1778. Not long after in 1810, King Kamehameha conquered all other rulers and the entire archipelago was united into one kingdom. In 1820 Christian missionaries arrived followed by traders and whalers who brought diseases that devastated the Native Hawaiian populations (Smithsonian.com 2007). The first sugar plantation was established on the Island of Kauaʻi in 1835 and agriculture became a dominant part of the Hawaiian economy. In 1893 Queen Liliʻuokalani was placed under house arrest and the overthrow of the Kingdom of Hawaiʻi began resulting in the annexation of the Islands of Hawaiʻi by the United States in 1898. On August 21, 1959, following a popular vote, Hawaiʻi became the 50th state of the United States of America.

Figure 3.2-1. General Features of the State of Hawaiʻi



Source: Hawaiʻi Climate Change Mitigation and Adaptation Commission, 2017

3.3 Political Divisions

Politically, the State of Hawaiʻi is divided into five counties: County of Kauaʻi, City and County of Honolulu, County of Maui, County of Kalawao, and County of Hawaiʻi. The County of Kauaʻi encompasses the Islands of Kauaʻi and Niʻihau. The City and County of Honolulu includes the Island of Oʻahu and the Northwestern Hawaiian Islands. The County of Maui consists of the Islands of Molokaʻi (with the exception of the Kalaupapa peninsula which constitutes the County of Kalawao), Lānaʻi, Kahoʻolawe, and Maui. Lastly, the County of Hawaiʻi has jurisdiction over the Island of Hawaiʻi (State of Hawaiʻi HMP, 2013). For the 2018 HMP Update, the County of Kalawao statistics are included with the County of Maui's.

3.4 Physical Setting

The following sections describe the geography, topography, and climate of the State of Hawaiʻi.

3.4.1 Geography and Topography

The following sections provide a brief overview of the geography and topography of each of the State's counties. The information is presented here and throughout the 2018 HMP Update, in general, from the westernmost County to the easternmost.

County of Kauaʻi

The County of Kauaʻi is situated northwest of the Island of Oʻahu, separated by the Kauaʻi Channel. Known as the Garden Isle, the Island of Kauaʻi is the northernmost and geologically oldest of the major Hawaiian Islands. The County of Kauaʻi includes the Island of Niʻihau (73 square miles) and the tiny uninhabited islets of Kaʻula and Lehua. These islands are volcanic in origin, although there are currently no active volcanoes in the county. The circular Island of Kauaʻi rises three miles from the ocean floor and is roughly 550 square miles (County of Kauaʻi HMP 2015).

In the center of the Island of Kauaʻi is Kawaikini Peak, rising 5,170 feet, and Mount Waiʻaleʻale, rising 5,080 feet. Mount Waiʻaleʻale is the rainiest spot on earth, averaging 460 inches of rain a year, and contributes to this island's nickname—the Garden Island. Many streams flow from these mountains to the sea through canyons in the volcanic rock. Waimea Canyon has colorful rock walls that are 2,857 feet high. Rugged cliffs along the northwestern coast make it impossible to build a road around the whole island. The Island of Niʻihau, nicknamed "The Forbidden Island," is a private island owned by the Robinson family of Kauaʻi. The island is semi-arid with a dry climate, although several lakes provide fresh water (County of Kaua'i HMP 2015).

City and County of Honolulu

The City and County of Honolulu consists primarily of the Island of Oʻahu but also includes the Northwestern Hawaiian Islands, with the exception of Midway Atoll, which is administered by the U.S. Fish and Wildlife Service (County of Honolulu HMP 2012). The Northwestern Hawaiian Islands consist largely of uninhabited low-lying atolls and islets. The Island of Oʻahu consists of the remains of two shield volcanoes: the Koʻolau Volcano on the east side of the island and the Waiʻanae Volcano on the west side of the island. The valley between the mountains of these two extinct volcanoes consists of a fertile, rolling plain that supported both sugar and pineapple plantations in the past. Those industries have now been largely replaced by residential development and diversified agriculture. A most notable landmark is the 760-foot extinct volcanic crater, known as Diamond Head, located on the southeastern end of the island at the end of world-famous Waikīkī beach (State of Hawaiʻi HMP 2013).

County of Maui

The Island of Maui is the second largest island in the Hawaiian Archipelago, covering 727 square miles. It was formed 1.3 million to 0.7 million years ago by two volcanic cones: Haleakalā on the east side of the island, with a current elevation of 10,023 feet; and Puʻu Kukui (Mauna Kahalawai) on the west side, with a current elevation of 5,788 feet. Haleakalā, which last erupted in 1790, is a dormant volcano that could erupt in the next 100 years. A relatively flat isthmus of sand joins the two cones. East Maui is geologically younger than West Maui, as apparent by the absence of deeply incised canyons and extensive areas of volcanic lava and cinders on the southwestern slopes of Haleakalā. The lands more suitable for agriculture, including the gentle slopes of central Maui and tablelands of West Maui, resulted from alluvial deposits and the decomposition of basaltic materials (County of Maui HMP 2015).

The Island of Molokaʻi is the fifth largest of the main Hawaiian Islands, covering approximately 260 square miles. It is 38 miles long and 10 miles wide and has approximately 100 miles of shoreline. It was formed primarily by the coalescence of two shield volcanoes 1.8 million to 1.3 million years ago: the East Molokaʻi Volcano (also known as Kamakou) and the West Molokaʻi volcano (also known as Mauna Loa) (County of Maui HMP 2015).

The Island of Lānaʻi is the sixth largest of the main Hawaiian Islands, with an area of 141 square miles. The island was formed from a single shield volcano that last erupted about 1.3 million years ago. A low-lying basin in the center of the island is what is left of the volcano's caldera (County of Maui HMP 2015).

The smallest of the main Hawaiian Islands, Kahoʻolawe has a land area of 45 square miles. It was formed by a single volcano that underwent shield and post-shield stages. The highest point on the island is a crater Puʻu ʻO Moaʻula Nui, at 1,483 feet above sea level (County of Maui HMP 2015).

County of Hawaiʻi

The Island of Hawaiʻi is the southeastern most 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 and continues to grow as a result of ongoing eruptions The Island of Hawaiʻi was formed from the coalescence of five volcanoes—Kohala, Mauna Kea, Hualālai, Mauna Loa, and Kīlauea. These five dominant mountains create wind acceleration zones on the island (County of Hawaiʻi HMP 2015).

3.4.2 Climate

The following sections provide a general overview of the climate in the State of Hawaiʻi and how the El Niño-Southern Oscillation cycle effects climate conditions in the State.

General Overview of the Climate of the State of Hawaiʻi

The following description of the climate of the State of Hawaiʻi was extracted and condensed, in part, from the National Weather Service (NWS) National Oceanic and Atmospheric Administration's (NOAA) website. According to the website, it is a condensed chapter on the State of Hawaii's climate from the Second Edition (University of

Hawaiʻi Press, 1983) of the "Atlas of Hawaiʻi." The author is the late Saul Price, former Hawaiʻi State Climatologist and Staff Meteorologist for the NWS Pacific Region (NWS 2018).

Air, Ocean Temperatures and Seasons

The climate of the State of Hawaiʻi can be generally characterized as including mild temperatures throughout the year, moderate humidity, persistence of northeasterly trade winds, significant differences in rainfall within short distances, and infrequent severe storms. For most of the State, there are only two seasons: "summer" (*kau*), between May and October, and "winter" (*hoʻoilo*), between October and April. The State of Hawaii's longest and shortest days are about 13½ hours and 11 hours, respectively, compared with 14½ and 10 hours for Southern California and 15½ hours and 8½ hours for Maine. Uniform day lengths result in small seasonal variations in incoming solar radiation and, therefore, temperature.

Like the ambient air temperatures, ocean temperatures differ slightly between the seasons with about 6 degrees of fluctuation, from a low of 73 degrees Fahrenheit (˚F) or 74˚F between late February and March to a high near 80˚F in late September or early October. Because the State of Hawaiʻi is more than 2,000 miles from the nearest continental land mass, air that reaches it, regardless of source, spends enough time over the ocean to moderate its initial harsher properties. For example, Arctic air that reaches the State of Hawaiʻi during the winter may have a temperature increase by as much as 100˚F during its passage over the waters of the North Pacific. The State of Hawaii's warmest months are August and September. Its coolest months are February and March, reflecting the seasonal lag in the Pacific Ocean's temperature.

Terrain

The State of Hawaii's mountains significantly influence every aspect of its weather and climate. The endless variety of peaks, valleys, ridges, and broad slopes, gives the State of Hawaiʻi a climate that is different from the surrounding ocean, as well as a climatic variety within the islands. The mountains obstruct, deflect, and accelerate the flow of air. When warm, moist air rises over windward coasts and slopes, clouds and rainfall are much greater than over the open sea. Leeward areas, where the air descends, tend to be sunny and dry. In places sheltered by terrain, local air movements are significantly different from winds in exposed localities. Since temperature decreases with elevation by about 3˚F per thousand feet, the State of Hawaii's mountains, which extend from sea level to nearly 14,000 feet, contain a climatic range from the tropic to the subarctic.

The climate of the State of Hawaiʻi can be defined by what it has and by what it does not have. It does not have the extremes of cold winters and summer heat waves, and it usually does not have hurricanes and hailstorms. However, the State of Hawaii's tallest peaks do get their share of winter blizzards, ice, and snow. Highest temperatures may reach into the 90s˚F. Thunderstorms, lightning, hail, floods, hurricanes, tornadoes, and droughts are not unknown. However, these phenomena are usually less frequent and less severe than their counterparts in continental regions.

The highest temperature ever recorded in the State of Hawaiʻi was 100˚F at Pahala (elevation 870 feet) on the Island of Hawaiʻi on April 27, 1931. The lowest ever recorded was 12˚F on Mauna Kea (elevation 13,770 feet), also on the Island of Hawaiʻi, on May 17, 1979.

Rainfall

Over the ocean near the State of Hawaiʻi, rainfall averages between 25 and 30 inches a year. The islands receive as much as 15 times that amount in some places and less than one third of it in others (see Figure 3.4-1). This is caused mainly by orographic or mountain rains, which form within the moist trade wind air as it moves from the sea over the steep and high terrain of the islands. Over the lower islands, the average rainfall distribution resembles closely the topographic contours. Amounts are greatest over upper slopes and crests and least in the leeward lowlands. On the higher mountains, the belt of maximum rainfall lies between 2,000 to 3,000 feet and amounts decrease rapidly with further elevation. As a result, the highest slopes are relatively dry.

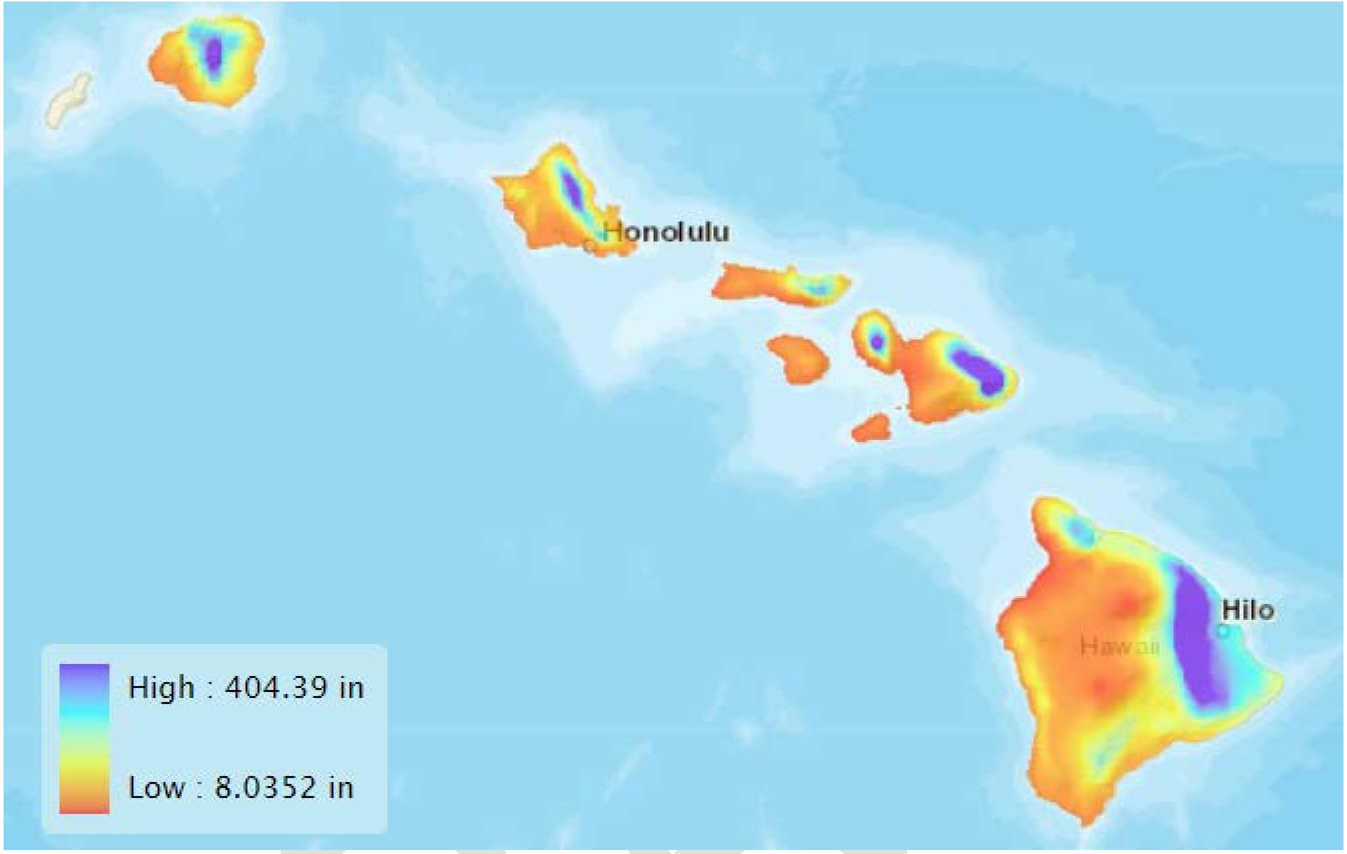
Another source of rainfall is the towering cumulus clouds that build up over the mountains and interiors on sunny calm afternoons. Although such convective showers may be intense, they are usually brief and localized. Hawaii's heaviest rains come from winter storms between October and April. While the effects of terrain on storm rainfall are not as great as on trade wind showers, large differences over small distances do occur, because of topography and location of the rain clouds. Differences vary with each storm.

Frequently, the heaviest storm rains do not occur in areas with the greatest average rainfall. Relatively dry areas may receive, within a day or a few hours, totals exceeding half of their average annual rainfall.

The leeward and other dry areas obtain their rainfall mainly from a few winter storms. Therefore, their rainfall is usually seasonal and, their summers are dry. In the wetter regions, where rainfall comes from both winter storms and trade wind showers, seasonal differences are much smaller.

At the opposite extreme, drought is not unknown in the State of Hawaiʻi, although it rarely affects an entire island at one time. Drought may occur when there are either no winter storms or no trade winds. If there are no winter storms, the normally dry leeward areas are hardest hit. A dry winter, followed by a normally dry summer and another dry winter, can have serious effects. The absence of trade winds affects mostly the windward and upland regions, which receive a smaller proportion of their rain from winter storms.

Figure 3.4-1. Annual, Average Rainfall in Hawaiʻi



Source: Image from Giambelluca et. al. 2014

El Niño and La Niña Effects on The State of Hawaii's Climate

El Niño and La Niña are opposite phases of what is known as the El Niño-Southern Oscillation (ENSO) cycle. The ENSO cycle is a scientific term that describes the fluctuations in temperature between the ocean and atmosphere in the east-central Equatorial Pacific (approximately between the International Date Line and 120 degrees West). La Niña is sometimes referred to as the cold phase of ENSO and El Niño as the warm phase of ENSO. These deviations from normal surface temperatures can have a large impact on ocean processes, global weather, climate, and influences on extreme weather (NOAA 2017).

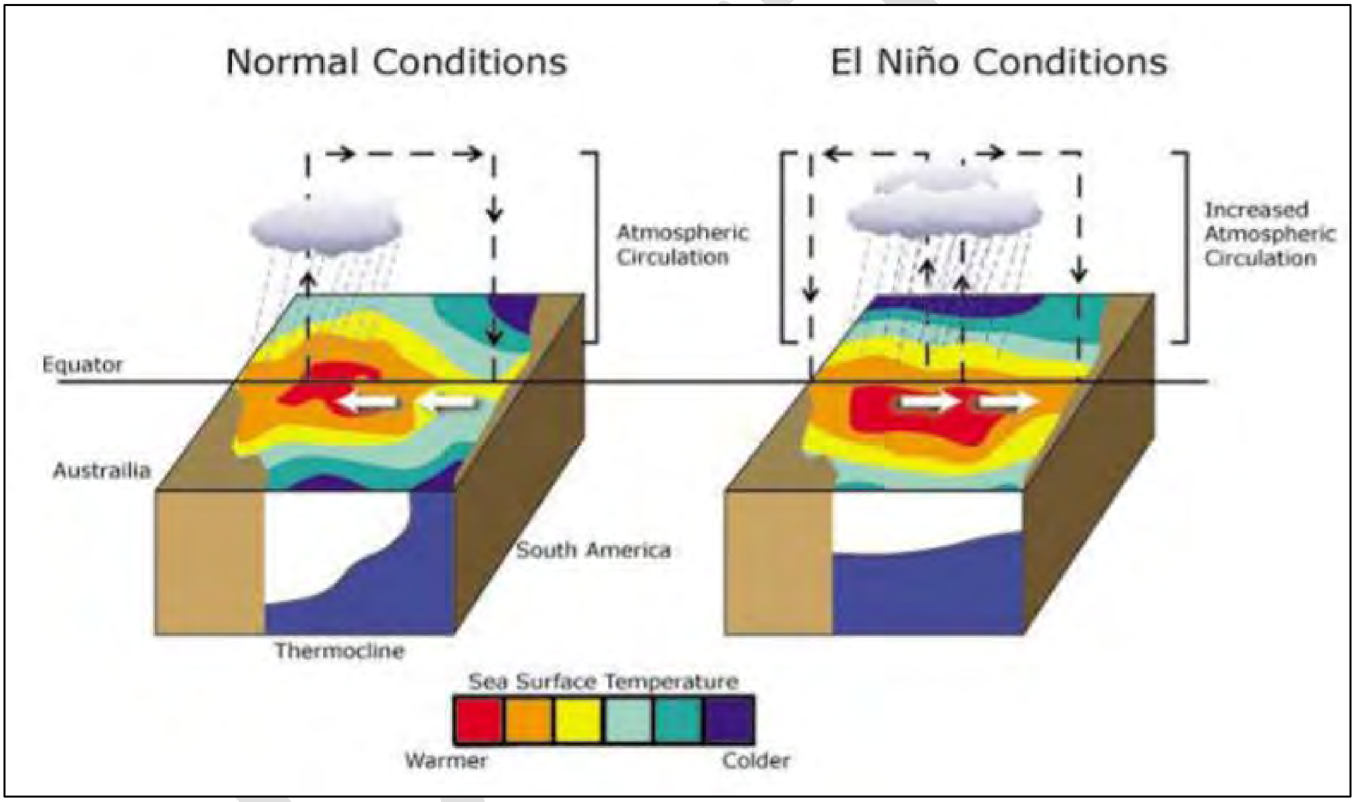
El Niño and La Niña episodes typically last 9 to 12 months, but some prolonged events may last for several years. While the frequency of events can be quite irregular, El Niño and La Niña events occur on average every two to seven years. Typically, El Niño occurs more frequently than La Niña (NOAA 2017).

El Niño

El Niño refers to the large-scale, ocean-atmosphere climate interaction linked to a periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific. It brings increased rainfall to the east Pacific Basin; however, drought occurs at locations west of the Pacific Basin, such as in Australia. El Niño is typically responsible for destructive flooding in the East Pacific and drought in the West Pacific, sometimes associated with devastating brush fires in Australia. Observations of conditions in the tropical Pacific are considered essential for the prediction of short-term (a few months to 1 year) climate variations. To provide necessary data, NOAA operates a network of buoys which measure temperature, currents and winds in the equatorial band. These buoys daily transmit data which are available to researchers and forecasters around the world in real time (NOAA 2017; Hawaiʻi State HMP 2013).

Figure 3.4-2 illustrates the difference between normal conditions and El Niño conditions. In normal conditions, the trade winds blow from east to west pushing warm surface waters toward Asia, piling it up in the western Pacific. During El Niño conditions, the trade winds weaken and the warm surface water moves eastward. This reduces the upwelling of cold water off the coast of South America. The climate impacts of El Niño show up mostly during the winter months over North America.

Figure 3.4-2. Normal Conditions vs El Niño Conditions



Source: NOAA Date Unknown
Note: NOAA National Oceanic and Atmospheric Administration

During El Niño, the State of Hawaiʻi typically experiences more rain in the beginning of the season then rapidly less; causing a drier wet season. Trade winds are weaker and occasional the State will experience westerly winds. Sea level is near to slightly above normal, causing high run-up from distant swells. Ocean temperatures are much warmer at and below the surface. Lastly, El Niño increases the risk of storms forming closer to and moving towards the islands (NOAA Date Unknown). Other significant impacts include increased risk of wildfires associated with drought; coastal erosion with changes in sea level and storm impacts; coral reef bleaching (coral reefs protect islands from waves and storm impacts); loss of plants, agriculture, and degradation of habitat; and, landslides associated with heavy rainfall (Hawaiʻi State HMP 2013).

La Niña

La Niña episodes represent periods of below-average sea surface temperatures across the east-central Equatorial Pacific. It occurs after El Niño as the warmer ocean fuels an intensification and southward shift of the jet stream. Eventually, the trade winds pick up again and can become stronger than normal. When this occurs, the trade winds blow the warm water back into the western Pacific. This restarts the upwelling of cool water towards the surface in the eastern Pacific, known as La Niña. La Niña brings unusually cold conditions to the tropical Pacific and displaces the jet stream northward. In the tropics, ocean temperature variations in La Niña also tend to be opposite to those of El Niño. (NOAA 2017).

During La Niña, rainfall in the State of Hawaiʻi tends to be near or above normal during the winter months. The rainy season usually lasts longer into the spring. The State may receive above normal rainfall not only during the wet season of January through March, but during a strong La Niña period the excess wetness may continue through May in many locations (Hawaiʻi Guide 2018).

3.5 Demographics

The following sections discuss demographic information for the State of Hawaiʻi.

3.5.1 Resident Population

Knowledge of the composition of the population, how it has changed in the past and how it may change in the future is needed to make informed decisions. Information about population is a critical part of planning because it directly relates to needs such as housing, industry, stores, public facilities and services, and transportation. According to 2016 estimates, the State of Hawaiʻi has a resident population of 1,428,557 people. The majority of the population is concentrated on the Island of Oʻahu (City and County of Honolulu) with a total of 992,605 residents. Between 2010 and 2016, the State of Hawaii's resident population increased by 5.0% (State of Hawaiʻi Data Book 2016). Resident population figures by county are shown in Table 3.5-1.

Table 3.5-1. Resident Population by County, 1990 to 2016

County	Resident Population				
	1990	2000	2010	2016	% Change (2010 to 2016)
County of Kaua'i	51,177	58,463	67,091	72,029	+7.4%
City and County of Honolulu	836,231	876,156	953,207	992,605	+4.1%
County of Maui[a]	100,504	128,241	154,924	165,474	+6.8%
County of Hawaiʻi	120,317	148,677	185,079	198,449	+7.2%
Total[b]	**1,108,229**	**1,211,537**	**1,360,301**	**1,428,557**	**5.0%**

Source: 2016 State of Hawaiʻi Data Book
Notes:
a. *Includes the County of Kalawao, which had 147 people in 2000, 90 in 2010, and 88 in 2016.*
b. These estimates include military personnel stationed or homeported in the State. The U.S. Department of Defense estimates that there are 43,540 active duty military in the State as of March 2018. Additional military personnel who are not stationed or homeported in the State but are currently ported or otherwise present in the State are not included.
The de facto population of the State of Hawaiʻi is much larger than the resident population due to the substantial number of visitors in the State on any given day. The statewide average daily visitor population is 217,675 visitors as of 2016. This means that the de facto population is 15.2% greater than the resident population. Additional discussion on tourism can be found in Section 3.6.3.

Population projections for the State indicate that the statewide population is expected to increase by approximately 280,000 by 2040 representing a 19.6% increase over 2016 population estimates. More than a third of this increase is expected to be in the County of Hawaiʻi, which has the largest projected increase for both total people and the percent of current population. Table 3.5-2 shows population projections for each county until 2040.

Table 3.5-2. Resident Population Projections by County, 2020 to 2040

County	Resident Population			
	2020	2030	2040	% Change (2016 to 2040)
County of Kauaʻi	75,640	84,380	93,020	29.1%
City and County of Honolulu	1,003,710	1,052,130	1,086,710	9.5%
County of Maui[a]	181,020	207,310	232,860	40.7%
County of Hawaiʻi	220,880	258,510	296,320	49.3%
Total	**1,481,240**	**1,602,340**	**1,708,920**	**19.6%**

Source: 2016 State of Hawaiʻi Data Book
Note: a. Includes the County of Kalawao

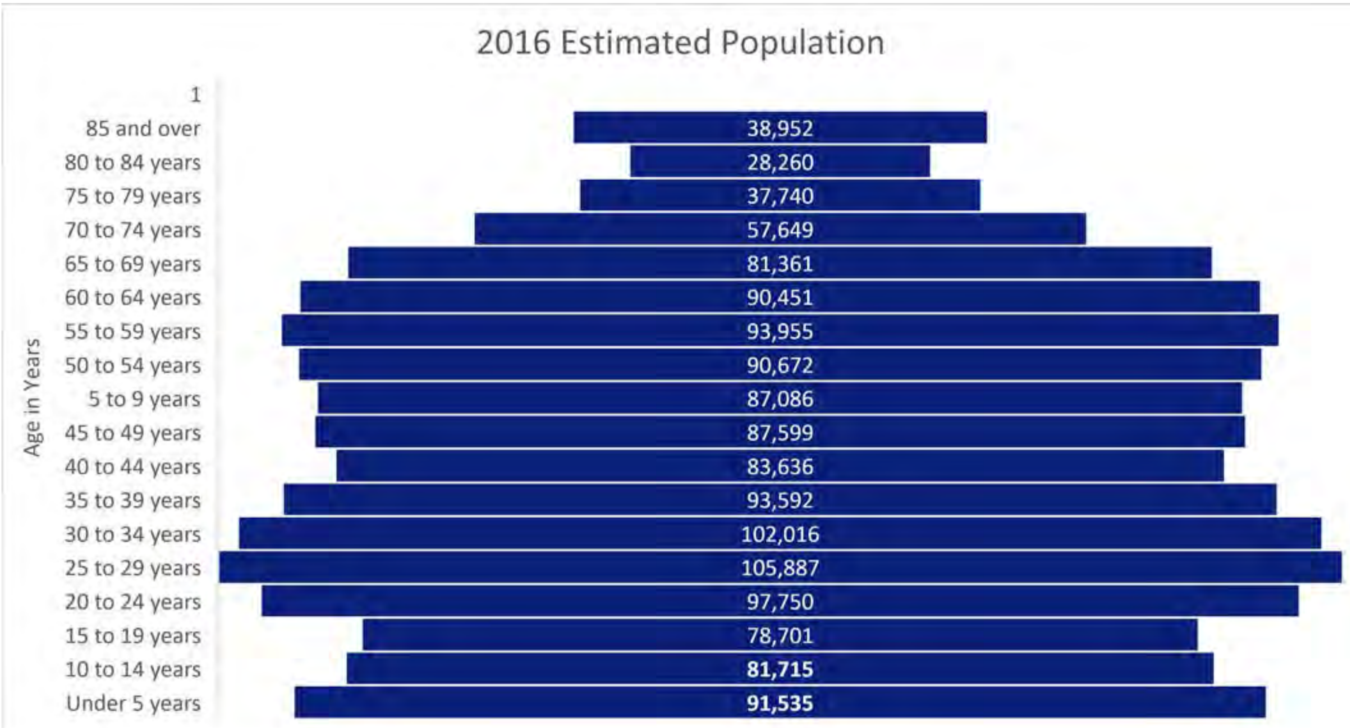
3.5.2 Age Distribution

The residents of the State of Hawaiʻi have a median age of 38.6 as of 2016, which is slightly older than the national average of 37.9. Women in Hawaiʻi have a median age of 40.4, which is slightly older than the median age of men (37.0). As of 2016, 17.1% of the population is now over the age of 65 and the single largest age cohort is 15 to 29 years old (State of Hawaiʻi Data Book 2016). By 2040, population projections suggest that 23.6% of the total population of the State will be 65 years or older and 18.5% of the total population will be 14 years or younger (State of Hawaiʻi Data Book 2016). The age distribution of the estimated population for 2016 and the projected population for 2040 are shown in Figure 3.5-1.

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. 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.

Children under 14 are also 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.

Figure 3.5-1. State of Hawaiʻi 2016 Estimated Population and 2040 Projected Population Distribution



Source: Hawaiʻi State Data Book 2016

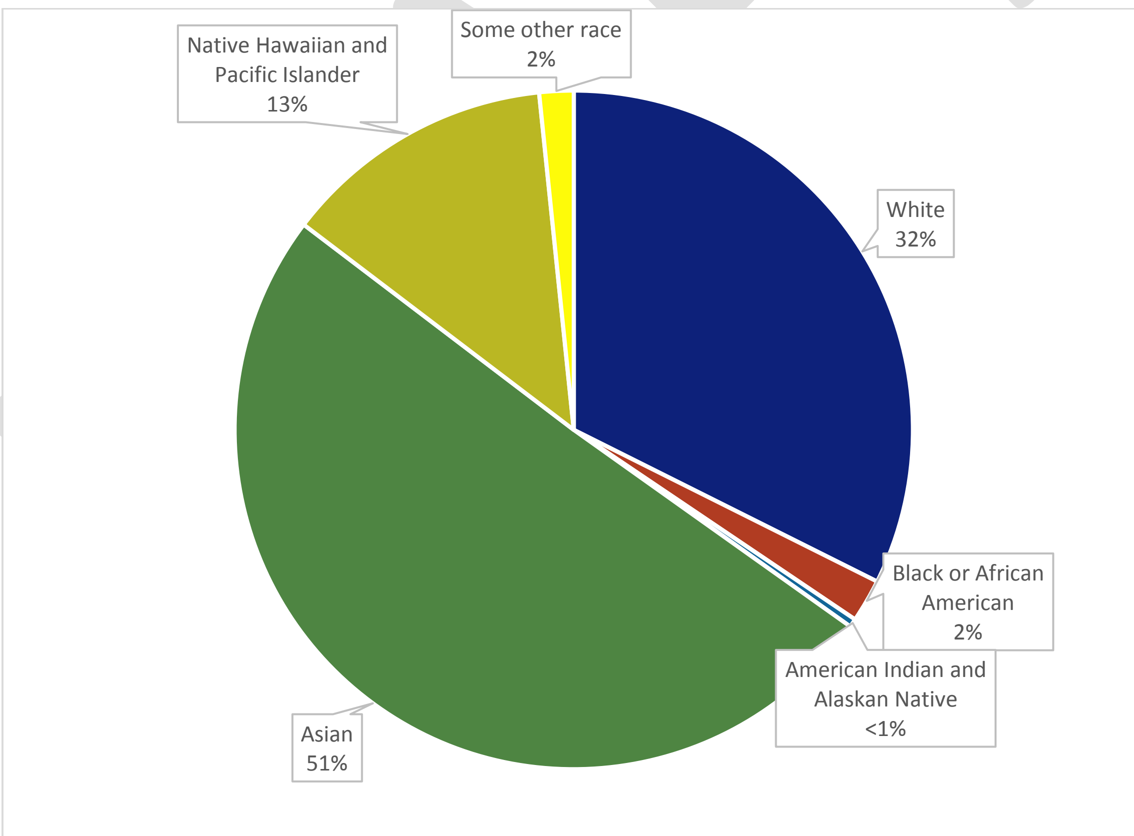
3.5.3 Race, Place of Birth, and Language

According to the 2010 U.S. Census, persons of Asian descent make up the largest proportion of the population in the State of Hawaiʻi at 38.6% followed by White residents (24.7%) and residents of two or more races (24.7%) (State of Hawaiʻi Data Book 2016). Native Hawaiians and Pacific Islanders account for 9.9% of the total population. Table 3.5-3 shows the racial distribution by county.

Approximately 82.3% of the State population was born in the United States with about 53.8% born in Hawaiʻi. Of the 17.7% of foreign-born residents, approximately 10.1% are U.S. Citizens. More than 45% of residents born outside of the United States were born in the Philippines, followed by Japan at 9.3%, and China at 7.4% (State of Hawaiʻi Data Book 2016).

Approximately 331,000 of State of Hawaiʻi residents, a third of all residents over the age of five, speak a language other than English at home. About 20% of these residents, almost 63,000, speak English less than well. Pacific Island languages are the most common language spoken other than English, followed by Tagalog and Japanese (Hawaiʻi State Data Book 2016). Understanding the language that residents speak is important in ensuring that risk and emergency information is effectively communicated to the population.

Figure 3.5-2. Racial Distribution in the State of Hawaiʻi



Source: State of Hawaiʻi Data Book 2016

Table 3.5-3. Racial Distribution of the State of Hawaiʻi Population by County

County	White	Black or African American	American Indian and Alaskan Native	Asian	Native Hawaiian and Pacific Islander	Some other race	Two or more races	Total
County of Kauaʻi	22,159	278	254	21,016	6,060	608	16,716	67,091
City and County of Honolulu	198,732	19,256	2,438	418,410	90,878	10,457	213,036	953,207
County of Maui	53,360	870	603	44,602	16,095	3,052	36,342	154,924
County of Hawaiʻi	62,348	1,020	869	41,050	22,389	2,868	54,535	185,079
Total	**336,599**	**21,424**	**4,164**	**525,078**	**135,422**	**16,985**	**320,629**	**1,360,301**

Source: State of Hawaiʻi Data Book 2016

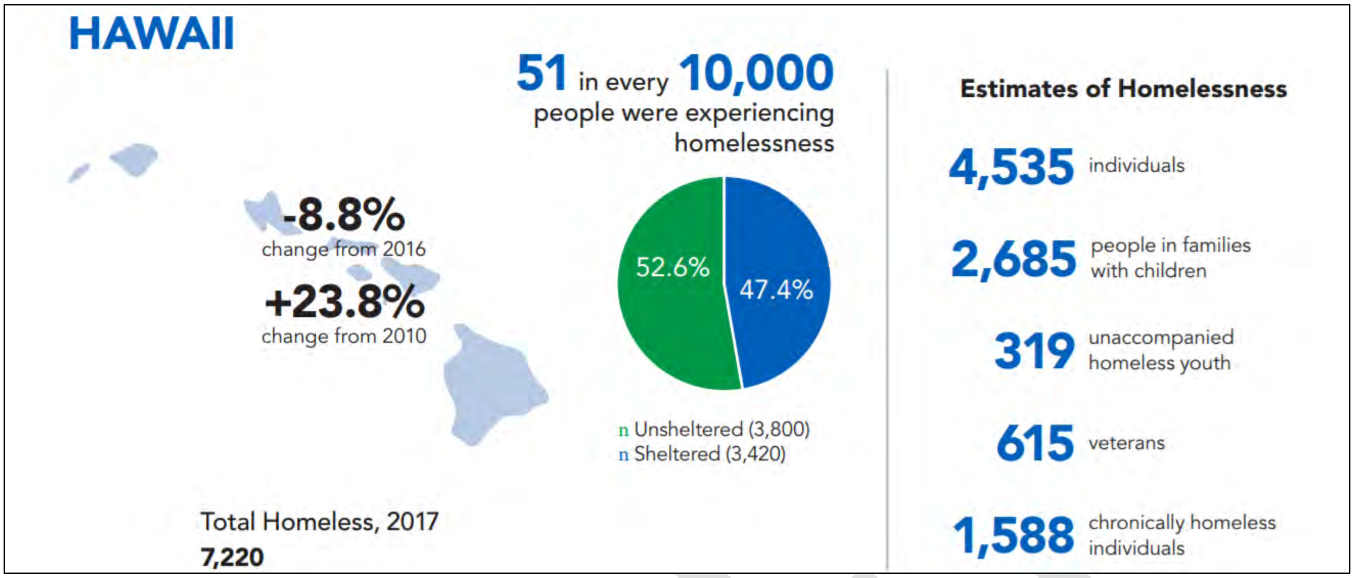
3.5.4 Persons with Disabilities or with Access and Functional Needs

The 2010 U.S. Census estimates that 54 million non-institutionalized Americans with disabilities or with access and functional needs live in the U.S. This equates to about one in five persons. This population is more likely to have difficulty responding to a hazard event than the general population. State and 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 allows 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 American Community Survey 2016 estimates, persons with disabilities make up approximately 11% of the total civilian non-institutionalized population of the State of Hawaiʻi (American Community Survey 2016). The likelihood of having a disability varies by age with an estimated 3% of the population under 18 years old, to 8% of people 18 to 64 years of age, and 35% of those 65 and older.

3.5.5 Persons Experiencing Homelessness

As of 2017, there are estimated to be 7,220 persons experiencing homelessness in the State of Hawaiʻi (see Figure 3.5-3; U.S. HUD 2017). This represents a decrease of 701 people statewide, nearly a 9% decrease, from 2016 estimates. This is the first time that homelessness counts have decreased in eight years; however, the number of persons experiencing homelessness increased by approximately 16% over the performance period of the 2013 HMP from 6,246 in 2012 (Department of Human Services, 2017; Department of Human Services 2012). According to the U.S. Department of Health and Human Services, people experiencing homelessness have limited resources and are likely to have previously experienced traumatic events. As a result, such persons may be more at risk to adverse physical and psychological reactions after a disaster event than the general population (U.S. Department of Health and Human Services, 2018). In addition, many persons experiencing homelessness are unsheltered and may be particularly vulnerable to some hazard events due to inadequate shelters (for example, tents), exposure to the elements, and residing in high hazard risk areas, such as along creeks and streams.

Figure 3.5-3. Persons Experiencing Homelessness Estimates in the State of Hawai'i, 2017



Source: U.S. HUD, 2017

3.6 Economy

The following sections provide information on the Hawai'i State Economy including employment and industry income and tourism.

3.6.1 Employment and Industry

After a natural hazard event, economic resiliency helps to drive and expedite recovery. An understanding of the major employers and economic sectors whose losses or inoperability would impact the community and its ability to receive from a disaster is essential.

According to the 2016 Hawai'i State Data Book, there are 664,180 employed civilians in the State. Of these employees, the largest proportion (20.4%) are employed in the educational, health and social services fields. Other notable fields include: arts, entertainment, recreation, accommodation and food services (16.6%); retail (11.8%); and professional, scientific, management, administrative and waste management services (10.4%). High proportions of employment in retail, arts, entertainment, recreation, accommodation and food services reflect the state's strong tourism economy (State of Hawai'i Data Book 2016).

It is expected that the State of Hawaii's future growth will be primarily related to the rate of expansion of the economies of the United States mainland and Japan. These two economies are the sources of the State of Hawaii's tourism demand and the main export markets for the State's goods and services (State of Hawai'i HMP 2013).

3.6.2 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 or experiencing financial difficulties are automatically disadvantaged when confronting hazards. A household that experiences financial difficulties may find it hard or impossible to invest in other areas that can increase safety and resilience. Necessary structural and mechanical improvements, modern technology to access information, vehicles to improve mobility and evacuation procedures, among other investments may not be possible. Additionally, low-income residents 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 or experiencing financial difficulties have a great deal to lose during an event and may be the least prepared to deal with potential losses.

The median household income for the State of Hawaiʻi in 2016 is$71,977 and the unemployment rate is 5.5%. Approximately 10.8% of residents are considered below the poverty line, 4.2% receive Supplemental Security Income, 3.5% receive cash public assistance, and 11.6% receive food stamps and SNAP benefits (American Community Survey 2016). Table 3.6-1 shows the median income and population below the poverty level in each county.

Table 3.6-1. Income Statistics in the State of Hawaiʻi by County

County	Median Household Income	Population Below Poverty Level in the Past 12 Months	
		Percent	Number
County of Kauaʻi	$68,224	9.6%	6,915
City and County of Honolulu	$77,161	9.5%	94,297
County of Maui[a]	$68,777	9.8%	16,216
County of Hawaiʻi	$53,936	18.7%	37,110
Average/Total	**$71,997**	**10.8%**	**154,284**

Source: 2012-2016 American Community Survey 5-year estimates
Notes:
a. Median household income estimates do not include the County of Kalawao, which is estimated to be $65,625. Population below poverty level does not include the County of Kalawao, which is estimated to be 12.9%.

3.6.3 Tourism

In addition to the resident population, the State of Hawaiʻi receives high volumes of tourists throughout the year that contribute to the needs for public infrastructure and services. Table 3.6-2 below shows the average daily visitors by county in 2016 (State of Hawaiʻi Data Book 2016). Average daily visitors increased statewide over the performance period of the 2013 HMP by 15% from an average of 182,531 daily visitors from 2009 to 2012, to an average of 210,176 daily visitors from 2013 to 2016 (Hawaiʻi State Data Book 2016). According to the Hawaiʻi Tourism Authority (2016), 2016 set a new record for the number of visitors in the State with 8,934,277 visitors.

Visitors to the State are not reflected in official population estimates, such as the U.S. Census' American Community Survey. When the 2016 average daily visitor rate is included in population estimates, the actual population in the State at any given time increases by 14.7%. The City and County of Honolulu has the greatest number of average daily visitors; however, visitors contribute to the greatest increase in actual population in the County of Maui with a 36.2% increase. This is followed by the County of Kauaʻi at 34.5%, the County of Hawaiʻi at 16.0%, and the City and County of Honolulu at 10.2%.

Table 3.6-2. Average Daily Visitors by County

County	2016		
	Total	Domestic	International
County of Kauaʻi	24,842	22,755	2,088
City and County of Honolulu	101,006	57,552	43,454
County of Maui	59,982	50,564	9,418
County of Hawaiʻi	31,845	27,082	4,763
TOTAL	**217,675**	**157,953**	**59,723**

Source: 2016 State of Hawaiʻi Data Book

3.7 State Assets and Critical Facilities

The following sections provide information on state assets and critical facilities within the State. The vulnerability of state assets and critical facilities to the identified hazards of concern are discussed in Section 4 (Risk Assessment).

3.7.1 State-Owned or Leased Buildings

The State of Hawaiʻi owns and/or leases buildings in all of its counties. Statewide, there are 6,634 state-owned or leased buildings with a total estimated replacement value of more than $27.6 billion (see Table 3.7-1). The majority of these facilities, 57%, are located in the City and County of Honolulu. A breakdown of the number and replacement cost value of state-owned or leased buildings by state agency can be found in Section 4.0 (Risk Assessment Overview). The location of these buildings can be seen in Appendix X (Map Atlas).

Table 3.7-1. Number and Replacement Cost Value of State Facilities by County

County	Total Number of State Buildings[a]		Total Replacement Cost Value[b]	
	Number	Percent	Dollar Value	Percent
County of Kauaʻi	570	8.6%	$1,067,278,062	3.9%
City and County of Honolulu	3,752	56.6%	$18,548,040,469	67.0%
County of Maui[c]	879	13.2%	$2,983,348,758	10.8%
County of Hawaiʻi	1,433	21.6%	$5,095,297,885	18.4%
Total	**6,634**	**100%**	**$27,693,965,174**	**100%**

Source: Hawaiʻi State Risk Management Office 2017
Notes:
a. Not all identified facilities included sufficient information to be geocoded; therefore, the vulnerability assessment results provided for each hazard in Section 4.0 will show a discrepancy in the total number and replacement cost value of facilities. For more information, please see Section 4.0.
b. Total replacement cost value represents both structure and contents. For more information, please see Section 4.0.
c. Includes the County of Kalawao.

3.7.2 State Roads

The State of Hawaiʻi Department of Transportation Highways Division is charged with maintaining the state highway system, which amounts to more than 1,096 miles of road statewide. The length and percent of total state roads by county is shown in Table 3.7-2. Refer to Appendix X (Map Atlas) which includes a map of each island and the major roads under the State's jurisdiction.

Table 3.7-2. State Highway System by County

County	Total Length (Miles)	Percent of Total State Mileage
County of Kauaʻi	378.7	34.5%
City and County of Honolulu	375.3	34.2%
County of Maui[a]	104.0	9.5%
County of Hawaiʻi	238.6	21.8%
Total	**1,096.5**	**100.0%**

Source: State of Hawaiʻi SDOT State Routes GIS Layer
Notes:
a. Includes the County of Kalawao
GIS Geographic Information System
SDOT State Department of Transportation

3.7.3 Critical Facilities

In 2017 a collaborative planning effort was conducted with county, state, federal, private sector and non-governmental organizations to address temporary emergency power planning requirements outlined in the *2015 Hawaiʻi Catastrophic Hurricane Plan*. The results of this effort were memorialized in the *Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report* and included the definition and identification of critical facilities within the State. Critical facilities were defined as "those structures from which essential services and functions for victim survival, continuation of public safety actions, and disaster recovery are performed or provided" and more than 1,500 facilities statewide were identified. The database of identified facilities served as the basis for the critical facility assessment in this 2018 HMP Update.

Each critical facility identified in the State was assigned to a core category so that discussion and vulnerability could be aggregated. The facility type assigned to each core category can be found in Appendix X (State Profile and Risk Assessment Supplement). Table 3.7-3 shows the State's critical facilities by core category and replacement cost value. Mass Care Support Service and Water Waste, and Wastewater Systems account for almost half (45%) of all critical facilities in the State. Table 3.7-4 shows the State's critical facilities by county. More than half (53%) of the State's critical facilities are located in the City and County of Honolulu. The location of these facilities can be seen in Appendix X (Map Atlas).

Table 3.7-3. Critical Facilities by Core Category and Replacement Cost Value

Facility Core Category	Total Number of Critical Facilities[a]	Total Replacement Cost Value[a, b]
Commercial Facilities	60	$206,894,206
Communications	142	$552,061,935
Emergency Services	149	$1,017,628,710
Energy	91	$2,623,607,668
Food & Agriculture	39	$829,869,410
Government Facilities	103	$416,789,890
Healthcare & Public Health	193	$3,399,521,375
Mass Care Support Services	353	$11,497,547,155
Transportation Services	61	$1,897,249,920
Water, Waste, & Wastewater Systems	351	$10,906,318,080
Total	**1,542**	**$33,347,488,348**

Source: Hawaiʻi State Risk Management Office 2017
Notes:
a. Not all identified facilities included sufficient information to be geocoded; therefore, the vulnerability assessment results provided for each hazard in Section 4 will show a discrepancy in the total number and replacement cost value of facilities. For more information, please see Section 4.0.
b. Total replacement cost value represents both structure and contents. For more information, please see Section 4.0.

Table 3.7-4. Critical Facilities by County

County	Total Number of Critical Facilities[a, d]		Total Replacement Cost Value[a, b, d]	
	County	Percent	Dollar Value	Percent
County of Kauaʻi	167	10.8%	$2,859,152,410	8.6%
City and County of Honolulu	794	51.5%	$19,235,387,455	57.7%
County of Maui[c]	311	20.2%	$6,286,051,833	18.9%
County of Hawaiʻi	270	17.5%	$4,966,896,651	14.9%
Total	**1,542**	**100.0%**	**$33,347,488,348**	**100.0%**

Source: Hawaiʻi State Risk Management Office 2017
Notes:
a. Not all identified facilities included sufficient information to be geocoded; therefore, the vulnerability assessment results provided for each hazard in Section 4 will show a discrepancy in the total number and replacement cost value of facilities. For more information, please see Section 4.0.
b. Total replacement cost value represents both structure and contents. For more information, please see Section 4.0.
c. Includes the County of Kalawao.
d. There is overlap between the state building and critical facility dataset including 36 records in the County of Kauaʻi, 206 records in the City and County of Honolulu, 78 records in the County of Maui, and 59 records in the County of Hawaiʻi.

3.7.4 Commercial Harbors

The State of Hawaiʻi has 10 commercial harbors located on six islands that are vital to the economic wellbeing of the State. Almost all imported goods arrive in the State via island ports. Table 3.7-5 lists the commercial harbors by county and the tons of cargo that pass through each harbor where estimates are available. Honolulu Harbor serves as the distribution hub for the State meaning that inter-island cargo distribution branches out from Honolulu Harbor (Hawaiʻi State Department of Transportation No Date).

It should be noted that harbors, themselves, are not listed as critical facilities within the definition utilized for this 2018 HMP Update; however, the facilities that make harbors operational (e.g., pump stations, support facilities, communications sites, etc.) are included in the critical facility database.

Table 3.7-5. Commercial Harbors in the State of Hawaiʻi

County	Harbor	Waterborne Commerce (tons)[a,b]
County of Kauaʻi	Nāwiliwili	1,929,000
	Port Allen	Not available
City and County of Honolulu	Honolulu	13,832,000
	Kalaeloa	Not available
	Barbers Point	10,570,000
County of Maui	Kahului	3,720,000
	Kaunakakai	Not available
	Kaumalapau	Not available
County of Hawaiʻi	Hilo	2,130,000

	Kawaihae	1,995,000

Source: Hawaiʻi State Data Book 2016
Notes:
a. Excludes cargo carried by Army and Navy Vessels and cargo in transit.
b. Tons reported are for the year 2015.

3.8 Land Use and Development

44 CFR §201.4(d):[The State] Plan must be reviewed and revised to reflect changes in development

Land use and development patterns are major factors that influence risk to natural hazards. Major areas of concern are where the built environment interests hazard risk areas. Understanding how past, current, and projected development patterns have or are likely to increase or decrease risk in hazard areas is a key component to understanding the State's overall risk to its hazards of concern. The following sections discuss changes in development over the performance period of the 2013 HMP, current land use and development trends, and projected changes in development. Additional discussion on land use and development can be found in Section 5 (Capability Assessment) of the 2018 HMP Update.

3.8.1 Changes in Development Over the Performance Period of the 2013 HMP

The State of Hawaiʻi experienced changes in development over the performance period of the 2013 HMP. Unfortunately, there is no statewide system that tracks where this development has occurred or its location in hazard areas. The current county local hazard mitigation plans were reviewed and do not report that significant changes in development have been occurring at the county level. Because there are no statewide systems for tracking changes in development, permits issued at the local level and changes in land use classification for taxable parcels are used to generally establish and discuss trends.

Number of Building Permits and New Residential Construction

According to the State of Hawaiʻi Data Book, between 2013 and 2016 there were estimated to be 105,886 building permits issued within the State of Hawaiʻi as shown in Table 3.8-1. Issuance of building permits increased over the performance period of the 2013 HMP by 14% (12,876 permits) over the previous 4-year period (2009 to 2012). The overall distribution of these permits by construction type (e.g. residential, commercial, etc.) is unknown. More than three-quarters of all building permits issued were issued by the City and County of Honolulu.

Table 3.8-1. Building Permits Issued by County, 2013 to 2016

	Building Permits Issued[a]					
County	**2013**	**2014**	**2015**	**2016**	**Total**	**% of Total**
County of Kauaʻi	158	187	199	229	773	0.7%
City and County of Honolulu	26,568	18,541	20,146	16,983	82,238	77.7%
County of Maui	1,200	1,267	1,280	1,178	4,925	4.7%
County of Hawaiʻi	4,320	4,811	5,426	3,393	17,950	17.0%
Total	**32,246**	**24,806**	**27,051**	**21,783**	**105,886**	**100.0%**

Source: Hawaiʻi State Data Book 2016
a. Includes residential, hotel, non-residential and additions and alterations permits. Other types of permits such as for demolitions are not included.

The American Community Survey (2012 to 2016) estimates that there are 530,289 housing units in the State of Hawaiʻi. More than half of these units are believed to have been built before 1980. According to the U.S. Census Bureau's Building Permits Survey, there were more than 1,900 permits issued for new residential construction between 2014 and 2017 amounting to almost 16,000 new residential units. Approximately 57% of the total units were single-family construction. About 73% of the permits and 57% of units were issued in the City and County of Honolulu. In addition to new construction, there were estimated to be 833 housing units demolished in 2015 and 2016 (2014 and 2017 estimates are unavailable) amounting to an average annual demolition rate of 417 units (Hawaiʻi State Data Book 2016).

The American Community Survey (2012 to 2016) indicates that there are approximately 452,030 occupied housing units and 78,259 vacant housing units in the State of Hawaiʻi amounting to an average household size of three persons per unit. The 2040 population projections indicate that the State's population is expected to increase by 280,363 persons over the next 22 years. Assuming the average household size, average demolition rate, and occupancy rate remain constant, approximately 116,300 new housing units would need to be constructed by 2040 in order to accommodate the projected population. This amounts to an approximate, annual average construction rate of 5,300 units per year. This means that average annual new residential construction would need to increase by a third when compared to construction during 2014 to 2017.

Table 3.8-2. New Residential Construction by County, 2014 to 2017

	New Residential Construction									
	2014		2015		2016		2017		Total	
County	Permits	Units	Permits	Units	Permits	Units	Permits	Units	Permits	Units
County of Kauaʻi	31	192	7	205	15	172	17	312	70	881
City and County of Honolulu	583	1,578	568	3,833	62	1,658	191	1,968	1,404	9,037
County of Maui	34	338	28	502	34	567	58	861	154	2,268
County of Hawaiʻi	76	958	77	882	86	978	47	894	286	3,712
Total	**724**	**3,066**	**680**	**5,422**	**197**	**3,375**	**313**	**4,035**	**1,914**	**15,898**

Source: SOCDS Building Permits Database 2018
Note: SOCDS State of the Cities Data Systems

LAND USE CLASSIFICATION OF TAXABLE PARCELS

The City and County of Honolulu Department of Budget and Fiscal Services publishes annual, statewide summaries of real property records by land use class. Table 3.8-3 shows the changes in land use class over the performance period of the 2013 HMP (fiscal years 2013-2014 to 2016-2017). Drawing statewide conclusions from this data is difficult, as land use classes differ among the counties; subdivision of parcels may indicate changes in number of classifications although total land area in each class may not have changed; and some land use classes were introduced during the performance period. The following general observations can be made from this dataset:

- More than half of the taxable parcels in the State are classified as "Residential" (including Residential A, which is a City and County of Honolulu classification for residential property that meets certain parameters including an assessed value of $1 million or more). When these classifications are combined, the percent of total parcels in this classification remained steady over the performance period of the 2013 HMP.

- The number of taxable parcels classified as “Agricultural/Native Forest” decreased by more than 1,400 parcels statewide.
- The number of taxable parcels classified as “Hotel Resort” increased by more than 2,300 statewide, now accounting for 4% of total parcels.

A detailed table can be found in Appendix X (State Profile and Risk Assessment Supplement).

Table 3.8-3. Change in Land Use Classes from Fiscal Year 2013-2014 to 2016-2017

Land Use Class[a]	City and County of Honolulu		County of Maui		County of Hawaiʻi		County of Kauaʻi		Statewide	
	FY16-17 % of Total	Change in Total Parcels[b]	FY16-17 % of Total	Change in Total Parcels[b]	FY16-17 % of Total	Change in Total Parcels[b]	FY16-17 % of Total	Change in Total Parcels[b]	FY16-17 % of Total	Change in Total Parcels[b]
Residential	88%	(3,525)	14%	29	15%	266	25%	(1,583)	55%	(4,813)
Residential A[c, d, e]	4%	10,808	0%	-	0%	-	0%	-	2%	10,808
Apartment[d]	0%	-	13%	463	7%	(250)	0%	-	4%	213
Commercial	2%	265	4%	195	1%	25	3%	76	2%	561
Industrial	1%	127	1%	15	1%	18	1%	43	1%	203
Agricultural/Native Forest	1%	91	12%	213	47%	(1,240)	7%	(492)	15%	(1,428)
Vacant Agricultural[d]	0%	(22)	0%	-	0%	-	0%	-	0%	(22)
Conservation/Preservation	0%	48	2%	13	1%	20	1%	(26)	1%	55
Hotel/Resort	3%	1,826	16%	1,168	0%	(79)	10%	(566)	4%	2,349
Homeowner[d]	0%	-	36%	(352)	27%	1,059	0%	-	12%	707
Homestead[d]	0%	-	0%	-	0%	-	32%	233	2%	233
Public Service[d]	0%	(12)	0%	-	0%	-	0%	-	0%	(12)
Time Share[d]	0%	-	3%	108	0%	-	0%	-	0%	108
Affordable Rental[d]	0%	-	0%	-	1%	294	0%	-	0%	294
Commercialized Residential[d]	0%	-	0%	51	0%	-	6%	1,981	0%	2,032
Vacation Rental[d]	0%	-	0%	-	0%	-	10%	(244)	1%	(244)
Residential Investor[d]	0%	-	0%	-	0%	-	1%	289	0%	289
Commercialized Home Use[d]	0%	-	0%	-	0%	-	5%	1,734	0%	1,734
Total	**100%**	**9,606**	**100%**	**1,903**	**100%**	**113**	**100%**	**(578)**	**100%**	**11,044**

Source: City and County of Honolulu 2018
Notes:
a. The following land use classes were excluded from the table as no parcels were included in these classes: Improved Residential, Unimproved Residential, and Single Family.
b. Numbers in parenthesis are negative numbers.
c. Land Use Class did not exist in Fiscal Year 13-14.
d. Land Use Class is only applicable to three or fewer counties.
Nontaxable parcels are not included.

3.8.2 Current Land Use and Development

The following sections discuss the State Land Use Classification System, county land use planning, and general building stock in the State. Additional information on land use and development is included in Section 5.

State Land Use Classification System

The State Land Use Law (Chapter 205, Hawaiʻi Revised Statutes) is unique in the history of the State of Hawaiʻi land use planning. Originally adopted by the State Legislature in 1961, the Land Use Law establishes an overall framework of land use management within the State. The statewide land use classifications established in the State Land Use law are administered by the Land Use Commission (LUC), which is composed of nine members appointed by the Governor and confirmed by the State Senate (one member appointed for each of the counties except the County of Kalawao and five members appointed at large).The State Land Use Law classifies the lands within the State of Hawaiʻi into one of four Districts: Urban, Rural, Agricultural, and Conservation (State of Hawaiʻi HMP, 2013).

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 the respective counties. Generally, lot sizes and uses permitted in the Urban District area are established by the respective county through ordinances or rules (State of Hawaiʻi HMP 2013).

Rural Districts are composed primarily of small farms intermixed with low-density residential lots with a minimum size of one-half acre. Jurisdiction over Rural Districts is shared by the Commission and county governments. Permitted uses include those relating or compatible to agricultural use and low-density residential lots. Variances can be obtained through the special use permitting process (State of Hawaiʻi HMP 2013).

The Agricultural District includes lands for the cultivation of crops, aquaculture, raising livestock, wind energy facility, timber cultivation, agricultural-support activities (i.e., mills, employee quarters, etc.) and land with significant potential for agricultural uses. Golf courses and golf-related activities may also be included in this district, provided the land is not in the highest productivity categories (A or B) of the Land Study Bureau's detailed classification system. Uses permitted in the highest productivity agricultural categories are governed by statute. Uses in the lower-productivity categories—C, D, E or U—are established by the Commission and include those allowed on A or B lands as well as those stated under Section 205-4.5, Hawaiʻi Revised Statutes (State of Hawaiʻi HMP 2013).

Conservation Districts are comprised primarily of lands in existing forest and water reserve zones and 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; and all submerged lands seaward of the shoreline. The Conservation District also includes lands subject to flooding and soil erosion. Conservation Districts are administrated by the State of Hawaiʻi Board of Land and Natural Resources and uses are governed by rules promulgated by the State of Hawaiʻi Department of Land and Natural Resources' (DLNR) Office of Conservation and Coastal Lands (OCCL) and Land Division (State of Hawaiʻi HMP, 2013).

As of 2016 the Conservation and Agricultural District classifications account for the vast majority of land area in the County of Hawaiʻi, 49% and 46% respectively. In all four counties, conservation and agricultural land districts are predominant, with rural land use districts representing the smallest land area. Statewide, urban land use districts account for only 5% of the total land area; however, more than half the total acreage in the Urban District is in the City and County of Honolulu. Since 2013, statewide land use classifications have mostly remained static. A total of 261 acres statewide were reclassified from the Agricultural District to the Urban District (OP 2017). Table 3.8-4 summarizes the area of current land uses by county. Figure 3.8-1 through Figure 3.8-4 show the land use district classifications for each county.

Section 4 includes an assessment of each state land use district's exposure to each hazard of concern with a defined spatial extent and location.

Table 3.8-4. Land Use District Classification by County

County	Total Land Areaa	Agricultural Total	Agricultural % of Total	Conservation Total	Conservation % of Total	Rural Total	Rural % of Total	Urban Total	Urban % of Total
County of Kaua'i	630	299.1	47.5%	305.8	48.5%	2.2	0.3%	23.3	3.7%
City and County of Honolulu	601	189.2	31.5%	248.4	41.3%	0	0.0%	163.2	27.2%
County of Maui[b]	1,176	610.1	51.9%	508.8	43.3%	12.6	1.1%	44.1	3.8%
County of Hawai'i	4,028	1,844.4	45.8%	2,093.3	52.0%	1.4	0.0%	89.0	2.2%
TOTAL	**6,435**	**2,942.8**	**45.7%**	**3,156.3**	**49.0%**	**16.1**	**0.3%**	**319.7**	**5.0%**

(All area columns in Square Miles.)

Source: State Land Use District Boundaries for the Eight Main Hawaiian Islands, State Land Use Commission 2016
Notes:
a. Total area for each county calculated using State Land Use District boundaries downloaded from State of Hawai'i GIS Program Geospatial Data Portal. The total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
b. Includes the County of Kalawao
GIS Geographic Information System

County Land Use Planning

The counties in Hawai'i administer and enforce land uses in all State Land Use Districts, aside from the Conservation District. County zoning generally establishes acceptable uses, density and arrangement of urban, rural, and agricultural district lands, but must be consistent with state policy laws and regulations. All counties have general plans and zoning codes (sometimes called land use ordinances). These plans and codes are updated and administered at the county level and there is no statewide system for assessing whether county-level changes in zoning allow for increased development in hazard risk areas.

Figure 3.8-1. State Land Use District Classifications and Hawaiian Home Lands in the County of Kaua'i

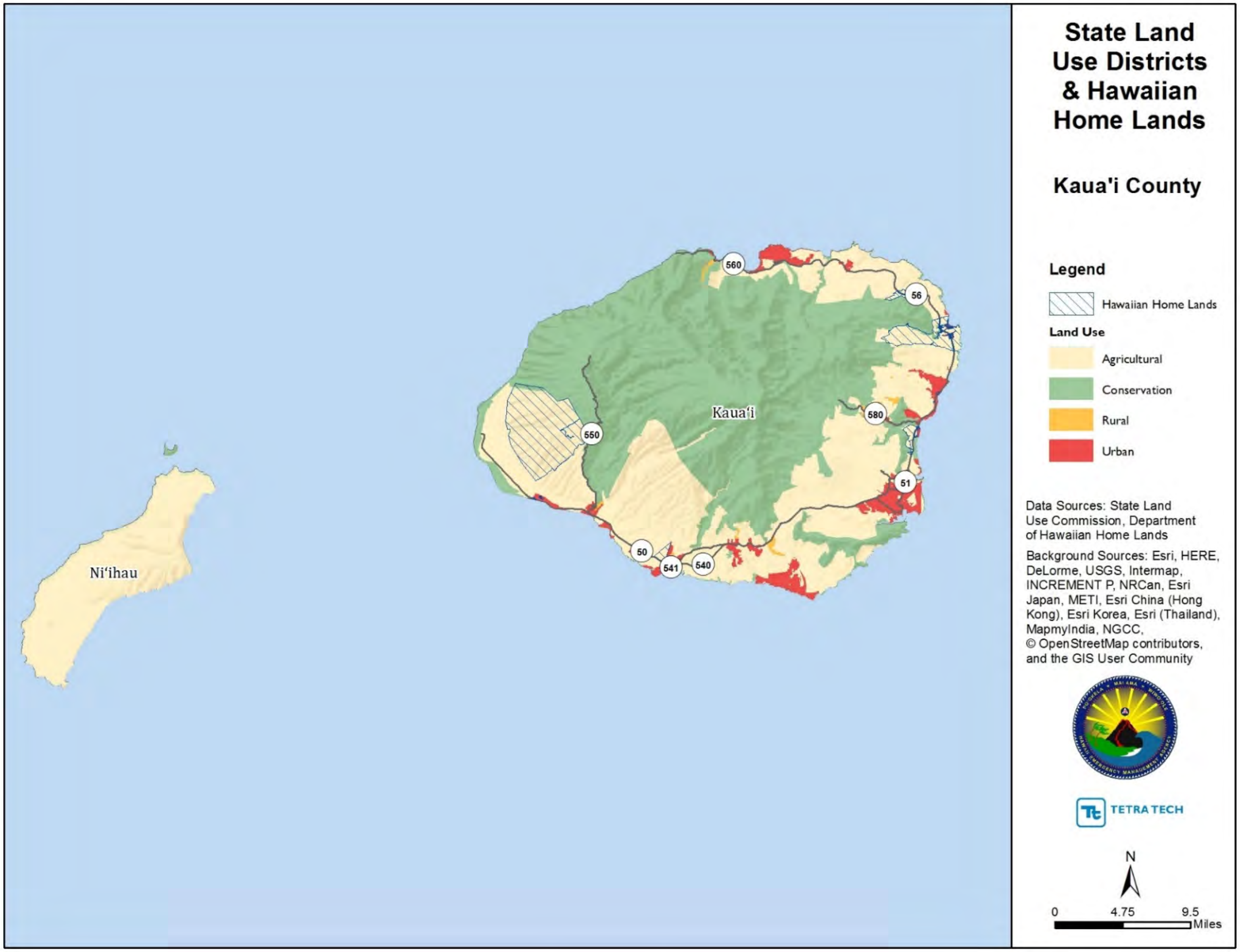


Figure 3.8-2. State Land Use District Classifications and Hawaiian Home Lands in the City and County of Honolulu

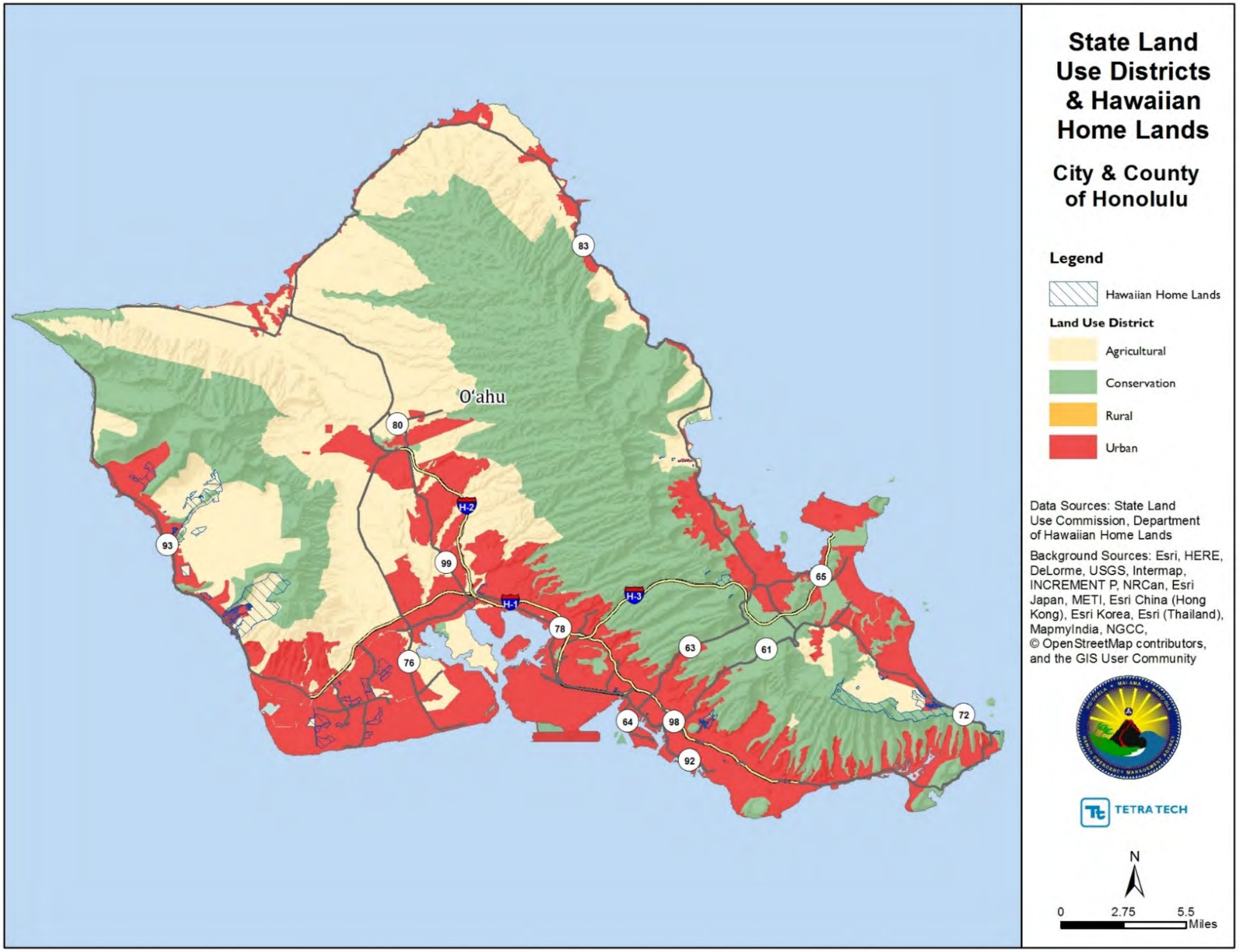


Figure 3.8-3. State Land Use District Classifications and Hawaiian Home Lands in the County of Maui

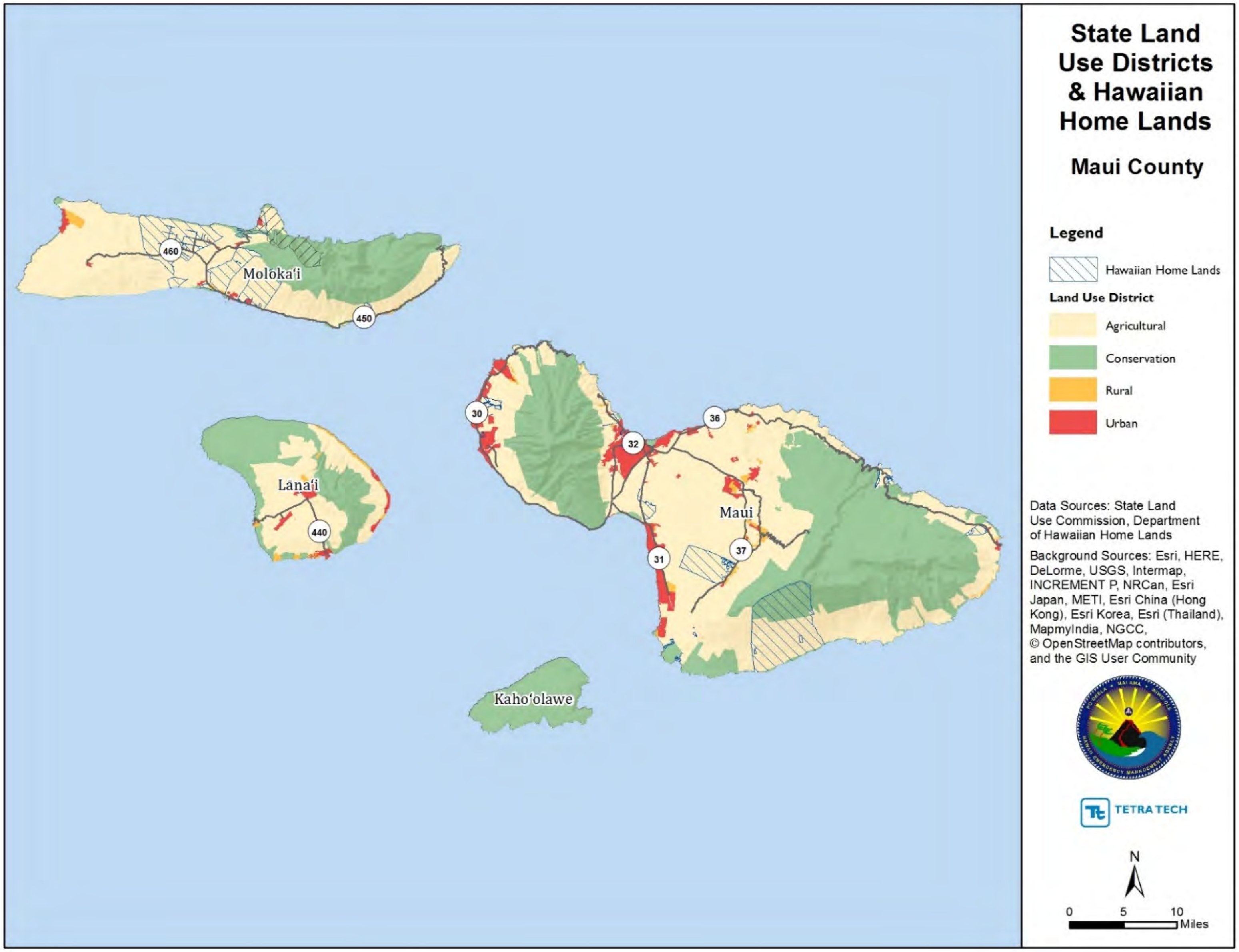
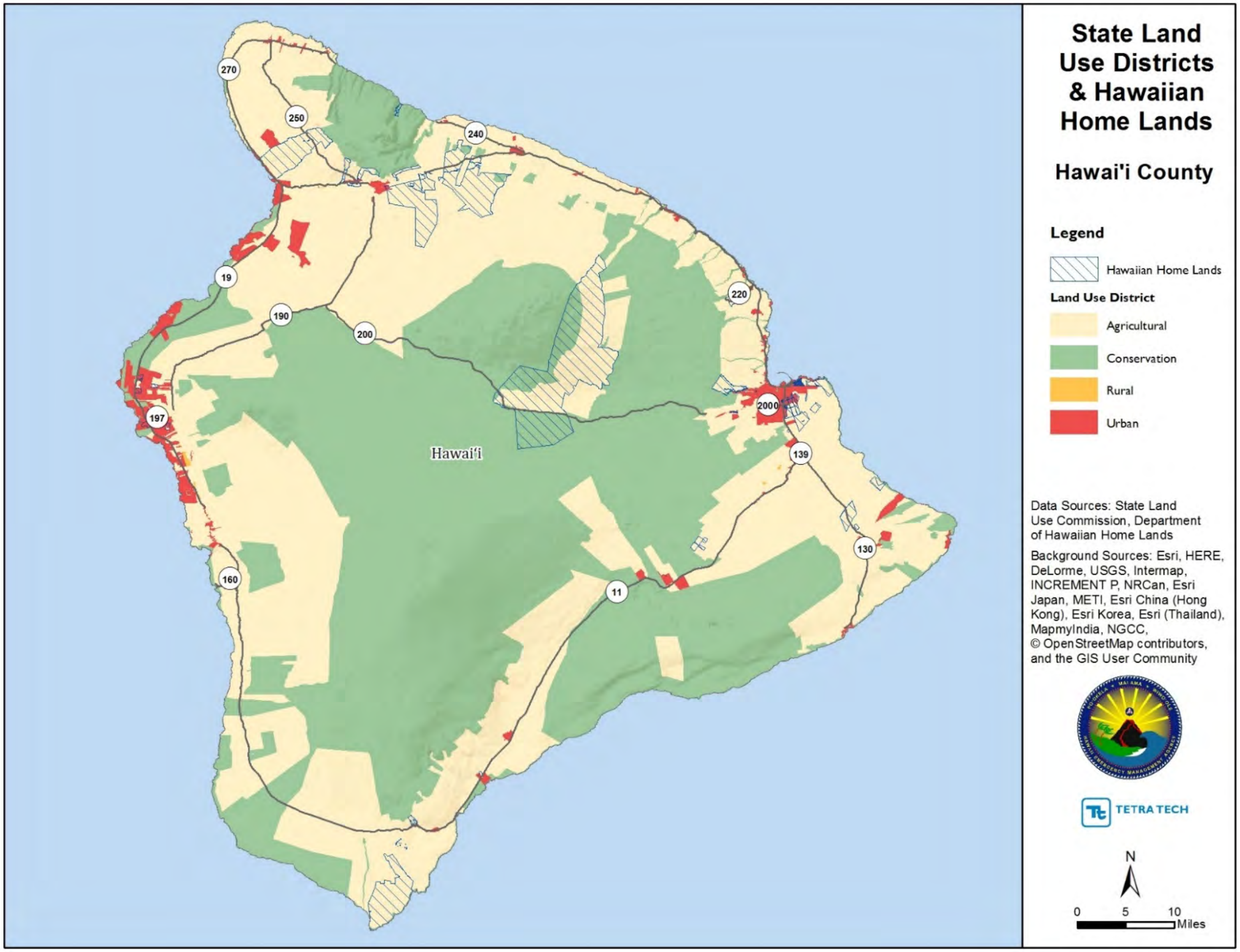


Figure 3.8-4. State Land Use District Classifications and Hawaiian Home Lands in the County of Hawaiʻi



General Building Stock

Residential, commercial, industrial, and other structures in the State make up the State's general building stock. Understanding where structures are located, their value, and their potential for damage is a critical component of understanding the State's overall risk to the hazards of concern. Damages to the general building stock can have far reaching consequences to recovery efforts and can help planners understand where mitigation efforts will be cost effective and have the greatest potential for reducing risk to lives and property. The vulnerability assessment conducted for each hazard of concern in Section 4.0 includes an assessment of impacts to the State's general building stock.

Table 3.8-5. General Building Stock in the State of Hawaiʻi by County

County	Replacement Cost Value [a, b]	
	Dollars	Percent of Total
County of Kauaʻi	$33,326,392,000	13.7%
City and County of Honolulu	$164,787,212,000	67.9%
County of Maui c	$13,287,882,000	5.5%
County of Hawaiʻi	$31,320,693,000	12.9%
TOTAL	**$242,722,179,000**	**100.0%**

Source: Hazus v4.2
Notes:
a. Replacement cost value includes estimates for both structural components and contents.
b. Replacement cost value does not include any development that has occurred in the State since 2010.
c. Includes the County of Kalawao.

3.8.3 Projected Changes in Development

Just as there is no statewide system for tracking where development occurred over the performance period of the 2013 HMP, there is also no statewide system for tracking where development is likely to occur over the performance period of the 2018 HMP Update. A review of available data in the State identified three datasets that could be used to generally discuss where development may occur. The following sections provide information on these areas. The hazard exposure for each area is discussed is assessed in Section 4 (Risk Assessment).

Community Development Districts

The Hawaiʻi Community Development Authority (HCDA) establishes community plans in Hawaii's Community Development Districts. Districts are designated in order to plan for the future development of underutilized urban areas in the State (HCDA 2018). As of 2018, there are three community development districts in the State: Kakaʻako, Kalaeloa and Heʻeia. All districts are located in the City and County of Honolulu and are a combined 7.4 square miles. These districts are described in the *Hawaiʻi Community Development Authority 2017 Annual Report* as follows (HCDA 2017):

- **Kakaʻako**—The Kakaʻako Community Development District consists of 600 acres of land. HCDA's goal is to use sound planning to encourage use of Kakaʻako land supporting the legislative intent of a mixed-use district where residential, commercial, industrial, and public uses would complement each other. HCDA has improved infrastructure and public facilities in the district to attract development to increase housing opportunities for all segments of the community.

- **Kalaeloa**—The Kalaeloa Community Development District encompasses approximately 3,700 acres of land within the former Naval Air Station Barbers Point. The legislature designated the district in 2002, to facilitate the redevelopment of the area in accordance with the Barbers Point Naval Air Station reuse plan. HCDA has been working on various projects to bring infrastructure improvements to the district, including projects to bring firm energy to Kalaeloa. Facilitating the redevelopment of Kalaeloa is a complex undertaking. There are several challenges to development because of the existing infrastructure, and lack thereof. For example, there are 20 miles of roadways that do not meet city or state standards, drainage in parts of the district is inadequate and the electrical system is not reliable. The HCDA has partnered with the Hawaiʻi State Energy Office, U.S. Department of Energy and Sandia National Laboratories to plan, analyze and design a micro-grid to provide reliable energy throughout the 3,700-acre district and help the State of Hawaiʻi meet its clean energy goals.
- **Heʻeia**—The Heʻeia Community Development District was created in 1991, when the HCDA acquired approximately 400 acres of land in Heʻeia on the windward side of Oʻahu as part of a land exchange with the Estate of Bernice Pauahi Bishop. HCDA facilitates culturally appropriate agriculture, education, and natural resource restoration and management in alignment with the Honolulu Board of Water Supply's Koʻolaupoko Watershed Management Plan and the City and County of Honolulu's Koʻolaupoko Sustainable Communities Plan. In January 2010, the HCDA and Kākoʻo ʻŌiwi, a community-based nonprofit corporation entered into a 38-year lease. Kākoʻo ʻŌiwi's primary mission is to restore the Heʻeia wetlands into a working agricultural and cultural district.

Figure 3.8-6 shows the location of the Community Development Districts in the State of Hawaiʻi, as all Community Development Districts are located in the City and County of Honolulu.

Enterprise Zones

The Enterprise Zones Partnership Program gives state and county benefits to companies in an effort to stimulate business activity, job preservation, and job creation in areas where they are most appropriate or most needed (Business Development and Support Division 2018). Each county is able to select up to six zones that, after approval by the Governor, exist for 20 years. As of 2018, there are 20 zones statewide comprising more than 2,843 square miles. Figure 3.8-5 through Figure 3.8-8 shows the location of the Enterprise Zones in each of the counties. Table 3.8-6 shows the square miles per county as well as the percent of the county's total land area.

Table 3.8-6. Area of Enterprise Zones by County

County	Enterprise Zones (Square Miles)	Percent of Total County Land Area
County of Kauaʻi	252.3	40.0%
City and County of Honolulu	288.3	48.0%
County of Maui	1,016.7	86.5%
County of Hawaiʻi	1,286.6	31.9%
TOTAL	**2,843.9**	**44.2%**

Source: State of Hawaiʻi GIS
Note:
Total area for each county was calculated using coastline spatial layer downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal.
GIS Geographic Information System

MAUI DEVELOPMENT PROJECTS

The County of Maui maintains a database of development projects on the Island of Maui that have come to the attention of the Department of Planning. These projects include three categories as defined below:

- **Committed**—These projects have inclusion in the Maui Island Plan Growth Boundaries and generally have conforming Community Plan and zoning entitlements.
- **Maui Island Plan and Community Plan**—These projects have inclusion in the Maui Island Plan Growth Boundaries and the appropriate urban or rural Community Plan designations but not the conforming zoning entitlements to proceed.
- **Maui Island Plan Only**—These projects do have inclusion in the Maui Island Plan Growth Boundaries but do not have the appropriate Community Plan designation nor zoning to proceed.

It should be noted that these projects are not a complete picture of development projects within the County of Maui and are at varying stages of development. Some of these projects may never be started or be realized, or the project specifics may change over time. In total, the parcels on which these projects are located account for more than 27.6 square miles on the Island of Maui as shown on Figure 3.8-7.

Figure 3.8-5. Projected Development Areas in the County of Kauaʻi

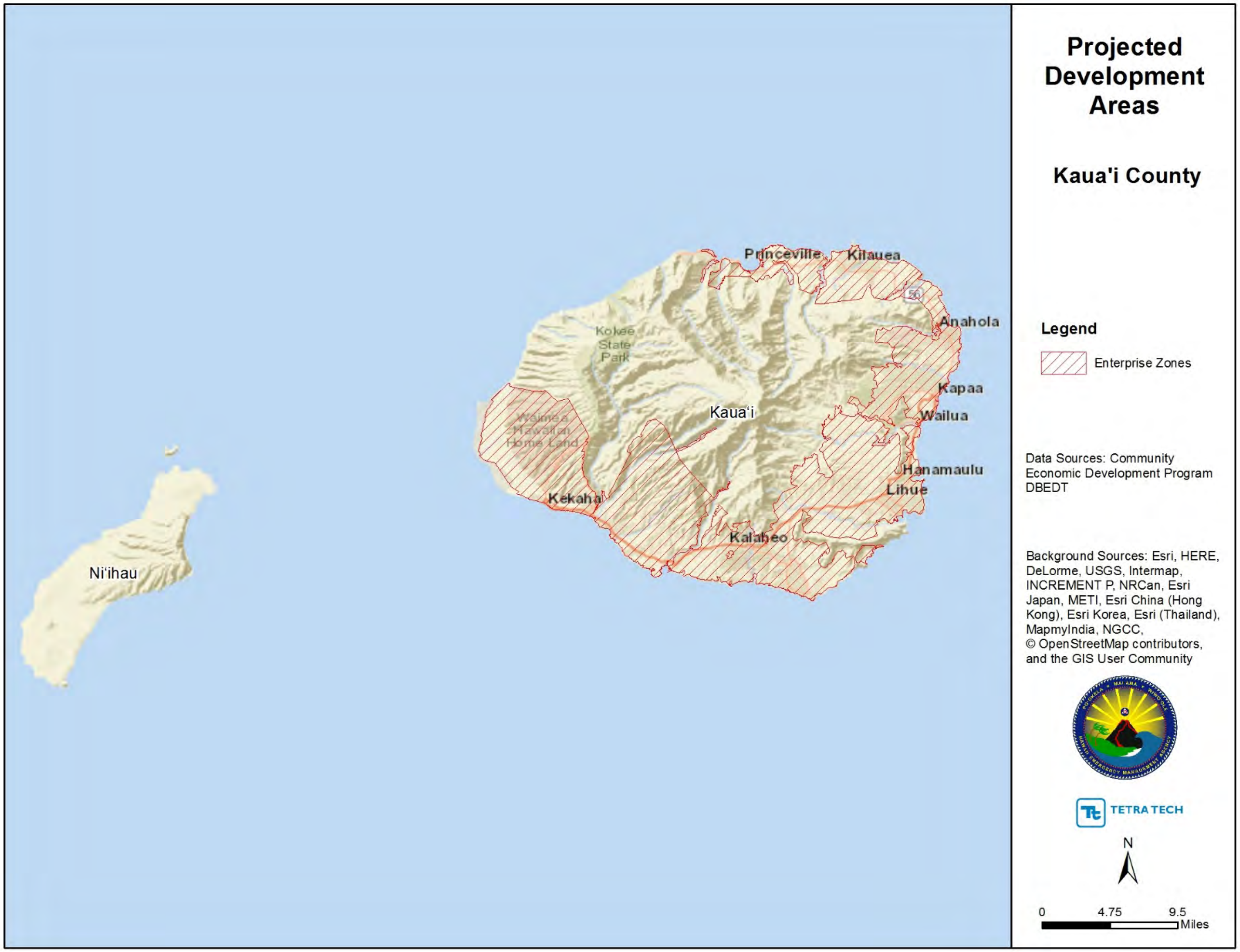


Figure 3.8-6. Projected Development Areas in the City and County of Honolulu

Figure 3.8-7. Projected Development Areas in the County of Maui

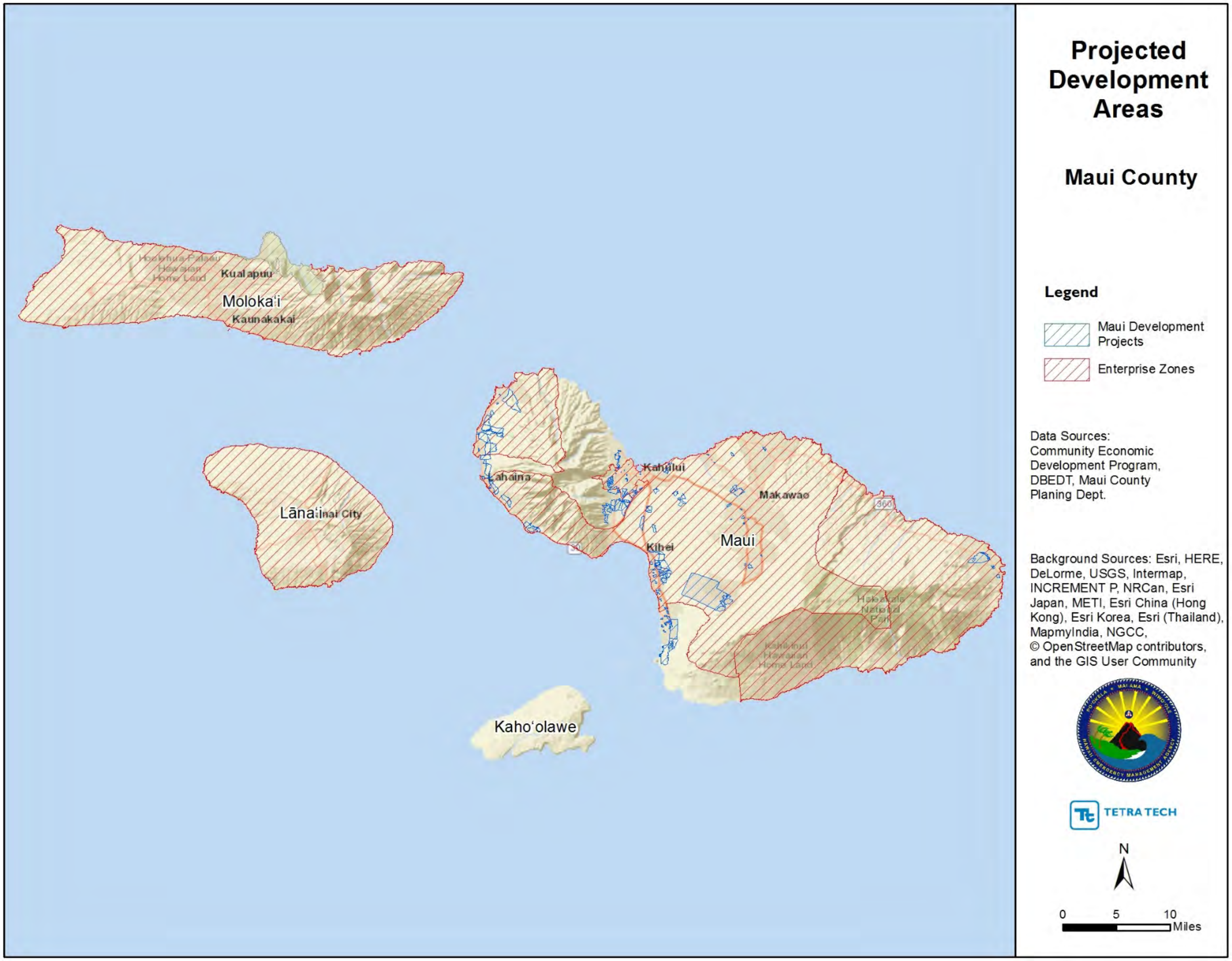
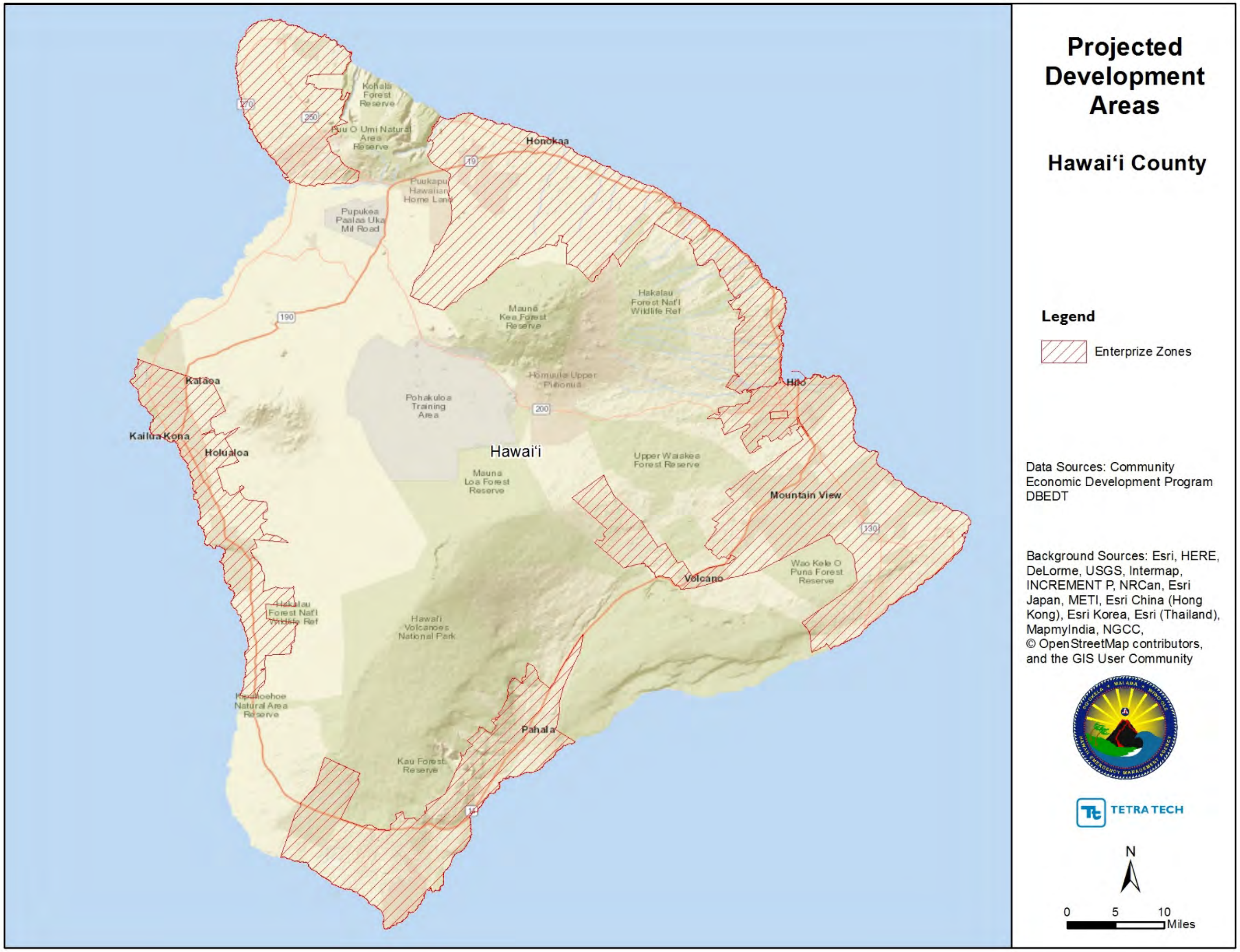


Figure 3.8-8. Projected Development Areas in the County of Hawaiʻi



3.9 Cultural Assets

3.9.1 Hawaiian Home Lands

Hawaiian Home Lands are intended to provide for the economic self-sufficiency of native Hawaiians through a homesteading program (University of Hawaiʻi 2015 as cited in Hawaiʻi Climate Change Mitigation and Adaptation Commission, 2017). Consistent with Native Hawaiian culture, Hawaiian Home Lands include areas from mauka to makai (from the mountain to the sea). These lands are developed and distributed to native Hawaiian beneficiaries by way of residential, agricultural, and pastoral leases for 99-year terms with lease payments of $1.00 per year. Some parcels are designated for income-producing purposes and are generally leased for industrial, retail, or other uses.

Hawaiian Home Lands account for only a small percent of the total land area statewide and in each county. There are approximately 326 square miles in the State of which 58% (190 square miles) is in the County of Hawaiʻi. There are 93 square miles of Hawaiian Home Lands in the County of Maui, 32 square miles in the County of Kauaʻi, and 11 square miles in the City and County of Honolulu. The location of Hawaiian Home Lands in each county can be seen in Figure 3.8-1 through Figure 3.8-4 above.

3.9.2 Other Cultural Assets

There are a wide array of cultural assets located on the Hawaiian Islands. The State Historic Preservation Division maintains an inventory of more than 38,000 historic sites in the State including historic and cultural resources, such as architecturally significant buildings and sites where significant historic events occur as well as sites that are culturally significant to Native Hawaiians, such as burial sites and fishponds. A location-based database of these assets was not available for use in the 2018 HMP Update. Future updates of the plan will strive to secure such a database so the risk and vulnerability of these important sites can be included in the vulnerability assessments conducted for each hazard of concern.

3.10 Natural Resources

The following sections discuss the extent and location of select natural resources in the State of Hawaiʻi including environmental resources and watershed partnerships. Areas where these resources, as well as those in conservation district lands discussed in Section 3.8.2, intersect with hazard risk areas as well as potential impacts are discussed in each of the vulnerability assessments presented in Section 4 of the 2018 HMP Update.

3.10.1 Environmental Resources

The State of Hawaiʻi contains an abundant array of onshore and offshore environmental resources, including many species that are endemic only to the Hawaiian Islands. Environmental resources should be considered in hazard mitigation planning because they are impacted by natural hazard events and can influence the way in which hazards impact the built environment. The exposure and vulnerability of the following environmental resources are discussed for each hazard of concern in this 2018 HMP Update:

- **Critical Habitat**—Critical habitat is the term used in the Endangered Species Act to define those areas of habitat that are known to be essential for an endangered or threatened species to recover and that require special management or protection. According to the U.S. Fish & Wildlife Service, there are 79 animal species and 424 plant species believes or known to occur within the State that are listed as endangered or threatened (U.S. Fish & Wildlife Service 2018). As of 2017, there is critical habitat in each of the State's counties, totaling more than 915 square miles.
- **Wetlands**—Wetlands provide a multitude of benefits including habitat for fish and wildlife, groundwater recharge, flood reduction, water quality, food, and recreational opportunities. There are more than 4,150 square miles of wetlands in the State.
- **Parks and Reserves**—There are a large number of beloved parks and reserves in the Hawaiian Islands that provide valuable recreational opportunities, economic benefits, and provide for the protection of natural and cultural resources. Statewide, there are more than 2,600 square miles of land designated as a park, preserve or reserve in the State.
- **Reefs**—The marine waters of the State of Hawaiʻi include coral and artificial reefs, which provide habitat to a diverse array of species, provide economic opportunities for fishers and tourism activities, and buffer adjacent shorelines from wave action preventing erosion. Statewide there are approximately 55 square miles of reefs in the State's offshore environment. The County of Maui has the largest share of the State's reef system with almost half of the total acreage of reefs located in the county's offshore environment.

Table 3.10-1 shows the total area of natural resources assessed in this plan by County. Locations of these environmental resources by county are available in Appendix X (Map Atlas).

Table 3.10-1. Square Miles of Environmental Resource Areas in the State of Hawaiʻi by County

Environmental Resource Area	Area in square miles				
	County of Kauaʻi	City and County of Honolulu	County of Maui[d]	County of Hawaiʻi	Statewide
Critical Habitat[a]	90.4	121.2	263.2	440.4	915.2
Wetlands	47.3	14.8	109.7	88.2	260.0
Parks and Reserves	205.4	105.5	311.3	1,985.4	2,607.7
Reefs[b]	4.5	15.7	25.8	8.6	54.7
Total[c]	**347.6**	**257.2**	**710**	**2,522.6**	**3,837.6**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal
Notes:
a. Critical area mileage includes the combined area of coverage of individual critical habitat areas.
b. Reefs include artificial and coral reefs.
c. Total square miles may be over reported as some environmental asset areas may overlap.
d. Includes the County of Kalawao.
GIS Geographic Information System

3.10.2 Watershed Partnerships

According to the Hawaiʻi Association of Watershed Partnerships (HAWP), a watershed is an area of land, such as a mountain or valley, which collects rainwater into a common outlet. In the State of Hawaiʻi, the common outlet is ultimately the ocean. Some of the rain is absorbed by plants, some of it is absorbed underground, and the rest flows into surface rivers and streams. A critical component of a watershed's ability to collect rainwater is the existence of forests. Fog condensing on trees high up in watershed areas can increase rainfall collection and absorption by as much as 30% annually (HAWP 2018).

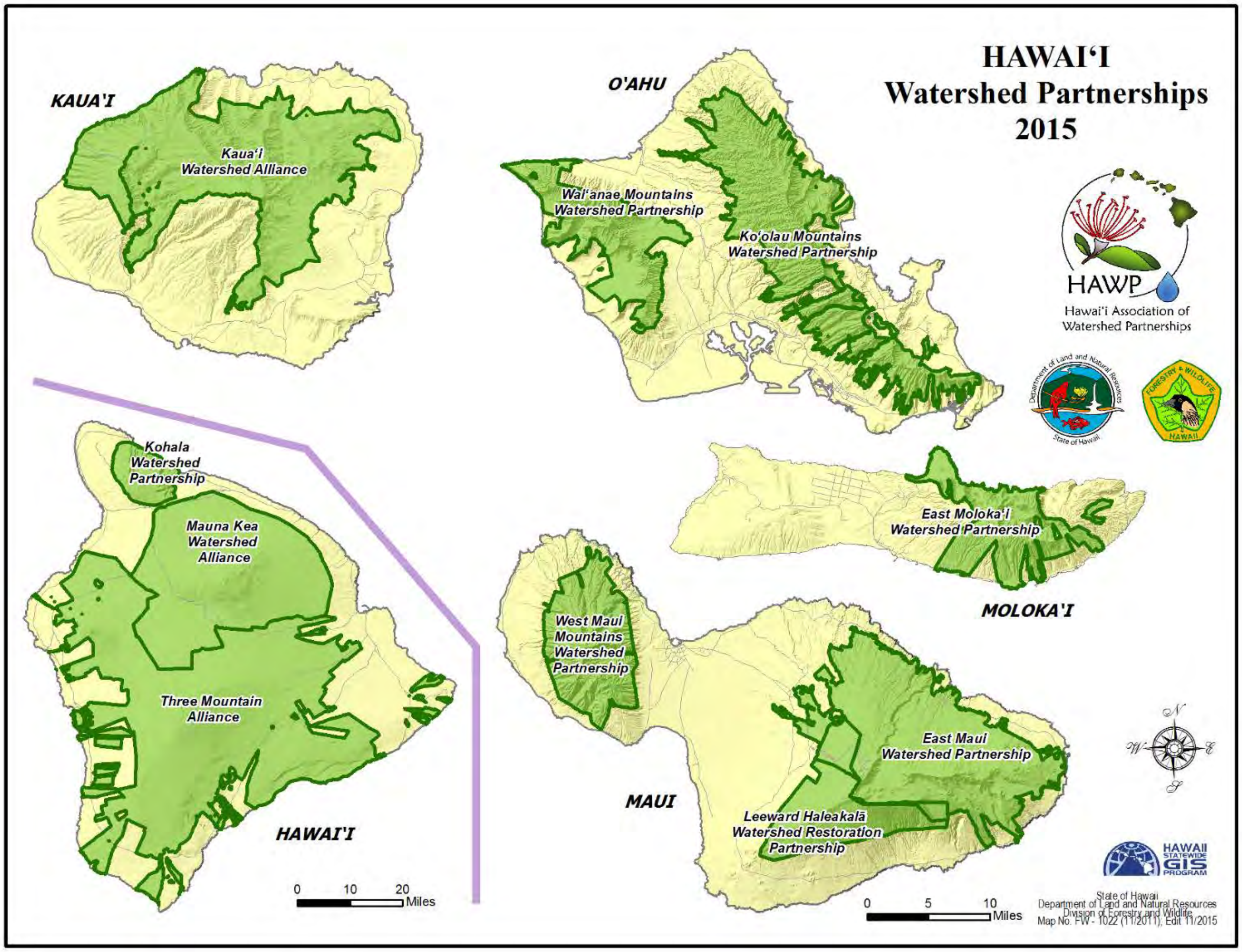
The Hawaiian equivalent of a watershed is the ahupuaʻa. In Hawaiian cultural tradition, an ahupuaʻa is a land division with the streams and valleys serving as boundaries. The size of the ahupuaʻa varies on different islands from as little as 100 acres to more than 100,000 acres. An ahupuaʻa includes the land from the mountains to the coast, and the coastal ocean extending out to and including the coral reef (HAWP 2018).

The State of Hawaiʻi has ten Watershed Partnerships on five of its islands. Hawaii's forested watersheds provide habitat, groundwater recharge, and other ecosystem services upon which the residents of the State of Hawaiʻi rely. Watershed partnership areas are those areas where public and private landowners who are committed to the common value of protecting forested watersheds engage in collaborative management. More than 3,131 square miles of the State's land area are located in a watershed partnership. Table 3.10-2 shows the total area of each watershed partnership and Figure 3.10-1 shows their locations (HAWP 2018).

Table 3.10-2. Watershed Partnerships in Square Miles by County

County	Watershed Partnership	Area (square miles)
County of Kauaʻi	Kauaʻi Watershed Alliance	225.0
	County Total:	**225.0**
City and County of Honolulu	Koʻolau Mountains Watershed Partnership	157.7
	Waiʻanae Mountains Watershed Partnership	72.5
	County Total:	**230.2**
County of Maui	East Maui Watershed Partnership	186.7
	East Molokaʻi Watershed Partnership	65.1
	Leeward Haleakalā Watershed Restoration Partnership	67.3
	West Maui Mountains Watershed Partnership	73.9
	County Total:	**393.0**
County of Hawaiʻi	Kohala Watershed Partnership	115.8
	Mauna Kea Watershed Alliance	400.4
	Three Mountain Alliance	1,767.3
	County Total:	**2,283.5**
	State of Hawaiʻi Total:	**3,131.8**

Figure 3.10-1. Watershed Partnership Areas in the State of Hawaiʻi



Source: Hawaiʻi Association of Watershed Partners 2018

SECTION 4. RISK ASSESSMENT

2018 HMP Update Changes

- For the 2018 HMP Update, all information on the risk assessment can be found in Section 4, as well as the referenced supporting appendices; previously located in Chapters 4 through 18 of the 2013 HMP. For ease of review, the vulnerability assessment follows each hazard profile, so that all information about a specific hazard is continuous. This section describes the identification of hazards, Presidential disaster declarations, hazard profiles, and the vulnerability assessment.
- In an effort to streamline the risk assessment, previous events captured in the 2013 HMP, lengthy tables and the majority of the maps have been moved to the Appendices (Appendix X – State Profile and Risk Assessment Supplement; Appendix X – Map Atlas).
- The hazards of concern have been reorganized to align with the associated events and impacts on the State, and to be consistent with the THIRA.
- A state building dataset and a more robust critical facility inventory was available and utilized in the risk assessment update.
- Updated hazard and asset spatial data sets were used to assess vulnerability.

4.1 Overview

44 CFR §201.4(c)(2): States are required to undertake a risk assessment that provides '…the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview.'

Risk

For the purposes of the 2018 HMP Update, risk is the potential for damage or loss created by the interaction of hazards with assets such as people, buildings, infrastructure, and/or natural and cultural resources.

The risk assessment is a process by which the State determines which hazards are of concern and addresses the potential impacts of those hazards statewide. The risk assessment helps communicate vulnerabilities, develop priorities and inform decision-making for both the hazard mitigation plan and for other emergency management efforts.

The risk assessment for the State of Hawaiʻi 2018 HMP Update provides the factual basis for developing a mitigation strategy for the State. It makes the connection between vulnerability and the proposed hazard mitigation actions.

The HI-EMA envisions the 2018 HMP Update to serve as a technical reference for local HMP updates. With that in mind, the 2018 HMP Update included a comprehensive update to the 2013 HMP risk assessment. The enhanced risk assessment not only evaluates state assets, but also evaluates each county's vulnerability to the identified hazards so that results may be integrated into upcoming local HMP updates. This will reduce the work required to update the local HMP risk assessments so that an enhanced focus may be placed on strengthening other areas of the local plans. In addition, the HI-EMA envisioned that the risk assessment be more easily understood by a person without a technical background, while paralleling the structure of the requirements outlined in 44CFR 201.4 and FEMA's State Mitigation Review Guide (March 2015) and State Mitigation Planning Key Topics Bulletins: Risk Assessment (June 2016). Therefore, mitigation capabilities and mitigation strategy elements were moved to Sections 5 (Capability Assessment) and Section 6 (Mitigation Strategy) to streamline the risk assessment sections.

For the 2018 HMP Update, the risk assessment for each hazard is divided into two parts: (1) hazard profile and (2) vulnerability assessment. The vulnerability assessment now follows the hazard profile, so that all information about a particular hazard is found in one concise section. The following is the consistent outline for each hazard's risk assessment section (Sections 4.2 through 4.15):

- Hazard Profile
  - Identify and describe hazards
  - Location of the hazards and areas vulnerable to damage
  - Extent (i.e. strength or magnitude) of hazard
  - Previous occurrences of hazard
  - Probability of future hazard events, including changes in weather patterns and climate
- Vulnerability Assessment
  - Assessment of State vulnerability and potential losses
  - Assessment of local vulnerability and potential losses
  - Future changes that may impact vulnerability

The 2018 HMP Update risk assessment characterizes the impacts of hazards on both state assets and counties allowing the State to compare potential loss and determine priorities for mitigation measures. To summarize vulnerability, the State ranked the identified hazards based on factors related to the risks faced. These risk factors include the probability of occurrence, impacts, spatial extent, warning time and duration as per the FEMA State Planning Key Topics Bulletin: Risk Assessment (June 2016). The State also integrated adaptive capacity and changing future conditions into the hazard ranking to ensure these important factors are considered. Refer to Section 4.16 (Risk Ranking) for further details on the ranking methodology and results.

The results presented throughout the risk assessment are summarized geographically, from west to east, by county. Meaning, county tabular results and maps presented throughout Sections 4.2 through 4.16 are in the following order: County of Kauaʻi, City and County of Honolulu, County of Maui and County of Hawaiʻi. Where results were given by island in other plan and studies, the cumulative results are presented in the 2018 HMP Update by county.

4.1.1 Identification of Hazards

The first step of the risk assessment is to identify and profile all-natural hazard occurrences. The goal of this first step is to identify and understand the characteristics of the state's most significant risks (FEMA State Mitigation Planning Key Topics Bulletin: Risk Assessment; 2016).

The HI-EMA considered a full range of hazards that could affect the State for the 2018 HMP Update. The process included a review of the 2013 HMP, a review of state and local hazard planning documents including local HMPs, a review of previous events and losses, as well as information on the frequency, magnitude and costs associated with hazards that have struck the State or could do so. Extensive outreach was conducted to subject-matter experts to ensure the appropriate elements of each hazard were included and best-available data was used for the risk assessment; described further below. The Forum was briefed on the updated list of hazards of concern for additional input.

Disaster History

The State of Hawaii's disaster history, in combination with an understanding of the location and type of State built and natural assets, provides direction on the identification of hazards and their significance to the State. Of the 50 federal disasters declared in the State of Hawaiʻi from 1955 to May 2018, Hawaiʻi received 31 major disaster declarations (DR); 1 emergency declaration (ER); and 18 fire management assistance declarations (FM). Table 4.1-1 outlines each FEMA declarations that the State of Hawaiʻi has received since 1955. It should be noted that declarations prior to 1964 do not contain county data as it is not available (FEMA 2018). Additional details regarding declarations during the performance period of the plan are discussed further in Sections 4.2 through 4.15.

Table 4.1-1. FEMA Major Disaster, Emergency and Fire Declarations

Date Declared	Incident Type	Disaster Number	Counties Affected
April 1, 1955	Volcano	DR-32	Not Reported
March 16, 1957	Tidal Wave	DR-71	Not Reported
August 16, 1959	Hurricane Dot	DR-94	Not Reported
January 21, 1960	Earthquakes & Volcanic Disruptions	DR-96	Not Reported
May 25, 1960	Tidal Waves	DR-101	Not Reported
April 24, 1963	Heavy Rains & Flooding	DR-152	Not Reported
September 13, 1968	Heavy Rains & Flooding	DR-251	Maui
May 16, 1973	Earthquake	DR-383	Hawaiʻi
May 7, 1974	Heavy Rains & Flooding	DR-433	Honolulu, Kauaʻi
December 7, 1975	Earthquake, Seismic Waves & Volcanic Eruption	DR-490	Hawaiʻi
March 7, 1979	Severe Storms & Flooding	DR-573	Hawaiʻi
February 6, 1980	Severe Storms, High Surf & Flooding	DR-613	Maui
April 22, 1982	Heavy Rains & Flooding	DR-656	Maui
November 27, 1982	Typhoon Iwa	DR-671	Honolulu, Kauaʻi
March 3, 1983	Hawaiʻi Kilauea	FM-2044	Not Reported
January 8, 1988	Severe Storms, Mudslides & Flooding	DR-808	Honolulu
May 18, 1990	Lava Flow, Kilauea Volcano	DR-864	Hawaiʻi
September 12, 1992	Hurricane Iniki	DR-961	Hawaiʻi, Honolulu, Kalawao, Kauaʻi , Maui, and Niihau (Census County Division)
November 18, 1996	Severe Storms and Flooding	EM-3122	Honolulu

Date Declared	Incident Type	Disaster Number	Counties Affected
November 26, 1996	Prolonged and Heavy Rains, High Surf, Flooding, Land/Mud Slide	DR-1147	Honolulu
February 18, 1998	Hawaiʻi Wildfire	FM-2195	Not Reported*
March 15, 1998	Puna District Wildfire	FM-2196	Not Reported*
August 24, 1998	Molokai Fire 98	FM-2236	Not Reported*
March 20, 2000	Puuaakapu Ranch Lot Fire	FM-2293	Hawaiʻi
November 9, 2000	Severe Storms and Flooding	DR-1348	Hawaiʻi , Maui
May 18, 2003	Hi - Waikoloa Village Fire - 05/18/2003	FM-2468	Hawaiʻi
September 14, 2004	Kawaihae Road Fire Hawaiʻi	FM-2556	Hawaiʻi
February 1, 2005	Severe Storms and Flash Flooding	DR-1575	Honolulu
August 2, 2005	Lalamilo Fire	FM-2573	Hawaiʻi
August 4, 2005	Akoni Pule Highway Fire	FM-2574	Hawaiʻi
August 15, 2005	Nanakuli Brush Fire	FM-2576	Honolulu
August 19, 2005	Waikele Fire	FM-2577	Honolulu
May 2, 2006	Severe Storms, Flooding, Landslides, and Mudslides	DR-1640	Honolulu, Kauaʻi
September 2, 2006	Ma'alaea Fire	FM-2673	Maui
October 17, 2006	Earthquake	DR-1664	Hawaiʻi, Honolulu, Kauaʻi , and Maui
June 28, 2007	Olowalu Fire	FM-2701	Maui
August 14, 2007	Waialua Fire	FM-2720	Honolulu
August 17, 2007	Kohala Mountain Road Fire	FM-2722	Hawaiʻi
October 28, 2007	Puako Fire	FM-2740	Hawaiʻi
February 6, 2008	Severe Storms, High Surf, Flooding, and Mudslides	DR-1743	Hawaiʻi, Kauaʻi , and Maui
January 5, 2009	Severe Storms and Flooding	DR-1814	Honolulu and Kauaʻi
August 31, 2009	Kaunakakai Fire	FM-2834	Maui
June 9, 2010	Maalaea Fire	FM-2844	Maui
April 8, 2011	Tsunami Waves	DR-1967	Hawaiʻi, Honolulu, and Maui
April 18, 2012	Severe Storms, Flooding, and Landslides	DR-4062	Kauaʻi and Maui
September 12, 2014	Tropical Storm Iselle	DR-4194	Hawaiʻi and Maui
November 3, 2014	Puʻu ʻŌʻō Volcanic Eruption and Lava Flow	DR-4201	Hawaiʻi
October 6, 2016	Severe Storms, Flooding, Landslides, and Mudslides	DR-4282	Maui
May 8, 2018	Severe Storms, Flooding, Landslides and Mudslides	DR-4365	Honolulu and Kauaʻi
May 11, 2018	Volcanic Eruption and Earthquakes	DR-4366	Hawaiʻi

Source: FEMA 2018
** For this event, as per the FEMA website, no additional information was filed for this event*
DR Major Disaster Declaration
EM Emergency Declaration
FEMA Federal Emergency Management Agency
FM Fire Management Assistance Declaration

Local HMP Risk Assessment Roll-Up

44 CFR §201.4(c)(2)(ii): An overview and analysis of the State's vulnerability to the hazards described …based on estimates provided in local risk assessments…

All local HMP risk assessments were reviewed, not only to consider data sources for the 2018 HMP Update, but to summarize losses across the state for each hazard. The local plan roll-up however proved challenging because all four local HMPs and specifically their risk assessments differ in structure, data used and analysis methods. Therefore, the 2018 HMP Update risk assessment not only included an evaluation of state asset vulnerability, but also assessed the vulnerability to the population and built environment (buildings and land use), environmental resources and cultural assets summarized by county. These results provide a technical resource for the next round of local HMP updates, and will lend to a smoother local plan roll-up for the State of Hawaii's 2023 HMP update.

The hazards identified in each local HMP were reviewed to determine the presence of each hazard on a county by county basis and to ensure that the 2018 HMP Update incorporates information from local risk assessments. Table 4.1-2 lists the hazards identified during each county's local mitigation planning efforts, alongside the 2013 and 2018 HMP Update hazards of concern.

Table 4.1-2. Summary of Hazards of Concern Captured in State and Local Hazard Mitigation Plans

Hazard	2018 State HMP	2013 State HMP	Local HMPs			
			County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawai'i
Climate Change and Sea Level Rise	◆	◆	◆		*	
Chronic Coastal Flood	◆	◆ Coastal Erosion, High Surf	◆	◆ High Surf, Storm Surge	◆ Coastal Erosion, High Surf	
Dam Failure	◆	◆	◆		◆ Dam and Reservoir Failure	
Drought	◆	◆	◆	◆	◆	◆
Earthquake	◆	◆	◆	◆	◆	◆
Event-Based Flood	◆	◆	◆	◆ Stream Flood, Flash Flood	◆	◆ Rainfall flooding, high waves
Hazardous Materials	◆	◆	◆		**	
Health Risks	◆	◆	◆			
High Wind Storms	◆	◆	◆ Hurricanes, strong winds combined	◆	◆	◆ Hurricane, Windstorms
Hurricane	◆	◆ Tropical Cyclone	◆ Hurricanes,	◆ Tropical Cyclones, Hurricanes	◆	◆ Hurricane, Windstorms

Hazard	2018 State HMP	2013 State HMP	Local HMPs			
			County of Kaua'i	City and County of Honolulu	County of Maui	County of Hawai'i
			strong winds combined			
Landslide and Rockfall	◆	◆	◆	◆ Debris & Rockfall	◆ Landslide, Debris Flow, Rockfall	◆ Landslide, Sea Cliff Erosion
Tsunami	◆	◆	◆	◆	◆	◆
Volcanic hazards (lava flow and VOG)	◆	◆	◆		◆ Lava flow and VOG	◆ Lava Flow
Wildfire	◆	◆	◆		◆	◆

Sources: County of Kaui, 2015; City and County of Honolulu 2012 and 2017; County of Mau 2015; County of Hawai'i 2015
**The County of Maui did not include climate change as a stand-alone hazard; however, there is a chapter on climate change and a sea-level rise exposure analysis was conducted and impacts on the other hazards of concern were discussed.*
***Hazardous materials may have been included as critical facilities in the local HMPs and therefore estimated potential impacts discussed in all hazard sections.*

2018 HMP Update Hazards of Concern

Based on this review, all hazards of concern in the 2013 HMP are included in the 2018 HMP Update. There are no commonly recognized natural hazards that have been omitted from the plan. However, changes have been made to the grouping and/or renaming of existing hazards; further, additional elements to existing hazards were included to capture a more current snapshot of risk. The hazards of concern evaluated for the 2018 HMP Update are presented below in alphabetical order; the order of the listing does not indicate the hazards' relative severity:

- Climate Change and Sea Level Rise *(formerly Climate Change Effects)*
- Chronic Coastal Flood *(formerly Flood, High Surf and Coastal Erosion)*
- Dam Failure
- Drought
- Earthquake
- Event-Based Flood *(formerly Flood)*
- Hazardous Materials
- Health Risks *(formerly Health Risks and Vulnerability)*
- High Wind Storm
- Hurricane *(formerly Tropical Cyclone)*
- Landslide and Rockfall
- Tsunami
- Volcanic Hazards (VOG and lava flow)
- Wildfire

Changes to the 2013 HMP hazards of concern are summarized below.

- The tropical cyclone hazard is now referred to as the 'hurricane' hazard to be consistent with the THIRA.

- The flood hazard was split into two distinct flood hazards: 1) chronic coastal flood and 2) event-based flood.
  - This separation is consistent with the 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, more accurately reflects events that take place in the state and will allow for more specific and measurable mitigation actions.
  - Coastal erosion and high surf were separate hazards of concern in the 2013 HMP but are now included with the chronic coastal flood hazard.
  - Chronic coastal flood includes passive inundation, annual high waves, coastal erosion, and tidal flooding/king tides with sea level rise.
  - Event-based flood focuses on the 1% annual chance flood.
- Health risks now includes the rat lungworm due to this risk emerging in 2017.
- The climate change effects hazard is now referred to as 'climate change and sea level rise' and includes best available data developed for the sea level rise hazard.

In addition to the separate climate change and sea level rise hazard, each hazard section contains a subsection that discusses the potential changes in future probability resulting from climate change. In addition, there is a subsection that discusses the future changes that may impact vulnerability including climate change impacts where appropriate.

4.1.2 Asset Inventories

National, state, and county resources were reviewed to identify best-available data to update the risk assessment. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual properties.

STATE ASSETS

44 CFR §201.4(c)(2)(ii): .... State owned or operated critical facilities located in the identified hazard areas shall also be addressed;

44 CFR §201.4(c)(2)(iii): .... The State shall estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.

FEMA requires the state to identify their assets which may include state-owned or operated buildings, infrastructure and critical facilities. For the 2018 HMP Update, the State of Hawaiʻi assessed vulnerability of the following types of state assets: state owned- and leased-buildings; state roads; and critical facilities identified by the state and others, which includes local and state-owned critical facilities and infrastructure.

State Buildings

The State Risk Management Office provided a list of 6,634 state buildings to utilize for the risk assessment. The dataset did not have attribution to determine the number of owned versus leased buildings; this data will be referred to as state buildings in the 2018 HMP Update. The list of facilities was geocoded to generate a spatial layer with the attributes needed for the analyses. Not all facilities had sufficient location data for geocoding. Of the total 6,634 facilities, 6,095 had sufficient data to be successfully geocoded and included in the spatial analyses reported in Sections 4.2 through 4.15. The dataset included various structural attributes used for the analyses including replacement cost, agency that owns or leases the building, use description, year built, number of stories, and square footage. For buildings missing values for these attributes and for additional attributes required for the FEMA Hazus analyses, default values were used. Refer to Appendix X for more information on FEMA's Hazus model and the default values used. Table 4.1-3 summarizes the state building data set used in the risk assessment.

Table 4.1-3. Summary of State Buildings by Agency

Agency	State Building	
	Count	Total Replacement Cost Value
Dept of Accounting & General Services	66	$946,504,656
Dept of Agriculture	70	$133,065,375
Dept of Attorney General	15	$95,151,863
Dept of Budget & Finance	16	$26,624,294
Dept of Business, Economic Development & Tourism	25	$612,574,032
Dept of Commerce & Consumer Affairs	2	$35,611,360
Dept of Defense	69	$246,099,477
Dept of Education	4,090	$9,604,111,443
Dept of Hawaiian Home Lands	12	$100,471,477
Dept of Health	44	$387,068,440
Dept of Human Resources Development	1	$5,523,320
Dept of Human Services	130	$420,004,555
Dept of Labor & Industrial Relations	22	$79,322,626
Dept of Land & Natural Resources	90	$98,666,185
Dept of Public Safety	154	$427,884,909
Dept of Taxation	1	$6,864,408
Dept of Transportation	68	$2,912,510,888
Hawai'i State Ethics Commission	1	$891,212
Hawai‘i Health Systems Corporation	106	$1,223,962,810
Hawai‘i Housing Finance & Development Corporation	86	$333,526,064
Hawai‘i Public Housing Authority	273	$933,255,767
Hawai‘i State Legislature	2	$43,024,855
Hawai‘i State Public Library System	53	$525,584,082
Judiciary	41	$511,093,204
Legislative Reference Bureau	1	$2,686,408
Office of Hawaiian Affairs	11	$53,991,251
Office of the Auditor	2	$1,789,788
Office of the Governor	1	$2,686,408
Office of the Lieutenant Governor	2	$3,977,640
Office of the Ombudsman	1	$1,620,944
Research Corporation of the University of Hawai'i	3	$3,713,497
University of Hawai'i	637	$5,000,692,783
Total	**6,095**	**$24,780,556,017**

Source: State Risk Management Office 2017
RCV – Replacement Cost Value

State Roads

The State of Hawaiʻi Department of Transportation's state route inventory, downloaded from the State of Hawaiʻi GIS Program Geospatial Data Portal, was used to determine the state road exposure to spatially-delineated hazards. The spatial layer displays the State routes for the main Hawaiian Islands as of 2016. Economic impact of hazard events on road infrastructure has not been monetized, although exposure is identified and discussed. Appendix X (Map Atlas) includes maps of each island that depict the major transportation assets, highway and airports, located throughout the state.

The 2018 HMP Update risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate state and local vulnerability.

Critical Facilities

The HI-EMA provided a list of 1,542 critical facilities to utilize for the risk assessment. This list of facilities was compiled for the *Makani Pahili 2017 Emergency Power Prioritization Workshop Series Final Report*. The facility type assigned to each core category can be found in Appendix X (State Profile and Risk Assessment Supplement). The list contained spatial coordinates for the majority of the facilities. For the facilities that did not have spatial coordinates or the original coordinates were invalid, other location attributes were used to geocode the facilities. Not all facilities had sufficient location attributes for geocoding. Of the total 1,542 facilities, 1,475 had sufficient data to be geocoded and are included in the spatial analyses reported in Sections 4.2 through 4.15.

An estimated 400 critical facilities are state buildings that appear in both inventories used for the risk assessment. The duplication of these assets is acknowledged; and the datasets are reported separately. The majority of the overlap is with critical facilities in the Government Facilities, Healthcare and Public Health, and Mass Care Support Services (schools) core categories.

The original facility list only contained two attributes: facility name and critical facility type. Therefore, assumptions were made to populate the required fields needed to estimate potential losses using Hazus. The average values already populated in Hazus for each facility type (known as default values) for square footage were utilized; however it is recognized that the actual square footage could differ significantly. The replacement cost, or amount it will cost to replace the structure at the time of the loss, was calculated using the default square footage values and 2017 RS Means costs per square foot for each facility. RS Means is the industry-standard cost-estimate model for replacement cost. Therefore, replacement costs could vary significantly from actual values; however this is a suitable methodology for planning purposes. The Hazus default attribute data for essential facilities (fire, police, medical care, and school facilities) was used to replace the default attribute values where the essential facilities could be matched to the critical facilities using the facility name.

Table 4.1-4 summarizes the total number and replacement cost value of critical facilities by core category used in the risk assessment.

Table 4.1-4. Summary of Critical Facilities by Core Category

Core Category	Count	Total Replacement Cost Value
Commercial Facilities	60	$206,894,206
Communications	130	$523,848,060
Emergency Services	149	$1,017,628,710
Energy	90	$2,591,975,628
Food & Agriculture	39	$829,869,410
Government Facilities	100	$399,781,575
Healthcare & Public Health	193	$3,399,521,375
Mass Care Support Services	353	$11,497,547,155
Transportation Services	56	$1,739,256,960
Water, Waste, & Wastewater Systems	305	$9,481,445,760
Total	**1,475**	**$31,687,768,838**

Source: HI-EMA Temporary Emergency Power County Workshop Series Report Critical Facilities, 2017

LOCAL ASSETS

44 CFR §201.4(c)(2)(ii): The State shall describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events.

In addition to assessing the vulnerability of state assets, a key component to the risk assessment is to evaluate potential losses to jurisdictions in the state. As a first step, the four local HMPs were reviewed in an attempt to roll-up the local risk assessment results in the 2018 HMP Update to summarize losses in each county. However, the local plan risk assessment roll-up proved challenging because all four local HMPs and specifically their risk assessments differ in structure, data used and analysis methods. Therefore, the State of Hawaii's 2018 HMP Update risk assessment included a vulnerability assessment for the counties utilizing statewide population, building, environmental resource and cultural asset spatial datasets. Estimated exposure and potential impacts to these assets are reported in each hazard section. In addition, economic impacts are discussed qualitatively for each hazard.

Population

Research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. As discussed in Section 3.0 (State Profile) these vulnerable populations include individuals living near or below the poverty threshold, the elderly, children, ethnic minorities and visitors.

The 2010 U.S. Census block data layers were used to estimate exposure and potential impacts to the general population. The 2010 U.S. Census demographic data available in FEMA's Hazus model was used to estimate potential impacts to the elderly (over 65 years of age) and populations with income below the poverty threshold for the state. The poverty threshold for the State is $24,000/year (Federal Register 2017); however, the demographic data available in FEMA's Hazus model is only available in increments of $10,000. Therefore, the total households with an income of $30,000 or less was utilized for the risk assessment. To obtain an understanding of how many people are living at or near the poverty threshold, the average number of persons per household (3.03 people) was multiplied by the households with annual incomes of less than $30,000 (U.S. Census Bureau QuickFacts; Hazus v4.2); refer to Table 4.1-5 for a summary of these statistics by county.

Table 4.1-5. Population Statistics by County

County	Total Population	Population Over the Age of 65 years	Population Living with an Income <$30K/year
County of Kauaʻi	67,091	9,985	15,777
City and County of Honolulu	953,207	138,490	177,621
County of Maui	154,924	19,829	33,036
County of Hawaiʻi	185,079	26,834	59,055
Total	**1,360,301**	**195,138**	**285,489**

Source: U.S. Census 2010; Hazus 4.2
K = Thousand

General Building Stock

To assess the built environment, the general building stock inventory dataset from Hazus version 4.2 was used for the risk assessment. This building data provides the building valuation for each occupancy classification (e.g., residential, commercial, industrial) developed from the Hazus square footage data by occupancy (derived from data from the U.S. Energy Information Administration and the 2010 U.S. Census for residential data, and adjusted Hazus-MH 2006 square footage data for non-residential data). This dataset was developed by applying 2014 R.S. Means "Square Foot Costs"-based replacement values per square foot for typical building floor areas and construction methods for each specific occupancy. The spatial hazard layers were overlaid with the building inventory in GIS to determine the replacement cost value located in the impact area of the hazard. When Hazus was utilized to evaluate the earthquake, flood, hurricane and tsunami events, the potential loss to the building stock was estimated. It is important to note that development that has occurred since 2010 is not reflected in the reported risk assessment results.

Environmental Resources

The State contains an abundant array of onshore and offshore environmental assets, including many species that are endemic only to the Hawaiian Islands. The HI-EMA identified the following assets to include in the risk assessment based on the availability of spatial data: critical habitats (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks and reserves, reefs and watersheds. The spatial hazard layers were overlaid with the environmental resources in GIS to determine which environmental resources are located in the impact area of the hazard. Refer to Section 3 (State Profile) for a more detailed description of these assets in the State.

Cultural Assets

Cultural asset information in the State of Hawaiʻi is managed by the Hawai`i State Historic Preservation Division in the Department of Land and Natural Resources. This information is not available for public review and use at this time and as such, could not be included in the analysis in this plan. It is a goal of the HI-EMA to work with the

Department in the future in order to access this information for inclusion in future state hazard mitigation plan updates.

For the 2018 HMP Update, the Hawaiian Home Lands spatial data was used to assess exposure to the natural hazards evaluated. The spatial hazard layers were overlaid with the Hawaiian Home Lands in GIS to determine the area of land located in the impact area of the hazard.

Changes That Impact Vulnerability

'*State hazard mitigation plans must be revised to reflect changes in development, including recent development, potential and projected land use and development, or conditions that may affect risk and vulnerability to the state and jurisdictions such as changes in population demographics*' (FEMA State Mitigation Planning Key Topics Bulletin: Risk Assessment; 2016).

In addition to summarizing the current vulnerability, the State of Hawaiʻi has identified three factors of change that can affect the State's vulnerability to hazards: 1. Changes in population; 2. Changes in development and 3. Other identified conditions as relevant and appropriate, including the impacts of climate change. Identifying these changes and integrating into the risk assessment ensures they are considered when developing the mitigation strategy to reduce these vulnerabilities in the future.

As summarized in Section 3 (State Profile) the State of Hawaiʻi has experienced changes in development over the performance period of the 2013 HMP; and new development, population demographic changes and increases in visitors/tourists are anticipated in the future. There is no statewide system that tracks where this development has occurred or is anticipated to occur. Therefore, it proves challenging to conduct a statewide assessment to determine if development has occurred in hazard areas.

Unfortunately, the 2013 HMP did not include an analysis of State owned and/or leased buildings or the same critical facility inventory; therefore, changes in risk and vulnerability of these facilities over the performance period of the plan cannot be assessed. In addition, different critical facility and general building inventories, hazard data and methodologies were used in the 2013 HMP than the 2018 HMP update making it impossible to conduct a side-by-side comparison analysis to determine changes in vulnerability. It is the HI-EMA and the SHMO's vision that the 2018 HMP Update set the new baseline for risk and will be used to assess changes of risk over time as future updates to the plan occur.

It is important to note that development continues to occur in the State. Any new development that has occurred since 2010 is not reflected in the reported general building stock risk assessment results. Generally speaking, damages and losses as a result of hazard events are generally associated with older existing infrastructure and buildings rather than new development. This is because building codes and land use regulations, described in Section 5 (Capability Assessment), limit development in hazard areas or require construction to meet higher standards within hazard areas. This provides a reduction of risk in areas where new development or redevelopment is occurring.

In an attempt to understand if projected new development may be impacted by hazards, an exposure analysis was conducted using three datasets that were available in spatial formats to generally assess and discuss where development may occur; 1) Hawaiʻi Community Development Authority's Community Development Districts; 2)

Enterprise Zones and 3) Maui Development Projects; refer to Section 3 (State Profile). The spatial hazard layers were overlaid with the projected development areas to determine the area of land located in the impact area of the hazard. These results are reported at the end of each hazard section (Sections 4.2 through 4.15). A qualitative discussion regarding other factors of change is also included, as appropriate.

Due to the fact that the State is currently experiencing the impacts of the changing climate today, climate change continues to be a stand-alone hazard of concern included in the HMP. Climate change and associated impacts are discussed in Section 4.2 (Climate Change and Sea Level Rise).

4.1.3 Hazard-Specific Data and Methodologies

44 CFR §201.4(c)(2)(i): The risk assessment shall include the following: An overview of the type and location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future events, using maps where appropriate.

To assess vulnerability, three different levels of analysis were used depending upon the data available for each hazard as described below. In addition, location and potential loss estimates documented in the four local HMPs were also integrated into each hazard section, when available. Table 4.1-6 summarizes the types of analyses performed for each hazard followed by a discussion of each approach.

1. **Historic Occurrences and Qualitative Analysis** – This analysis includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best available data and professional judgement.

- **Exposure Assessment** – This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets may be affected by the hazard. If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.

2. **Loss estimation** — The Hazus modeling software was used to estimate potential losses for the event-based flood, earthquake, hurricane and tsunami hazards. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards. Refer to Appendix X (State Profile and Risk Assessment Supplement) for more information on FEMA's Hazus model.

Table 4.1-6. Summary of Risk Assessment Analyses

	Data Analyzed						
Hazard	**State Buildings**	State Roads	**Critical Facilities**	**Population**	**General Building Stock**	**Environmental Resources**	**Cultural Assets**
Climate Change and Sea Level Rise	E	E	E	E, H	E, H	E	E
Chronic Coastal Flood	E	E	E	E	E	E	E
Dam Failure	E	E	E	E	E	E	E
Drought	Q	Q	Q	Q	Q	Q	Q
Earthquake	E, H	E, H	E, H	E, H	E, H	E	E

Hazard	Data Analyzed						
	State Buildings	State Roads	Critical Facilities	Population	General Building Stock	Environmental Resources	Cultural Assets
Event-Based Flood	E, H	E, H	E, H	E, H	E, H	E	E
Hazardous Materials	Q	Q	Q	Q	Q	Q	Q
Health Risks	Q	Q	Q	Q	Q	Q	Q
High Wind Storms	Q	Q	Q	Q	Q	Q	Q
Hurricane	E, H	E, H	E, H	E	E, H	E	E
Landslide and Rockfall	E	E	E	E	E	E	E
Tsunami	E	E	E	E, H	E, H	E	E
Volcanic Hazards	E	E	E	E	E	E	E
Wildfire	E	E	E	E	E	E	E

E – Exposure analysis; H – Hazus analysis; Q – Qualitative analysis
Note: The four local HMPs were also consulted and potential losses summarized in hazard location and vulnerability assessment subsections when available.

Extensive outreach was conducted at the early stages of the 2018 HMP Update process to collaborate with hazard subject-matter-experts to obtain the best available data and methodologies to assess risk (refer to Section 2 and Appendix X – Planning Process Documentation). The following summarizes the data and analysis conducted to evaluate each hazard of concern. Sections 4.2 through 4.15 summarize the vulnerability assessment results. Appendix X (State Profile and Risk Assessment Supplement) includes all data generated as a result of the risk assessment in further detail (e.g., by state agency). Appendix X (Map Atlas) includes additional maps gathered or generated to support the risk assessment.

CLIMATE CHANGE AND SEA LEVEL RISE

The climate change and sea level rise hazard is limited to the discussion and analysis of key indicators of the changing climate and sea level rise. A qualitative assessment was conducted for the climate change indicators presented: rising air temperatures; decreased rainfall and stream flow; increased rain intensity; increased sea level and sea surface temperatures; and acidification of the ocean.

Sea level rise data compiled for the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* was used to assess exposure. Three modeled hazards (passive flooding, annual high wave flooding and coastal erosion) were combined to define the projected extent of chronic flooding called the Sea Level Rise Exposure Area (SLR-XA). The SLR-XA for the islands of Hawaiʻi, Molokai and Lanai is based on modeling passive flooding only.

To assess the chronic coastal flood hazard (defined as SLR-XA with 1.1 feet of sea level rise discussed in Section 4.2) with sea level rise, the SLR-XA with 3.2 feet of sea level rise was utilized (SLR-XA-3.2).

To assess event-based coastal flooding with sea level rise, the 1% coastal flood zone with 3.2 feet of sea level rise (1%CFZ-3.2) was utilized. It is important to note when comparing 1% annual chance flood event with the 1%CFZ-3.2, that the 1%CFZ-3.2 analysis is based on the current regulatory V-zone; whereas the 1% annual chance flood event (Section 4.6 - Event-based flooding) includes the entire Special Flood Hazard Area (V- and A-zones).

Summary of New Terms in the 2018 HMP Update to Assess Flood and Sea Level Rise Vulnerability

***SLR-XA -** Depicts the area exposed to potential chronic coastal flooding and land loss based on modeling passive flooding, annual high wave flooding, and coastal erosion.*

***Chronic Coastal Flood -** Three chronic flooding hazards were modeled: passive 'bathtub' flooding, annual high wave flooding and coastal erosion (a.k.a. SLR-XA). The SLR-XA with 1.1 feet of sea level rise, or chronic coastal flooding, is currently happening in the State and was assessed in Section 4.3.*

***SLR-XA-3.2 –** The SLR-XA with 3.2 feet of sea level rise, representing chronic coastal flooding and sea level rise, was assessed in Section 4.2 (Climate Change and Sea Level Rise).*

***Event-Based Flood –** The 1% annual chance flood event as depicted on the FEMA Flood Insurance Rate Maps, also known as the Special Flood Hazard Area (inclusive of V- and A-zones) was assessed in Section 4.7.*

***1% CFZ-3.2**– The 1% annual coastal flood zone (V zones only) with 3.2 feet of sea level rise, was assessed to examine potential impacts to event-based flooding with SLR (Section 4.2 Climate Change and Sea Level Rise).*

When assessing impacts from the SLR-XA-3.2, permanent loss of the structure and land is assumed. The most accurate way to estimate this loss is to utilize the combined value of the structure and the land using tax assessor data. To estimate loss to the general building stock, the assessed value of both the structure and the land was utilized and reported in Section 4.2 (Climate Change and Sea Level Rise). However, this tax data (structure and land value) was not available to report permanent loss to state assets (state buildings and critical facilities). Therefore, to report the required potential impact to state assets, the replacement cost value of state buildings and critical facilities and the limitations of this are acknowledged.

Chronic Coastal Flood

To assess the State's risk to the chronic coastal flood hazard, the SLR-XA with 1.1 feet of sea level rise inundation developed for the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* was used for the state asset exposure analyses (refer to Section 4.2). The SLR-XA with 1.1 feet of sea level rise depicts the area exposed to potential chronic coastal flooding and land loss based on modeling passive flooding, annual high wave flooding, and coastal erosion with sea level rise for the Islands of Maui, Oʻahu, and Kauaʻi. The SLR-XA for the Islands of Hawaiʻi, Molokaʻi, and Lānaʻi is based on modeling passive flooding only. In addition, the *Sea Level Rise Vulnerability and Adaptation Report* quantitative results were integrated into the chronic coastal flood vulnerability assessment for estimated potential loss to population and the general building stock.

When assessing impacts from the SLR-XA-1.1, permanent loss of the structure and land is assumed. The most accurate way to estimate this loss is to utilize the combined value of the structure and the land using tax assessor data. To estimate loss to the general building stock, the assessed value of both the structure and the land was utilized and reported in Section 4.3 (Chronic Coastal Flood) as per the *Sea Level Rise Vulnerability and Adaptation Report*. However, this tax data (structure and land value) was not available to report permanent loss to state assets (state buildings and critical facilities). Therefore, to report the required potential impact to state assets, the replacement cost value of state buildings and critical facilities and the limitations of this are acknowledged.

Dam Failure

Statewide dam failure inundation area data was provided by the Pacific Disaster Center (PDC). The dam break scenarios depicted in the reports utilized the Danish Hydrological Institute's MIKE 21 model. Model results, and products were reviewed and approved by a consulting hydrologist. Best available data were utilized in the reports and as input to the model, however, due to variations in data currency and accuracy, final products should be interpreted as "best available estimates" only. Original Individual Assessment Reports prepared under contract for DLNR were not available for the 2018 HMP Update.

For the 2018 HMP Update, the total number of state assets located in all spatially-delineated dam failure inundation areas was examined. However, it is important to note that it is highly unlikely that all dams would fail at the same time. To assess local vulnerability, the HI-EMA Mitigation Section asked representatives from each County on the Forum which three dams they would like analyzed as part of the 2018 HMP Update. The following 12 dams were selected and exposure analyses were conducted.

- County of Kauaʻi – Waita Reservoir (HI00099), Huinawai Reservoir (HI00104), Kapaia Reservoir (HI00012)
- City and County of Honolulu – Wahiawa Dam (HI00017), Kaneohe Dam (HI00124), Nuuanu Dam No. 4 (HI00001)
- County of Maui – Horner Reservoir (HI00054), Kualapuu Reservoir (HI00041), Wailuku Water Reservoir 6 (HI00150)
- County of Hawaiʻi – Waikoloa Reservoir No. 1 (National ID HI00040), Waikoloa Reservoir No. 2 (HI00122), Waikoloa Reservoir No. 3 (HI00136)

Due to the limited number of dams evaluated to assess local vulnerability, the risk assessment in Section 4.4 (Dam Failure) does not fully represent each county's total exposure nor vulnerability.

DROUGHT

To assess the vulnerability of the State to drought and its associated impacts, a qualitative assessment was conducted. Information from the *Hawaiʻi Drought Plan 2017 Update* were used to support this section (Section 4.5).

EARTHQUAKE

ShakeMap data prepared by the U.S. Geological Survey (USGS) and probabilistic earthquake data in Hazus version 4.2 were used to assess the earthquake hazard. The evaluation of the historic events utilizing the current environment provides an understanding of potential loss if the event were to happen today.

- The Kalapana 1975 M7.7 scenario with an epicenter approximately 26 miles south southeast of Hilo. This scenario represents the Kalapana M7.2 earthquake on November 29, 1975.
- The Kau M8.0 scenario with an epicenter approximately 4 miles northwest of Pahala. This scenario represents the Kau District M7.9 earthquake on April 3, 1868.
- The Lanai M7.0 scenario with an epicenter approximately 13 miles north northwest of Lanai City. This scenario represents the Lanai M6.8 earthquake on February 20, 1871.
- The NE Maui M7.0 scenario with an epicenter approximately 31 miles northeast of Kahului. This scenario represents the Maui M6.5 earthquake on January 23, 1938.
- The standard Hazus 100-year probabilistic event.

A Level 2 analysis was performed in Hazus version 4.2 to estimate potential losses as a result of each scenario (Section 4.6); refer to Appendix X (State Profile and Risk Assessment Supplement) for further details on Hazus and Level 2 analyses. The general building stock data, for the Counties of Hawaiʻi and Maui, was enhanced with custom building mapping schemes for earthquake modelling. These customized mapping schemes provide the percentage of single-wall, and post and pier building types for each Census tract and associated Hawaiʻi -specific damage functions. These building types are the most vulnerable to earthquake damage. The enhanced general building stock data were provided by the Pacific Disaster Center. The Counties of Kauaʻi and City and County of Honolulu used the general building stock data that was already provided in Hazus v4.2.

The state buildings and critical facilities were imported into Hazus as individual facilities to support this assessment (also known as a Hazus user-defined analysis). The National Earthquake Hazard Reduction Program (NEHRP) soils and landslide susceptibility data were also integrated into the Hazus model. NEHRP soils D and E were identified as areas potentially more vulnerable to damage, these areas were used as the hazard extent for the exposure analysis.

- NEHRP soils data for the County of Hawaiʻi was provided by AECOM.
- NEHRP soils data for the County of Maui was originally compiled by Tetra Tech for the 2015 Maui County Hazard Mitigation Plan. The NEHRP soils data were generated using the USGS Geologic Map of the State of Hawaiʻi data and the County of Maui Probable Site Classes map in the 2013 Hawaiʻi State Mitigation Plan. Data was recreated from static sources, as GIS data files were unavailable. This methodology has resulted in a rather coarse resolution that is limited in applicability to planning purposes.
- Landslide susceptibility data for County of Hawaiʻi was provided by the Pacific Disaster Center. Landslide susceptibility data categorized for use in Hazus is not available for the other counties.

Event-Based Flood

The National Flood Hazard Layer Digital Flood Insurance Rate Map (DFIRM) data, effective September 29, 2017 with latest Letter of Map Amendment October 2, 2017, was used for the exposure and estimate potential losses from the 1-percent-annual-chance flood event in Hazus (refer to Section 4.7). Table 4-7 summarizes the effective dates of each County's DFIRM.

Using the 1-percent annual chance floodplain boundaries, also known as the Special Flood Hazard Area and inclusive of A- and V-zones, and the best available digital elevation model (DEM) data, flood depth grids were generated and integrated into the Hazus model. The DEM data included NOAA's 3-meter coastal DEM and USGS' 1-meter and 10-meter DEM data.

In Hazus, the dasymetric default general building stock was used to estimate potential loss. A Level 2 user-defined analysis was performed for state buildings and critical facilities. 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.

Table 4.1-7. FEMA Digital Flood Insurance Rate Maps Effective Dates

County	DFIRM Effective Date	Latest LOMA Effective Date
County of Kauaʻi	11/26/2010	-
City and County of Honolulu	11/5/2014	9/8/2017
County of Maui	11/4/2015	9/8/2017
County of Hawaiʻi	9/29/2017	10/2/17

Source: FEMA Map Service Center, 2017

According to DLNR, the flood maps need to be updated due to new development. In addition, there are large sections in the City and County of Honolulu and the County of Hawaiʻi that have not been studied. Therefore, the estimated results below may be underestimating vulnerability.

Hazardous Materials

The hazardous materials hazard is limited to the discussion and analysis of fixed site and in-transit hazard material releases. A qualitative assessment was conducted for the hazardous materials hazard (Section 4.8).

Health Risks

The health risks hazard is limited to the discussion and analysis of the following: infectious diseases (dengue fever, chikungunya, zika, rat lungworm, Legionnaires' disease, leptospirosis), water-borne disease, pandemic flu (including H5N1 or avian flu and H1N1 or swine flu) and bioterrorism. A qualitative assessment was conducted for the health risks hazard (Section 4.9). Risks to human health that occur as a result of natural hazard events are discussed throughout Sections 4.2 through 4.15.

High Wind Storm

Data showing defined geographical extents of terrain-related amplification of wind speeds were not available to evaluate the high wind storm hazard. A qualitative assessment on the high wind component of the trade winds and Kona storm events is presented in Section 4.9.

Hurricane

A Level 2 analysis was performed in Hazus version 4.2 to assess hurricane exposure and vulnerability for one statewide and four county-specific scenario events created for the 2015 Hawaiʻi Catastrophic Hurricane Plan. Wind field import files created for the Hawaiʻi Catastrophic Hurricane Plan and provided by the Pacific Disaster Center (PDC) were used for the Hazus analyses. A general building stock analysis was performed using the Hazus default data. A user-defined analysis was performed for state buildings and critical facilities. The five scenarios chose for analysis are:

- Statewide – Category 4 hurricane with a maximum wind speed of 140 mph. Approaches from the south traveling approximately 50 miles to the west of Hawaiʻi before turning to the northwest approximately 10 miles south of Lanai and traveling to the northwest off the south coast of Oahu.
- County of Kauaʻi – Category 4 hurricane with a maximum wind speed of 130 mph making landfall on the south coast of Kauaʻi .
- City and County of Honolulu – Category 4 hurricane with a maximum wind speed of 130 mph making landfall on the south coast of Oahu.
- County of Mauʻi – Category 4 hurricane with a maximum wind speed of 120 mph making landfall on the south coast of Kahoolawe.
- County of Hawaiʻi – Category 4 hurricane with a maximum wind speed of 120 mph making landfall on the northwest coast of Hawaiʻi.

Hurricane storm surge (SLOSH) data provided by the National Oceanic and Atmospheric Administration (NOAA) was used for the exposure analysis. The data is the maximum of maximums (MOM) for each hurricane category 1 through 4; the MOM provides a worst-case snapshot for a particular storm category. 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. An exposure assessment was conducted and results generated for the all category hurricanes. For the purposes of the 2018 HMP Update risk assessment, assets located in the Category 4 storm surge inundation area are reported in Section 4.10 to align with the Hawaiʻi Catastrophic Hurricane Plan and Hazus analysis performed. Exposure assessment results for Category 1 through 3 are reported in Appendix X (State Profile and Risk Assessment Supplement).

The two datasets referenced above (Hazus and SLOSH data) are not directly connected. The wind data was used to determine general building stock losses, displaced households and shelter needs. The storm surge data was used to determine exposure of state buildings, critical facilities, population, general building stock, and environmental/culture assets losses to the hazard.

Landslide and Rockfall

The landslide and rockfall hazard is limited to discussion and analysis of two types of landslides: debris flow (or mudslides) and rockfall. Landslide susceptibility data for the County of Hawaiʻi was provided by the Pacific Disaster Center. The following summarizes the criteria used to spatially categorize landslide susceptibility into high, moderate or low areas in the County of Hawaiʻi.

- **Slope**
  - Low Susceptibility – Slope less than 20 degrees
  - Moderate Susceptibility – Slope of 20 to 40 degrees
  - High Susceptibility – Slope greater than 40 degrees
- **Geology**
  - Low Susceptibility - Shallow rock, fresh volcanics
  - Moderate Susceptibility – Clay surficial soils, weathered rock
  - High Susceptibility – Weak soft soils, ash deposits, mapped historic slide talus
- **Soil Moisture** - Soil moisture assignments are derived from NOAA rainfall mapping of the island since regional groundwater and soil moisture data is unavailable island wide. Areas receiving greater than 2000 mm annual precipitation are considered wet soil, corresponding largely to the windward side of the island. In addition, coastal areas below elevation 200 feet are considered wet due to potential groundwater seepage gradients from higher elevations, except in the arid Kona coast areas.

For the landslide exposure analysis, we categorized the Hazus values provided in the PDC source data into three landslide susceptibility areas described below.

- Low – Hazus susceptibility type values 1 through 3
- Moderate – Hazus susceptibility type values 4 through 6
- High – Hazus susceptibility type values 7 through 10

This landslide susceptibility data has not been generated for the County of Kauaʻi, City and County of Honolulu and County of Maui. To determine the areas at greatest risk to landslide for these three counties, slope was calculated using a USGS 10-meter DEM. Areas of slope were assigned low, moderate and high landslide susceptibility categories to align with the slope categories for the County of Hawaiʻi. This data is considered suitable for planning purposes only.

A statewide spatial analysis was conducted using the high landslide susceptibility areas available to determine exposure and vulnerability to the landslide hazard. A qualitative assessment was conducted for the rockfall hazard. Refer to Section 4.12.

Tsunami

The Great Aleutian Tsunami (GAT) inundation area data provided by the PDC for use in the 2018 HMP Update. In addition, the PDC ran the Hazus v4.2 tsunami model for the GAT scenario to estimate potential losses in the state. A statewide spatial analysis was conducted using the GAT inundation area to determine exposure to state assets. The impacts to population, buildings and the economy were summarized utilizing the Hazus reports provided by the PDC and summarized in Section 4.13.

Volcanic Hazards (Lava Flow and VOG)

The volcanic hazard is limited to the discussion and analysis of the lava flow and vog hazards. There are spatially-delineated lava flow zones for the Counties of Hawaiʻi and Maui. In collaboration with the volcanic SME, specific zones were selected to assess risk to the lava flow hazard. The following defines all zones for each county and which were selected for the exposure analysis reported in Section 4.13.

Lava flow hazard zones data for the County of Hawaiʻi was provided by the Hawaiʻi Statewide GIS Program. In collaboration with the volcanic SME, zones 1 through 4 were selected to assess lava flow risk for the County of Hawaiʻi. The hazard zones are defined as follows.

- Zone 1 – Includes summits and rift zones of Kilauea and Mauna Loa, where vents have been repeatedly active in historic time.
- Zone 2 – Areas adjacent to and downslope from Zone 1. Fifteen to twenty-five percent of Zone 2 has been covered by lava since 1800, and 25 to 75 percent has been covered within the last 750 years. The relative hazard within Zone 2 decreases gradually as one moves away from Zone 1.
- Zone 3 – Areas less hazardous than Zone 2 because of greater distance from recently active vents and/or because of topography. One to five percent of Zone 3 has been covered since 1800, and 15 to 75 percent has been covered within the past 750 years.
- Zone 4 – Includes all of Hualalai, where the frequency of eruptions is lower than that for Kilauea or Mauna Loa. Lava coverage is proportionally smaller, about 5 percent since 1800, and less than 15 percent within the past 750 years.
- Zone 5 - Includes the area on Kilauea currently protected by topography
- Zone 6 - Includes two areas on Mauna Loa, both protected by topography
- Zone 7 - Includes the younger part of dormant volcano Mauna Kea; 20% of this area was covered by lava in the past 10,000 years
- Zone 8 is the remaining part of Mauna Kea; only a small percentage of this area has been covered by lava in the past 10,000 years.
- Zone 9 is the Kohala Volcano, which last erupted over 60,000 years ago

Lava flow hazard zones data for County of Maui provided by USGS. In collaboration with the volcanic SME, zones 1 and 2 were selected to assess lava flow risk for the County of Maui. This decision was based on the 2006 paper by D.R. Sherrod and others, which suggests that Maui Zone 1 is roughly equivalent to Hawaiʻi Island Zone 3, Maui Zone 2 is roughly equivalent to Hawaiʻi Island Zone 4, and Maui Zone 3 is roughly equivalent to Hawaiʻi Island Zone 6 (Sherrod, 2006). These comparisons are not explicitly stated in the paper, but Dr. Sherrod affirms how Maui lava-flow hazard zone numbers compare to Hawaiʻi Island lava-flow hazard zone numbers, which were established by Mullineaux and others (1987). In other words, no place on Maui has volcanic hazards equivalent to Lava-Flow Hazard Zones 1 and 2 on Hawaiʻi Island.

The hazard zones are defined as follows.

- Zone 1 – Encompasses the lower- and middle-altitude reaches of the southwest and east rift zones, Haleakala Crater itself, and an area on the northern flank of the east rift zone—all areas where eruptions have occurred frequently in the past 1500 years. At least five eruptive events, each encompassing several lava flows, have occurred in each of the designated areas. The attention drawn to zone 1 hazards presumes that the volcano's short-term future will be similar to that of the past 1500 years.

- Zone 2 – Encompasses the volcano's flanks downslope of the southwest and east rift zone axes, chiefly areas where lava has encroached at least once in the past 13,000 years. Included are some areas that have never been inundated during the past 50,000–100,000 years but that lie within the topographic boundaries of lava sheds for vents that could be expected to form along the rift zone axes.
- Zone 3 - Demarcates downslope reaches centered low on the Kaupo and Koʻolau lava fans. These areas, although within potentially active lava sheds, have become sheltered by topographic buildup during the past 40,000 years that now would deflect new lava toward the margins of the fans.
- Zone 4 - Encompasses those flanks shielded from lava during the past 100,000 years or for which the sparse eruptive products found are the consequence of off-rift cinder cones from random, infrequent eruptive events. Corresponds to essentially no hazard under most lava inundation conditions.

A qualitative discussion is also included regarding vog and potential impacts in the State. Refer to Section 4.14.

WILDFIRE

Communities at Risk from Wildfire (CAR) data was provided by the Hawaiʻi Wildfire Management Organization (HWMO). These data are based on HWMO's 2013 statewide Wildfire Hazard Assessment (WHA) which collected quantitative field data and qualitative firefighting capacity data of 36 hazard characteristics that contribute to wildland fire risk in developed communities. The DOFAW personnel reviewed the WHA and then made adjustments to better reflect consistency across CAR maps, which communicate risk levels based on staff experience. Tetra Tech assigned high, moderate and low fire risk categories to the communities delineated in the CAR data using the "DOFAW 2013: Communities at Risk from Wildfire" map published by HWMO as a reference. High, moderate, and low categories were used for the exposure analysis. For the purposes of this risk assessment, an asset is considered potentially vulnerable to wildfire if it is located in a high-risk community. It is important to note that the CAR data focuses on communities; or developed areas. Therefore, the wildfire risk to state assets located outside of these communities could not be determined.

HWMO provided the following disclaimer with the CAR data:

> "HWMO will not bear any responsibility for the consequences of using this data set, which are entirely the responsibility of the user. Therefore, the data does not indicate the full range of realistic fire threat, nor does it offer actual quantification of the potential exposure of homes to the ignition, spread, and intensity of wildfires or embers produced by wildfires. Although the data set and subsequent analyses may indicate general wildfire risk for a given area, the actual risk to homes and property can deviate based on the characteristics of the site around an individual home, community, or natural resource area."

An exposure assessment was conducted and results generated for the high, moderate and low wildfire risk areas. For the purposes of the 2018 HMP Update risk assessment, assets located in the high wildfire risk area are deemed exposed and vulnerable. Refer to Section 4.15; results for the low and moderate landslide risk areas are reported in Appendix X (State Profile and Risk Assessment Supplement). It is important to note that the wildfire risk rankings used for analysis focus on communities and developed areas. Therefore, assets located outside these areas have not be evaluated and it cannot be assumed they are not as risk. The results reported in Section 4.15 may underestimate the State's exposure and vulnerability to wildfire.

LIMITATIONS

The spatial hazard data used in this plan was generated by multiple agencies and organizations. Due to differing processes of data generation between these entities, spatial layer boundaries may not accurately align with the coastline.

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. The reader is urged to use caution when interpreting these results as each hazard event is unique, and climate change projections may change over time as technology and science advances. 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 event
- 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, the State of Hawaiʻi will continue to collect additional data, and update and refine existing inventories, to assist in estimating potential losses.

Potential economic loss is based on the present value of the state buildings and general buildings stock utilizing best available data. The State acknowledges significant impacts may occur to critical facilities and infrastructure (such as roads, airports, harbors, utilities) as a result of these hazard events causing great economic loss not only to one island, but that cascades throughout the State. However, monetized damage estimates to critical facilities and infrastructure, and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry such as tourism and the real-estate market were not analyzed.

SECTION 4. RISK ASSESSMENT

4.2 Climate Change and Sea Level Rise

2018 HMP Update Changes

- This profile now includes climate change with enhanced discussion and analysis on sea level rise. It has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence for chronic coastal flooding and event-based coastal flooding.
- New and updated statistics and figures from federal, state, academic, and local agencies are incorporated.

4.2.1 Hazard Profile

Climate Change

A change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties that persist for an extended period, typically decades or longer (IPCC 2007).

Climate is defined as long-term averages and variations in weather measured over a period of time. A change in the state of the climate can be identified by changes in the mean and/or variability of its properties that persist for an extended period of time, typically decades or longer. Key indicators of the changing climate include rising carbon dioxide in the atmosphere, rising air and sea temperatures, rising sea levels and upper-ocean heat content, changing ocean chemistry and increasing ocean acidity, changing rainfall patterns, decreasing base flow in streams, changing wind and wave patterns, changing extremes, and changing habitats and species distributions (State of Hawaiʻi 2018).

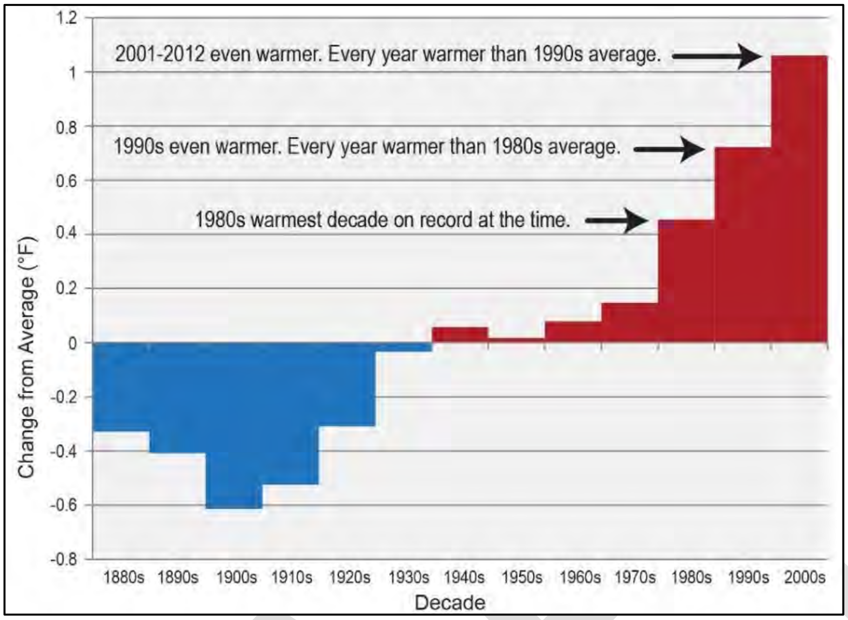
This section provides general information on the climate change hazard with an enhanced discussion on sea level rise. Chronic coastal flooding is discussed in Section 4.1 (Chronic Coastal Flood), flooding caused by dam failure is discussed in Section 4.3 (Dam Failure), event based flooding is discussed in Section 4.6 (Event-Based Flood), and storm surge is discussed in Section 4.10 (Hurricane).

Hazard Description

Climate Change

In the last century, air temperatures have increased between one-half and one degree Fahrenheit (˚F). Figure 4.2-1 shows the last five decades of the Earth's average temperatures and how it is has increased each decade since the 1880s.

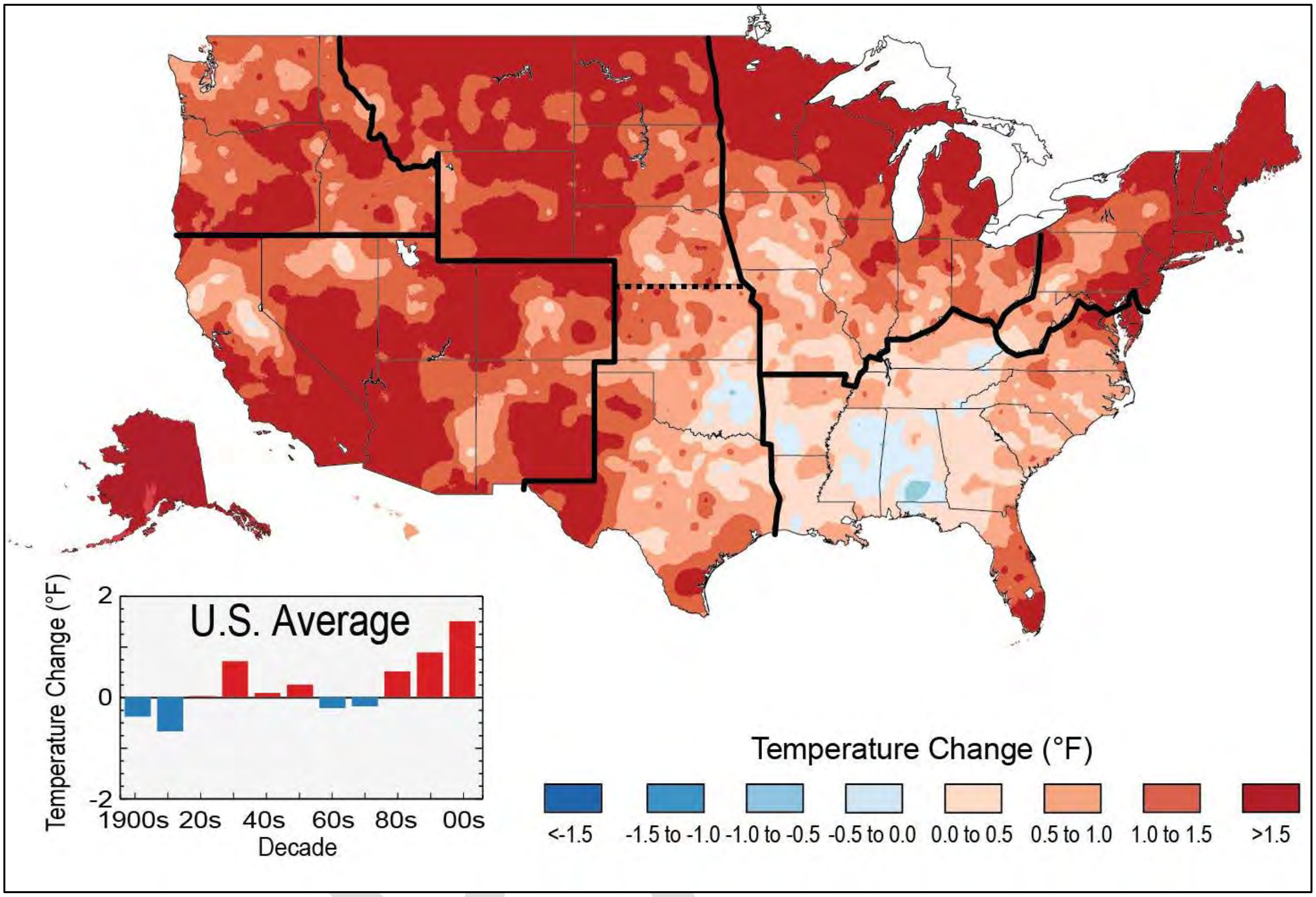
Figure 4.2-1. Global Temperature Change



Source: National Climate Assessment 2014

The planet's average surface temperature has risen largely due to increased carbon dioxide and other human-made emissions into the atmosphere. Most of the warming occurred in the past 35 years, with 16 of the 17 warmest years on record occurring since 2001. Figure 4.2-2 shows temperature changes across the United States over the past 22 years, from 1991 to 2012, compared to the 1901 to 1960 average for the contiguous United States, and the 1951 to 1980 average for Alaska and the State of Hawaiʻi. The bars on the graph show the average temperature changes by decade from 1901 to 2012 (relative to the 1901 to 1960 average). The far-right bar (2000s decade) includes 2011 and 2012. The period from 2001 to 2012 was warmer than any previous decade in every region (National Climate Assessment 2014).

Figure 4.2-2. Observed U.S. Temperature Change



Source: National Climate Assessment 2014

In the State of Hawaiʻi, its climate is changing in ways that are consistent with the influence of global warming. The State of Hawaiʻi has experienced rising air temperatures; decreased rainfall and stream flow; increased rain intensity; increased sea level and sea surface temperatures; and acidification of the ocean.

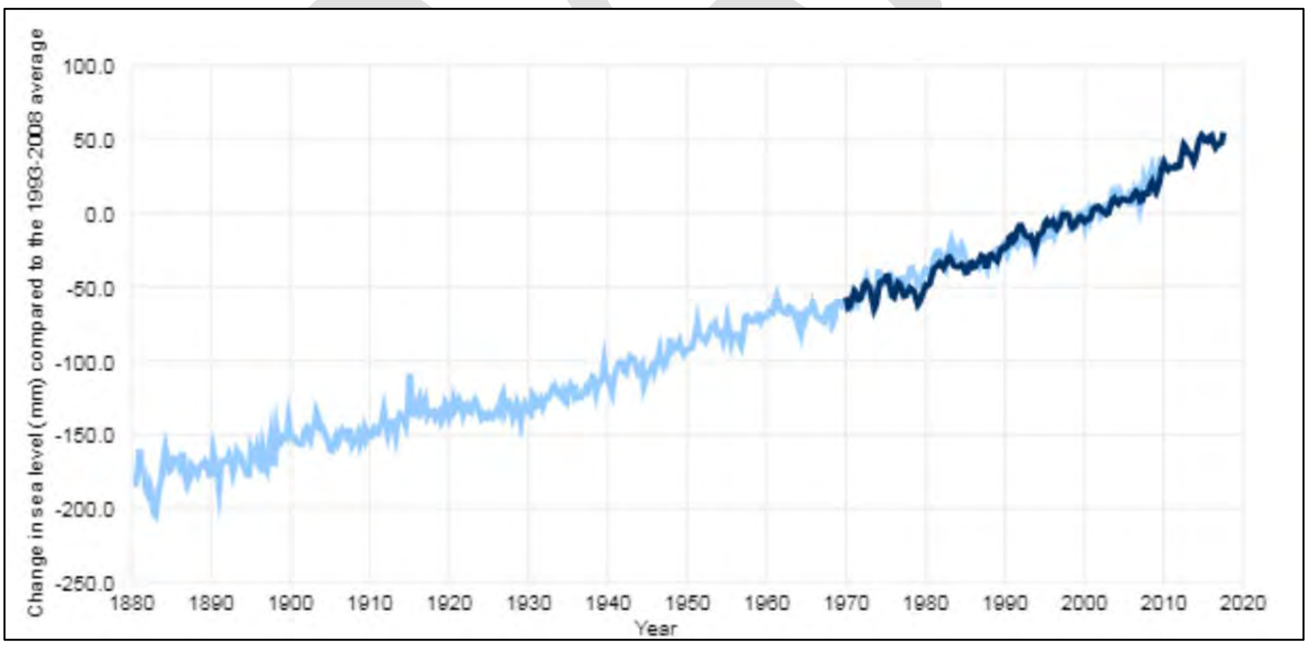
- **Surface Air Temperature**—Data has shown a rapid rise in air temperature in the past 30 years in the State of Hawaiʻi, averaging 0.3°F per decade, with stronger warming at high elevations (above 2,600 feet). The rate of temperature rise at low elevations (below 2600 feet), 0.16°F per decade, is less than the global rate (about 0.36°F per decade). However, the rate of warming at high elevations in the State of Hawaiʻi, 0.48°F per decade, is faster than the global rate.
- **Rainfall and Stream Discharge**—The State of Hawaiʻi has seen an overall decline in rainfall in the last 30 years, with widely varying precipitation patterns on each island. Projections show that the State of Hawaiʻi will see more drought and heavy rains. A decline in overall precipitation totals have caused a decrease in stream base flow, which may reduce aquifer discharge and freshwater supplies. This may also influence aquatic and riparian ecosystems and agriculture.

- **Rain Intensity**—Between 1958 and 2007, the amount of rain falling in the very heaviest downpours has increased by approximately 12%. These heavy rain events may lead to more flash flooding, damage to infrastructure, runoff, and sedimentation.
- **Sea Level**—Refer to the following subsection for information on sea level changes in the State of Hawaiʻi.
- **Sea Surface Temperature**—At Station ALOHA, marine researchers at the University of Hawaiʻi and cooperating institutions have measured an increase of sea surface temperature of 0.22°F per decade. With climate change impacts, this rate is likely to increase, potentially exposing coral reefs and other marine ecosystems to negative impacts related to increased temperatures including coral bleaching.
- **Ocean Acidification**—Rising carbon dioxide in the atmosphere mixes with seawater, causing the ocean to acidify. Measurements at Station ALOHA over the last 20 years have documented that the surface ocean around the State of Hawaiʻi has grown more acidic (University of Hawaiʻi at Mānoa Sea Grant College Program 2014; Fletcher 2010).

Sea Level Rise

Global mean sea level rise has been observed over the last century in tide station data from around the world and, more recently, in satellite-based ocean height measurements. The rate of global sea level rise has accelerated over the past century, as seen in Figure 4.2-2, and global mean sea level has risen by 8 to 9 inches since 1880, with a third of that rise occurring since 1993 (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; Lindsey 2017).

Figure 4.2-3. Global Sea Level Since 1880



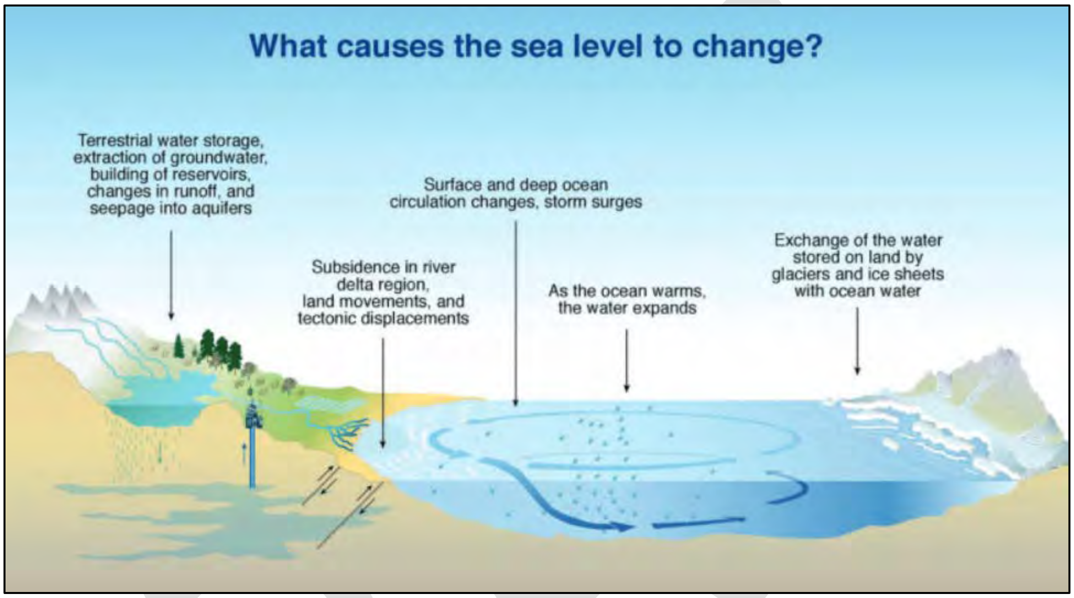
Source: Lindsey 2017

Notes: The light blue line shows seasonal (3-month) sea level estimates from Church and White (2011). The darker line is based on University of Hawaiʻi Fast Delivery sea level data.

mm Millimeter

There are two types of sea level rise: global and relative (local). Global sea level rise refers to the increase currently observed in the average global sea level trend. This is primarily attributed to changes in ocean volume due to ice melt and thermal expansion. The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, a steady increase in global atmospheric temperature creates an expansion of salt water molecules, increasing ocean volume (NOAA Tides & Currents 2018).

Figure 4.2-4. Causes of Sea Level Change



Source: U.S. Climate Resilience Toolkit 2015

Relative (or local) sea level is affected by global sea level fluctuations, changes in land elevation, winds, and ocean circulation. It refers to the height of the water as measured along the coast relative to a specific point on land. Tide stations measure local sea level rise. Water measurements at the tide stations are referenced to stable vertical points on the land and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). Since the heights of both the land and water change, the land-water interface can vary spatially and temporally and must be defined over time. Depending on the rates of vertical land motion relative to changes in sea level, observed local sea level trends may differ greatly from the average rate of global sea level rise, and vary widely from one location to the next. Relative sea level trends reflect changes in local sea levels over time and are typically the most critical sea level trend for many coastal applications, including coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, sustainable habitat restoration design, and the general public enjoying their favorite beach (NOAA Tides & Currents 2018).

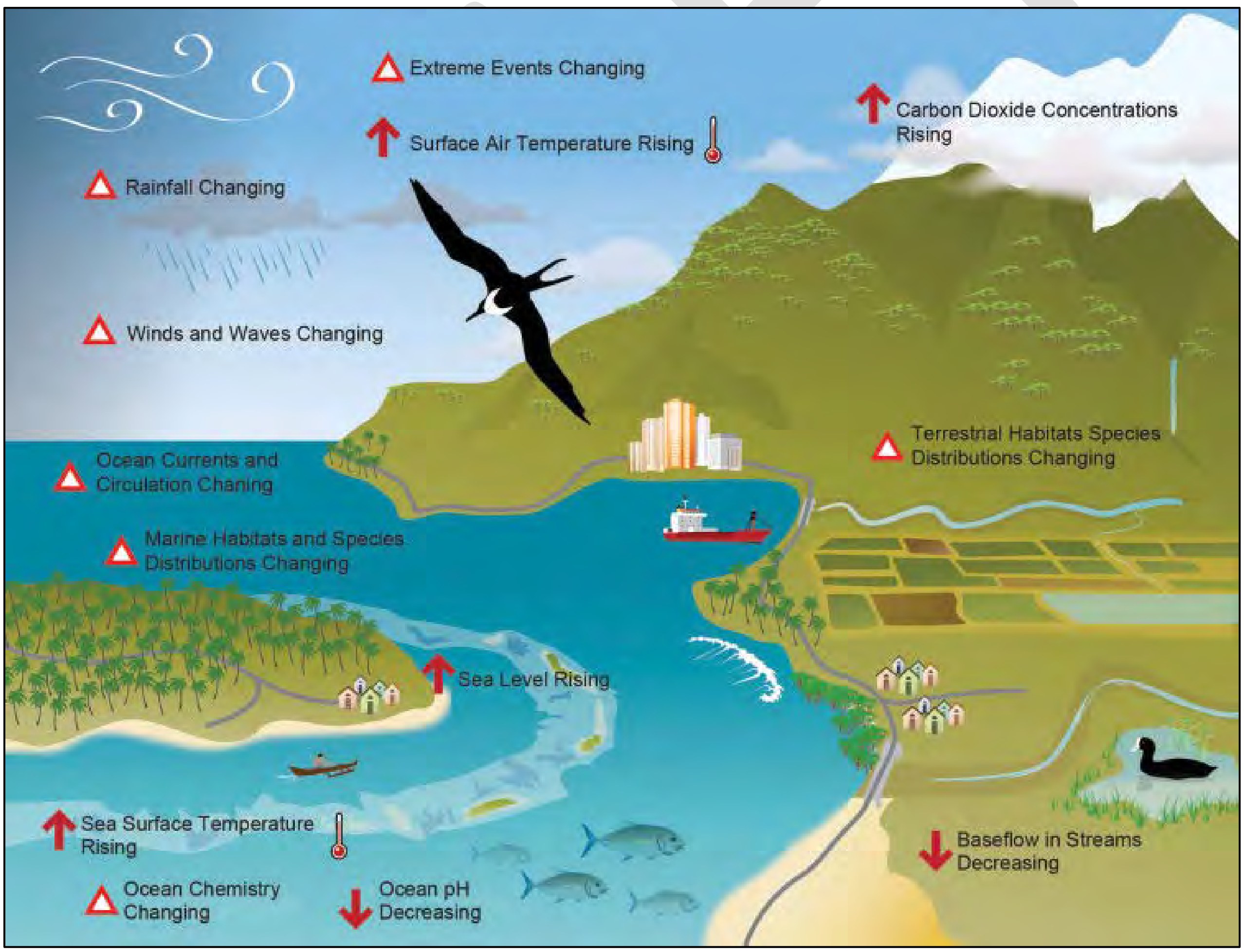
Rising sea level and projections of stronger and more frequent El Niño events and tropical cyclones in waters surrounding the State of Hawaiʻi all indicate a growing vulnerability to coastal flooding and erosion (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; EPA 2018). Changing sea levels can affect human activities in coastal areas. The rising sea level inundates low-lying wetlands and dry land, erodes shorelines, contributes to coastal flooding, and increases the flow of salt water into estuaries and nearby groundwater aquifers. Coastal areas become more vulnerable to damage from storms as well (EPA 2018).

LOCATION

The State of Hawaiʻi is experiencing climate change and sea level rise impacts in unique, region-specific ways. For example, the rapid acceleration observed in globally averaged rates of sea-level rise has not yet been observed in local sea-level data for the County of Hawaiʻi, whereas the Island of Oahu's daily temperature range is changing much more rapidly than the global mean. Climate change and sea level rise can impact marine ecosystems, coasts and the built environment, terrestrial ecosystems, freshwater resources, and human health. Some of these impacts have already been observed while others are projected to manifest in the coming years (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Climate change will continue to be felt from the upper reaches of each island to the sea and throughout the entire archipelago including the main Hawaiian Islands and Northwestern Hawaiian Islands. Figure 4.2-5 shows the key indicators of climate change in the Hawaiian Islands and the relative location of these changes.

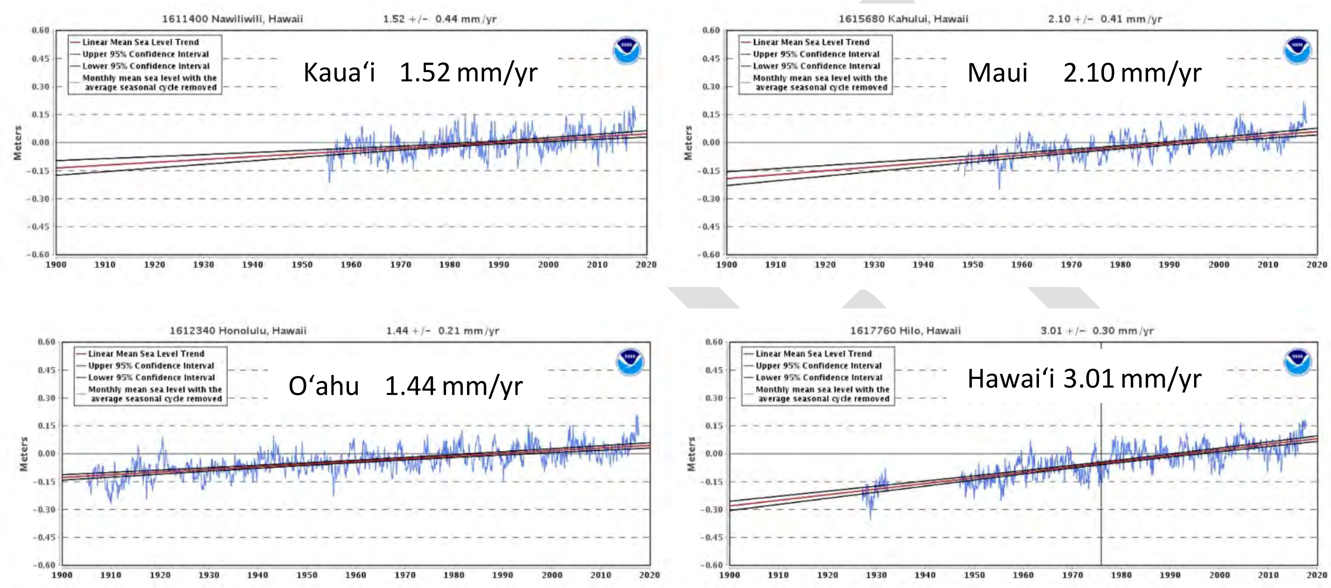
Figure 4.2-5. Indicators of Climate Change in the Pacific Islands Region



Source: National Climate Assessment 2014

The local relative rates of sea level rise vary among the Hawaiian Islands due to varying rates of subsidence along the volcanic island chain and possibly, in part, due to oceanic variability. As seen in Figure 4.2-5, the relative rate of sea level rise on the Island of Hawaiʻi is almost twice the rate on the Island of Kauaʻi. This is due to the fact that the Island of Hawaiʻi is slowly subsiding as it gains mass from active volcanoes, resulting in a higher relative rate of sea level rise while the Islands of Kauaʻi and Oʻahu, which are older islands, are relatively stable (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; NOAA 2018).

Figure 4.2-6. Observed Mean Sea Level Rise Trends and Rates of Rise in the Hawaiian Islands



Source: NOAA 2018
Notes: mm/y Millimeters per year
NOAA National Oceanic and Atmospheric Administration

Modeling was conducted using the best available data and methods to determine the potential future exposure of the State of Hawaii to multiple coastal hazards as a result of sea level rise (Hawaiʻi Climate Mitigation and Adaptation Commission 2017*)*. Chronic and event-based coastal flooding were modeled using the IPCC worst case scenario of 3.2 feet of sea level rise by the year 2100. As noted in the 2017 *Hawaii Sea Level Rise Vulnerability and Adaptation Report* and discussed in Section 4.2 (Chronic Coastal Flood), current or near-term exposure to coastal hazards is assessed using the Sea Level Rise Exposure Area with 1.1 feet of sea level rise (SLR-XA-1.1). To assess mid- to late century sea level rise on chronic coastal flooding, the Sea Level Rise Exposure Area with 3.2 feet of sea level rise (SLR-XA-3.2) is used for the 2018 HMP Update. These maps may be seen on the Hawaiʻi Sea Level Rise Viewer.

The 1% annual chance coastal flood zone (V-zones, referred to as the 1%CFZ) will expand with sea level rise meaning that more land area will be exposed to damaging wave impacts from a 100-year flood event. The 1%CFZ with 3.2 feet of sea level rise (1%CFZ-3.2) was utilized to assess mid- to late century sea level rise on coastal event-based flooding. It is important to note that the event-based flood hazard discussed in Section 4.6 assesses the entire Special Flood Hazard Area (V- and A-zones). Sea level rise on event-based flooding only includes the coastal V-zone with sea level rise. The 1%CFZ-3.2 areas are shown in Figure 4.2-6 through Figure 4.2-9.

Table 4.2-1 shows the estimated square miles of potential land loss/impact due to 3.2 feet of sea level rise for each County. The State's total potential lost area due to chronic coastal flooding with seal level rise will amount to an estimated 0.5% of the State's total land area; however, it comprises of some of the most developed and valued land. When examining the 1% annual chance coastal flood event with 3.2 feet of sea level rise, 1.7% of the State's land will be impacted. The City and County of Honolulu, with its expansive coastal plains, will have the most land unusable due to sea level rise, followed by the Counties of Kauaʻi and Maui.

Summary of Key Terms

SLR-XA – *The SLR-XA represents the area exposed to chronic coastal flooding and land loss based on modeling of passive flooding, annual high wave flooding and coastal erosion (refer to Section 4.0 for further details).*

Chronic Coastal Flood – *The SLR-XA with 1.1 feet of sea level rise (SLR-XA-1.1) approximates current or near-term exposure to chronic coastal flooding discussed in Section 4.2.*

SLR-XA-3.2 – *The SLR-XA with 3.2 feet of sea level rise was used to assess mid- to late century exposure to chronic coastal flooding.*

Event-Based Flood – *The 1% annual chance flood as depicted on the FEMA Flood Insurance Rate Maps, also known as the Special Flood Hazard Area (inclusive of V- and A-zones), was assessed in Section 4.6.*

1%CFZ-3.2 *–The 1% annual chance coastal flood zone (V zones only) with 3.2 feet of sea level rise was used to assess mid- to late century event-based coastal flooding.*

Table 4.2-1. Sea Level Rise Hazard Areas by County

County	Area				
	Total Area (square miles)	SLR-XA-3.2 (square miles)	SLR-XA-3.2 as % of Total Area	1%CFZ-3.2 (square miles)	1%CFZ-3.2 Area as % of Total Area
County of Kauaʻi	630.3	8.8	1.4%	32.8	5.3%
City and County of Honolulu	600.2	13.0	2.2%	41.2	6.9%
County of Maui	1,174.6	7.8	0.7%	15.7	1.3%
County of Hawaiʻi	4,027.8	4.3	0.1%	19.4	0.5%
Total	**6,432.9**	**33.9**	**0.5%**	**109**	**1.7%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017

Note: Total area for each County calculated using coastline spatial layer downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal

GIS Geographic Information System

SLR-XA-3.2 Sea Level Rise Exposure Area with 3.2 feet of sea level rise.

1%CFZ-3.2 1% Annual Chance Coastal Flood with 3.2 feet of sea level rise (V-zones only).

Figure 4.2-7. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise (1%CFZ-3.2) for the County of Kaua'i

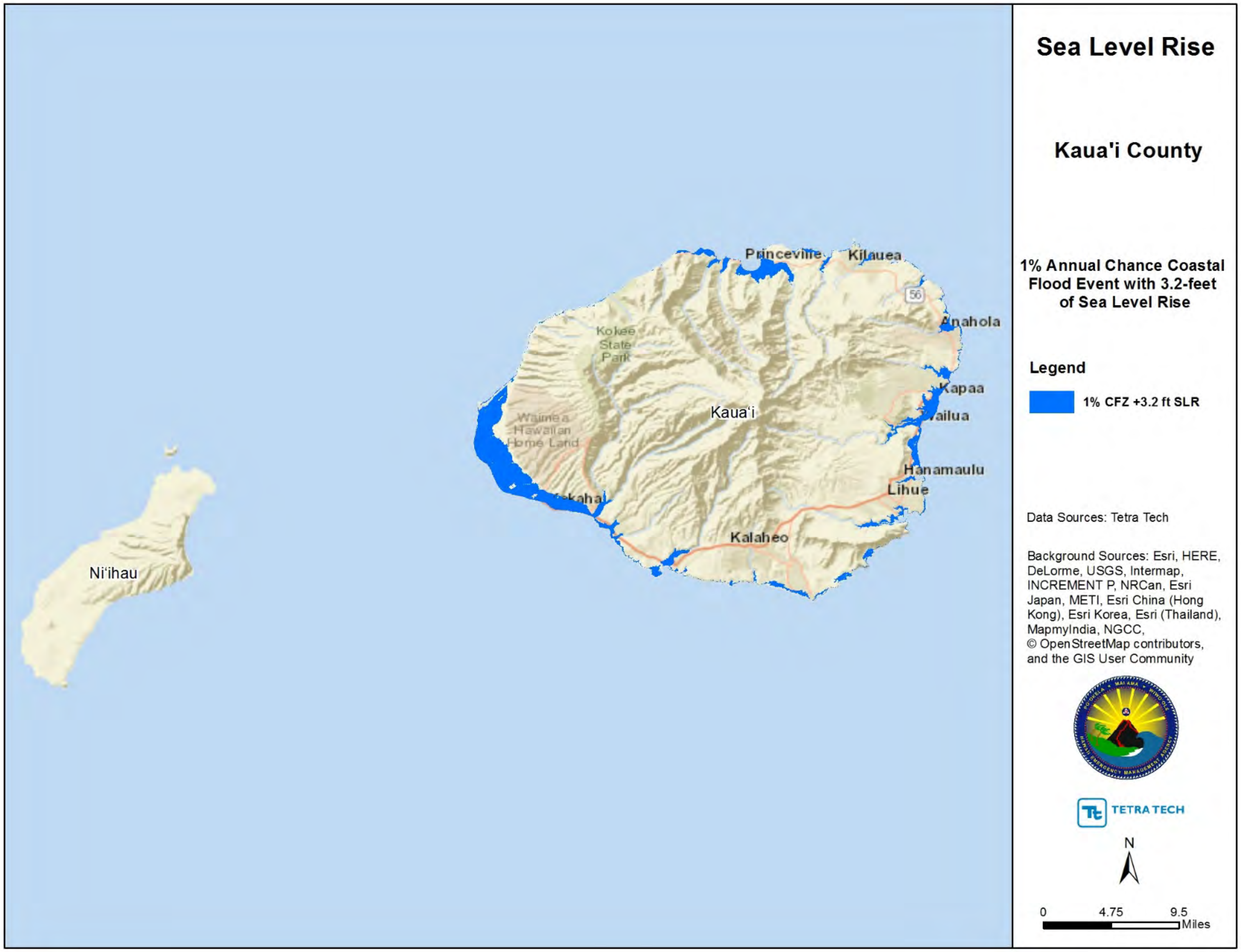


Figure 4.2-8. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise(1%CFZ-3.2) for the City and County of Honolulu

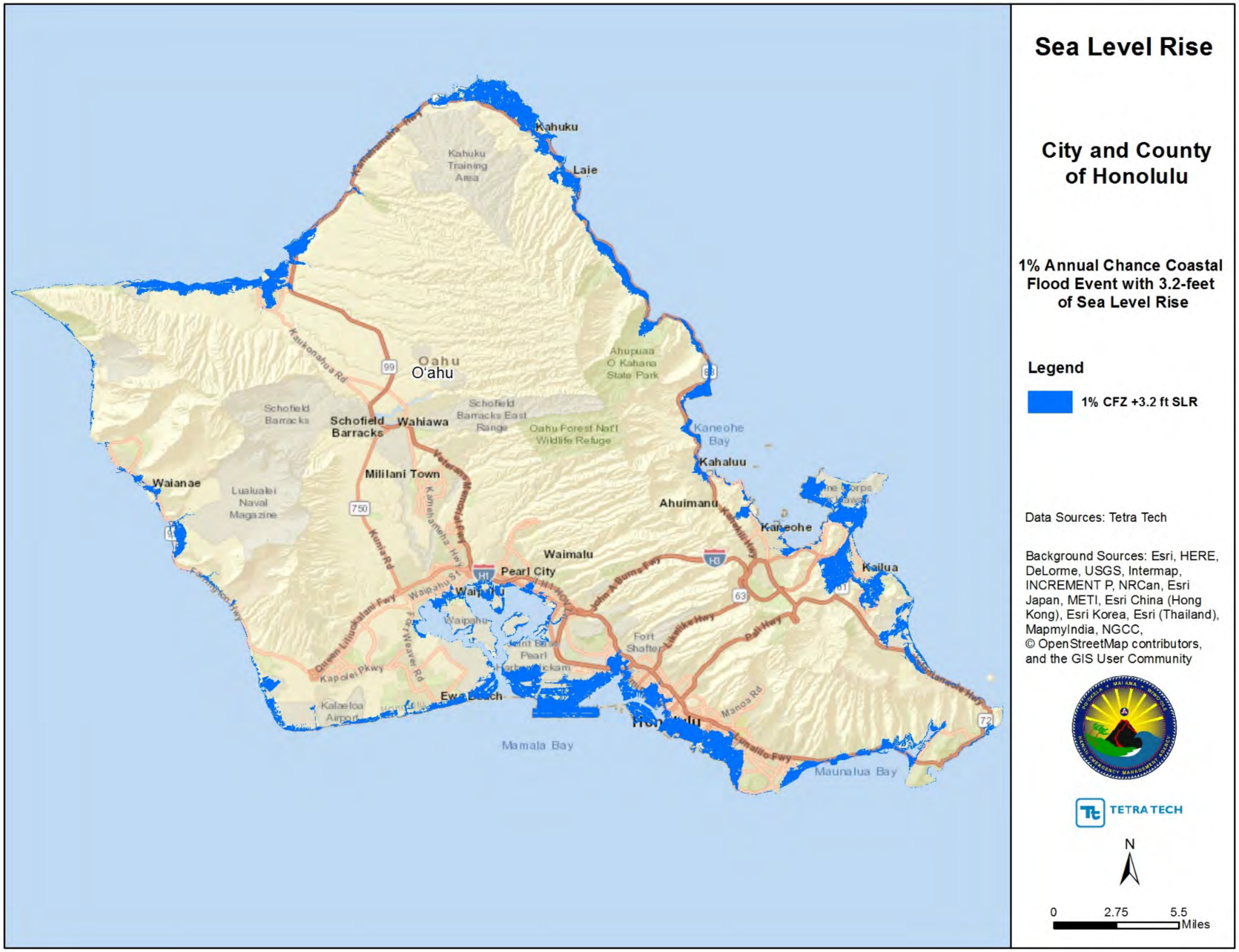


Figure 4.2-9. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise (1%CFZ-3.2) for the County of Maui

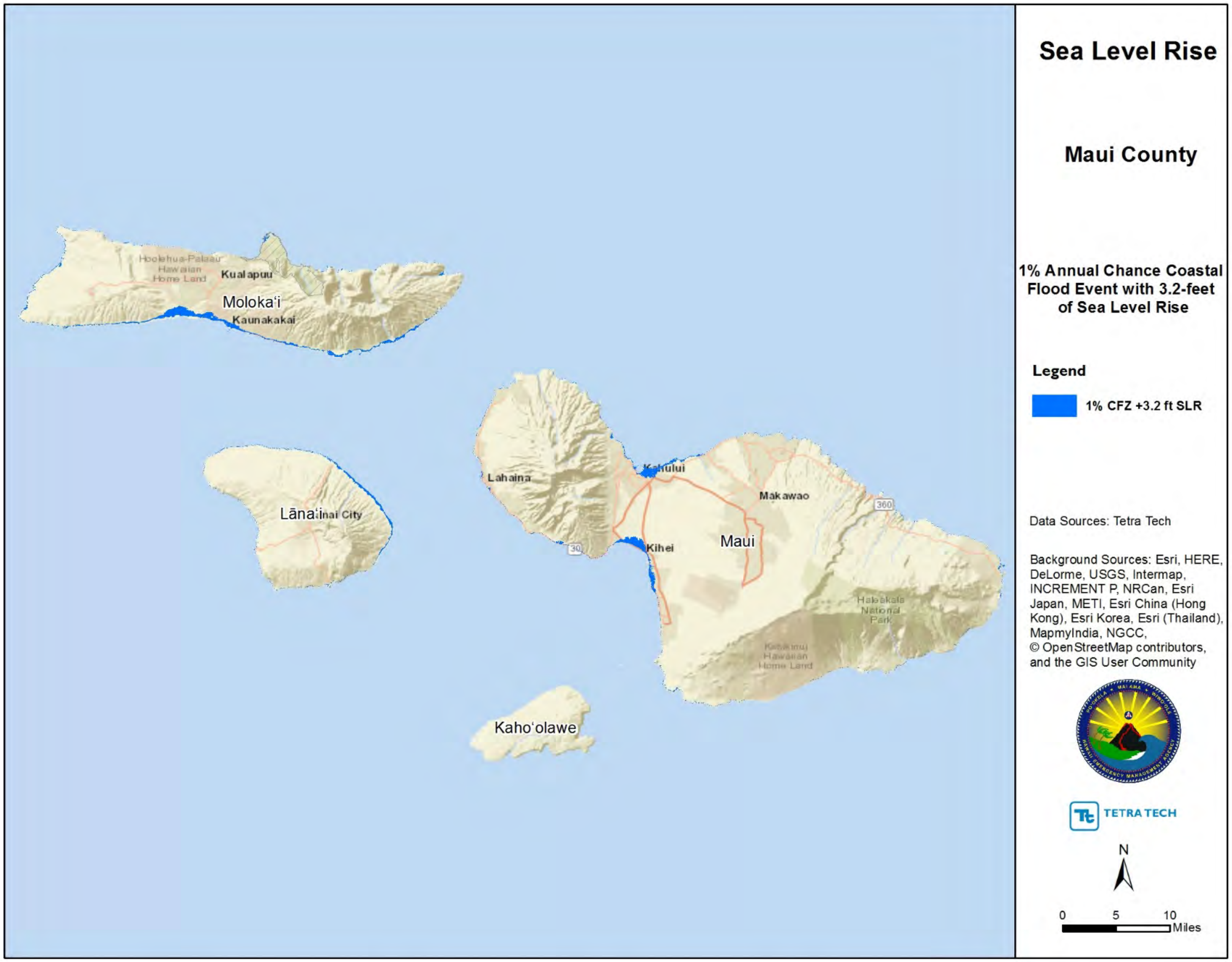
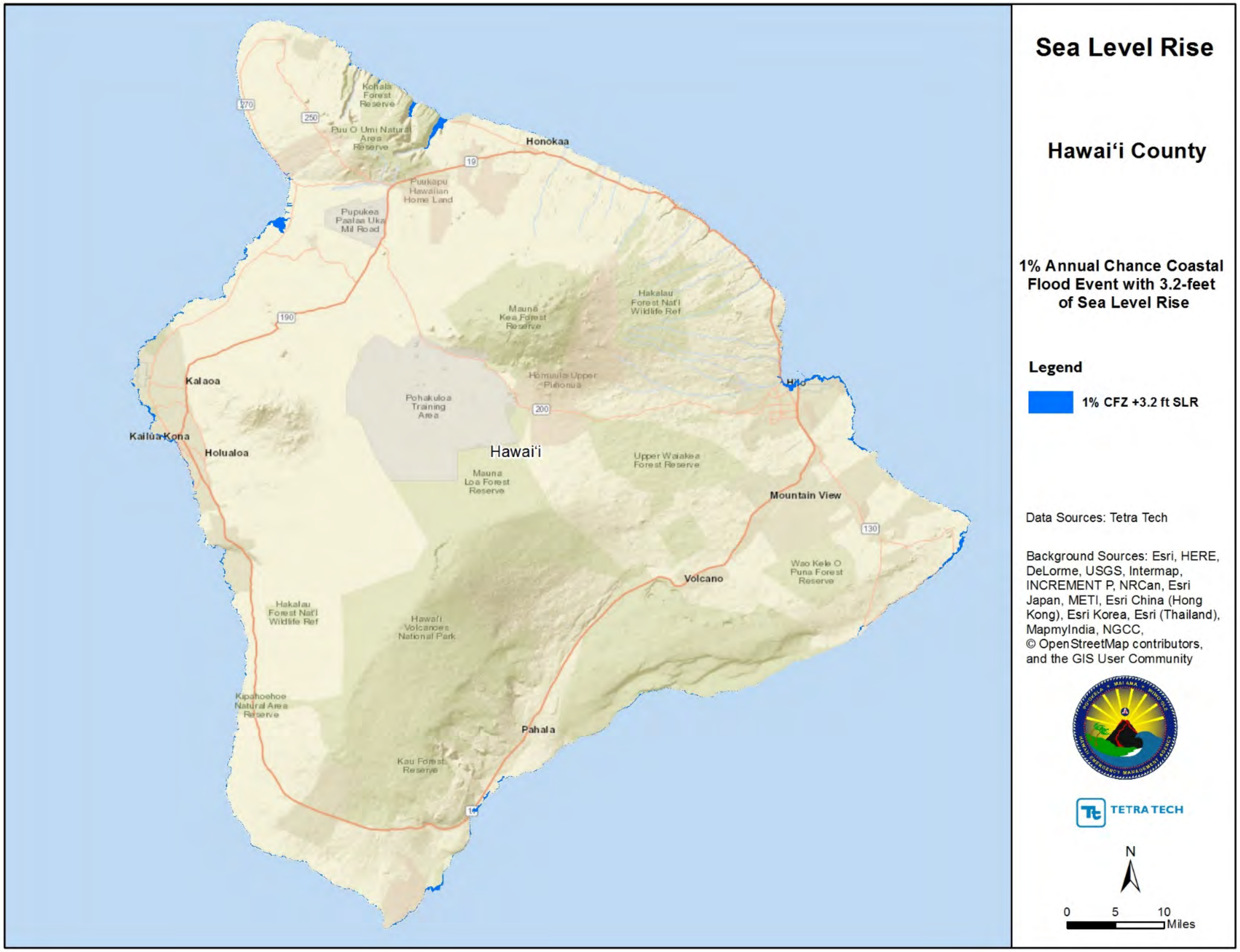


Figure 4.2-10. 1% Annual Chance Coastal Flood Event with 3.2-feet of Sea Level Rise(1%CFZ-3.2) for the County of Hawaiʻi



EXTENT

Climate Change

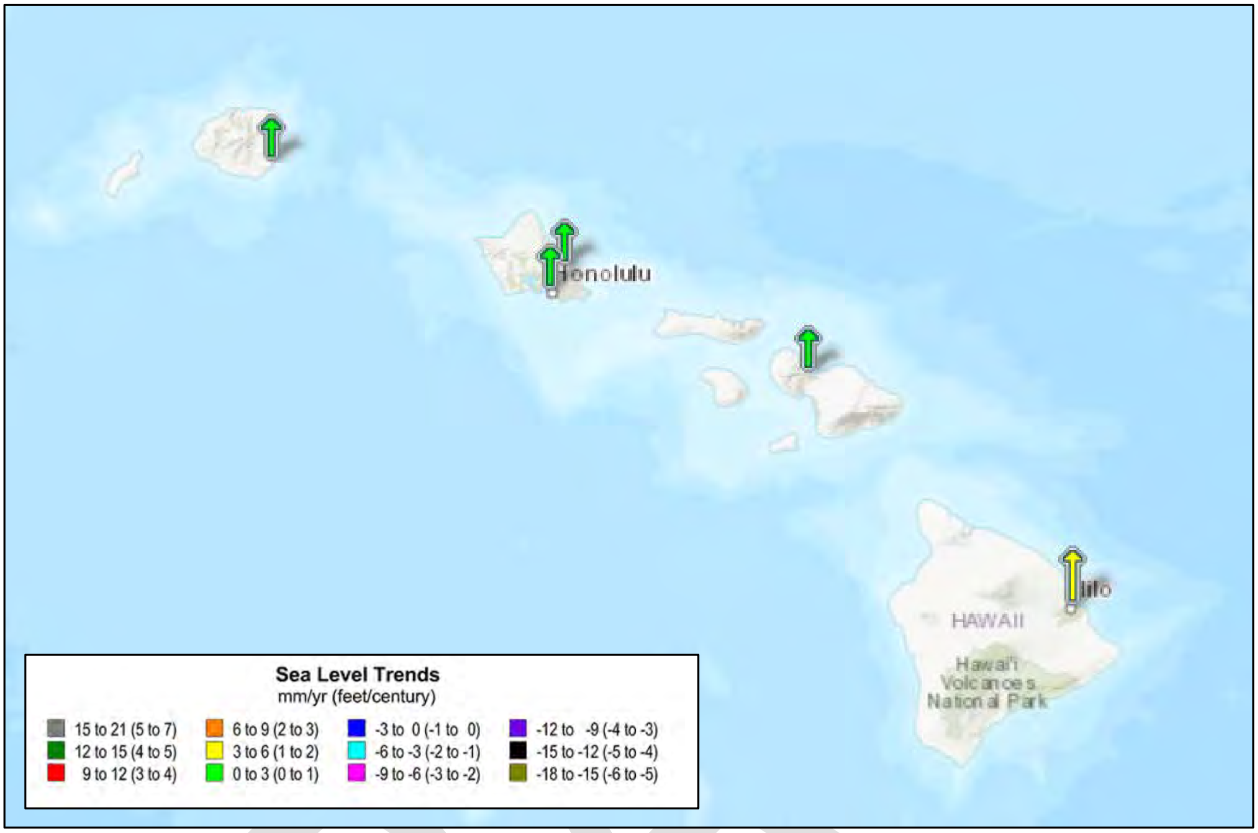
Increasing temperatures, and in some areas reduced rainfall, will stress native plants and animals, especially in high-elevation ecosystems with increasing exposure to invasive species, increasing the risk of extinctions (Leong et al 2014). Freshwater supplies are already constrained and will become more limited on many Hawaiian Islands (Leong et al 2014). Saltwater intrusion associated with sea level rise will reduce the quantity and quality of freshwater in coastal aquifers, especially on low islands. In areas where precipitation does not increase, freshwater supplies will be adversely affected as the air temperature rises.

Sea Level Rise

Rising sea levels, coupled with high water levels caused by storms, will incrementally increase coastal flooding and erosion, damaging coastal ecosystems, infrastructure, and agriculture, and negatively affecting tourism (Leong et al 2014). Global average sea levels are expected to continue to rise—by at least several inches in the next 15 years and by 1 to 4 feet by 2100. A rise of as much as 8 feet by 2100 cannot be ruled out (Wuebbles et al. 2017).

Sea level is measured by two main methods: tide gauges and satellite laser altimeters. Tide gauge stations from around the world have measured the daily high and low tides for over a century. Using data from these stations, scientists can calculate a global average of change. Since the early 1990s, the sea level has been measured from space using laser altimeters. This method determines the height of the sea surface by measuring the return speed and intensity of a laser pulse directed at the ocean. The higher the sea level, the faster and stronger the return signal (Lindsey 2017). Figure 4.2-10 illustrates the regional trends in sea level rise for the State of Hawaiʻi. The arrows represent the direction and magnitude of change. Sea level trends in the State of Hawaiʻi are on the rise and range between 0 millimeters per year (mm/yr) to 6 mm/yr. Table 4.2-2 discusses these changes for the State of Hawaiʻi.

Figure 4.2-11. Sea Level Trends in the State of Hawaiʻi



Source: NOAA 2018
Notes: mm/year millimeter per year
NOAA National Oceanic and Atmospheric Administration

Table 4.2-2. Linear Mean Sea Level Trends and 95% Confidence Intervals

Station Name	First Year	Year Range	MSL Trend (mm/year)	+/- 95% Confidence Interval	Equivalent To
Nāwiliwili	1955	61	1.52	0.44	0.50 feet in 100 years
Mokuoloʻe	1957	59	1.26	0.52	0.14 feet in 100 years
Honolulu	1905	111	1.44	0.21	0.47 feet in 100 years
Kahului	1947	69	2.1	0.41	0.69 feet in 100 years
Hilo	1927	89	30.1	0.3	0.99 feet in 100 years

Source: NOAA 2018
Notes mm/year millimeter per year
MSL Mean Sea Level

Previous Occurrences and Losses

The sea level has been rising in the State of Hawaiʻi for the past century or more (refer to Figure 4.1-3). Rates of rise vary amongst the islands due to differing rates of subsidence based on distance from actively-growing Island of Hawaiʻi. Rates of sea level rise in the State of Hawaiʻi ranged from 0.6 inches on the Islands of Oʻahu and Kauaʻi, to 1.3 inches on the Island of Hawaiʻi per decade over the last century. Other observations related to climate change and sea level rise in the State of Hawaiʻi include 70% of the beaches in the State of Hawaiʻi have eroded and over 13 miles of beach have been completely lost to erosion over the past century. This dominant trend of beach erosion could be driven by local sea level rise. Additionally, shoreline retreat, averaging one-foot per year statewide, wetland migration, and cliff collapse due to erosion are occurring now on many of the coastlines in the State of Hawaiʻi. Elevated groundwater tables, due in part to sea level rise, are contributing to chronic coastal flooding and flooding from heavy rainfall events (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Probability of Future Hazard Events

The State of Hawaiʻi is currently experiencing the impacts of climate change: surface temperatures are rising, rainfall and stream flow have decreased, rain intensity is increasing, sea level and sea surface temperatures have increased and the ocean is acidifying. It is anticipated that these trends will continue causing further increases in temperature, extreme variation in precipitation (resulting in droughts or flooding), potential changes in storm systems (possibly more frequent or increased magnitude), and continued rise in sea levels, impacting the State of Hawaii's water resources and forests, coastal communities, and marine ecology (Fletcher 2010).

As global temperatures continue to increase, sea level will also continue to rise. The rate of future carbon dioxide emissions and future climate change determines how much the sea level will rise. The speed at which it rises depends mostly on the rate of glacier and ice sheet melting (Lindsey 2017). The sea level is projected to rise 3.2 feet by year 2060 and impacts are assessed further in the Vulnerability Assessment below (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). In summary consequences of sea level rise for the State of Hawaiʻi are severe compared to many other coastal states, as the majority of the population, public infrastructure, and economic sectors exist on low-lying coastal plains which are highly susceptible to coastal hazards (State of Hawaiʻi 2018).

The impacts of El Niño may exacerbate the consequences of sea level rise. El Niño events in the tropical Pacific Ocean can cause sea levels to rise 6 to 12 inches above mean conditions in some areas (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

4.2.2 Vulnerability Assessment

A statewide sea level rise exposure analysis was conducted for two flood scenarios, chronic coastal flooding and event-based coastal flooding with 3.2-feet of sea level rise. The data used was generated for the Hawaiʻi Climate Mitigation and Adaptation Commission. Overall, vulnerability to SLR-3.2 is the potential permanent loss of assets and displacement of population located in the SLR-XA-3.2 hazard area. Land that is flooded in the 1%CFZ-3.2 is not considered 'lost', because it is assumed the flooding is temporary and the floodwaters

Sea Level Rise Hazard Area Definitions

SLR-XA-3.2 – *To assess chronic coastal flood with mid- to late century sea level rise, the SLR-XA with 3.2 feet of sea level rise was used. The hazard area is called SLR-XA-3.2.*

1%CFZ-3.2 *–To assess the 1% annual chance coastal flood in mid- to late century, the 1% annual chance coastal flood (V-zones only) with 3.2 feet of sea level rise was used. The hazard area is called 1%CFZ-3.2.*

would recede. However, buildings and natural resources on that land may be damaged or destroyed as a result the event. Therefore, vulnerability to the 1%CFZ-3.2 is the potential damage to assets as a result of the event-based coastal flooding exacerbated by sea level rise.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the climate change and sea level rise hazards.

State Assets

Across the State, there are 55 state buildings that may be compromised or lost due to sea level rise (SLR-XA-3.2). Almost all of these buildings are located in the City and County of Honolulu (52 of the 55 buildings with a replacement cost value of $55 million). Only replacement cost value was available for state buildings and reported as the total economic loss. However, a more accurate reflection of loss to the SLR-XA-3.2 hazard would be the combined value of the land and structure.

Table 4.2-3 summarizes the state buildings located in the SLR-XA-3.2 by county. The Department of Education has the greatest number of buildings (37) in the SLR-XA-3.2 hazard area as seen in Table 4.2-4. The loss of these structures may result in the interruption and/or relocation of state services if they remain in their present locations. Appendix X summarizes the state buildings by state agency.

Table 4.2-3. Estimated State Building Loss from Sea Level Rise (SLR-XA-3.2) by County

County	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value of State Buildings in SLR-XA-3.2	Percent (%) of Total Value
County of Kaua'i	531	$957,679,537	1	0.2%	$219,408	0.02%
City and County of Honolulu	3,472	$16,750,785,426	52	1.5%	$55,249,138	0.3%
County of Maui	831	$2,862,316,819	2	0.2%	$370,372	0.01%
County of Hawai'i	1,261	$4,209,774,236	0	0.0%	$0	0.0%
Total	**6,095**	**$24,780,556,017**	**55**	**0.90%**	**$55,838,918**	**0.23%**

Source: Hawai'i State Risk Management Office 2017; 2017 Hawai'i Sea Level Rise Vulnerability and Adaptation Report
Notes: Value Replacement Cost Value of state building; this does not include land value and may be underestimating the total loss.

Table 4.2-4. Estimated State Building Loss from Sea Level Rise (SLR-XA-3.2) by Agency

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value in SLR-XA-3.2	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	0	0.0%	$0	0.0%
Dept of Agriculture	70	$133,065,375	1	1.4%	$2,040,456	1.5%
Dept of Attorney General	15	$95,151,863	0	0.0%	$0	0.0%
Dept of Budget & Finance	16	$26,624,294	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value in SLR-XA-3.2	Percent (%) of Total Value
Dept of Business, Economic Development and Tourism	25	$612,574,032	1	4.0%	$2,300,000	0.4%
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.0%	$0	0.0%
Dept of Defense	69	$246,099,477	0	0.0%	$0	0.0%
Dept of Education	4,090	$9,604,111,443	37	0.9%	$16,732,208	0.2%
Dept of Hawaiian Home Lands	12	$100,471,477	1	8.3%	$4,748,597	4.7%
Dept of Health	44	$387,068,440	0	0.0%	$0	0.0%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%
Dept of Human Services	130	$420,004,555	2	1.5%	$2,839,820	0.7%
Dept of Labor and Industrial Relations	22	$79,322,626	0	0.0%	$0	0.0%
Dept of Land and Natural Resources	90	$98,666,185	8	8.9%	$1,195,202	1.2%
Dept of Public Safety	154	$427,884,909	0	0.0%	$0	0.0%
Dept of Taxation	1	$6,864,408	0	0.0%	$0	0.0%
Dept of Transportation	68	$2,912,510,888	1	1.5%	$3,368,912	0.1%
Hawai‘i State Ethics Commission	1	$891,212	0	0.0%	$0	0.0%
Hawai‘i Health Systems Corporation	106	$1,223,962,810	0	0.0%	$0	0.0%
Hawai‘i Housing Finance & Development Corporation	86	$333,526,064	0	0.0%	$0	0.0%
Hawai‘i Public Housing Authority	273	$933,255,767	1	0.4%	$5,340,000	0.6%
Hawai‘i State Legislature	2	$43,024,855	0	0.0%	$0	0.0%
Hawai‘i State Public Library System	53	$525,584,082	0	0.0%	$0	0.0%
Judiciary	41	$511,093,204	0	0.0%	$0	0.0%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	1	9.1%	$219,408	0.4%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-3.2	Percent (%) of Total Buildings	Total Value in SLR-XA-3.2	Percent (%) of Total Value
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawaiʻi	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawaiʻi	637	$5,000,692,783	2	0.3%	$17,054,314	0.3%
Total	**6,095**	**$24,780,556,017**	**55**	**0.9%**	**$55,838,918**	**0.2%**

Source: Hawaiʻi State Risk Management Office 2017; 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report
Note: Dept Department
Value Replacement Cost Value of state building; this does not include land value and may be underestimating the total loss.

Event-based coastal flooding from waves generated by infrequent but severe storms and other coastal hazards could occur at any time but will be exacerbated by sea level rise. There are 642 state buildings located in the 1%CFZ-3.2 area; of which the majority are in the City and County of Honolulu (454 buildings with a replacement cost value of $1.745 billion). Table 4.2-5 summarizes the state buildings located in the 1%CFZ-3.2 area by county. The Department of Education occupies the greatest number of buildings (392) that may be impacted as seen in Table 4.2-6.

Table 4.2-5. State Buildings Located in the 1%CFZ-3.2 by County

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings Exposed	Percent (%) of Total Buildings	Total RCV Exposed	Percent (%) of Total RCV
County of Kauaʻi	531	$957,679,537	112	21%	$190,039,468	20%
City and County of Honolulu	3,472	$16,750,785,426	454	13%	$1,745,537,900	10%
County of Maui	831	$2,862,316,819	50	6%	$156,360,444	5%
County of Hawaiʻi	1,261	$4,209,774,236	26	2%	$107,083,808	3%
Total	**6,095**	**$24,780,556,017**	**642**	**11%**	**$2,199,021,620**	**9%**

Source: Hawaiʻi State Risk Management Office 2017; 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report
Notes: RCV Replacement Cost Value

Table 4.2-6. State Buildings Located in the 1%CFZ-3.2 by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings Exposed	Percent (%) of Total Buildings	Total RCV Exposed	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	9	13.6%	$80,340,824	8.5%
Dept of Agriculture	70	$133,065,375	13	18.6%	$24,524,445	18.4%
Dept of Attorney General	15	$95,151,863	4	26.7%	$27,412,721	28.8%
Dept of Budget & Finance	16	$26,624,294	4	25.00%	$20,193,447	75.9%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings Exposed	Percent (%) of Total Buildings	Total RCV Exposed	Percent (%) of Total Value
Dept of Business, Economic Development and Tourism	25	$612,574,032	4	16.0%	$15,583,469	2.5%
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.0%	$0	0.0%
Dept of Defense	69	$246,099,477	9	13.0%	$26,767,373	10.9%
Dept of Education	4,090	$9,604,111,443	392	9.6%	$808,930,258	8.4%
Dept of Hawaiian Home Lands	12	$100,471,477	1	8.3%	$4,748,597	4.7%
Dept of Health	44	$387,068,440	5	11.4%	$9,525,587	2.5%
Dept of Human Resources Development	1	$5,523,320	0	0.00%	$0	0.0%
Dept of Human Services	130	$420,004,555	30	23.1%	$155,178,145	36.9%
Dept of Labor and Industrial Relations	22	$79,322,626	4	18.2%	$4,677,116	5.9%
Dept of Land and Natural Resources	90	$98,666,185	32	35.6%	$15,104,751	15.3%
Dept of Public Safety	154	$427,884,909	15	9.7%	$32,889,853	7.7%
Dept of Taxation	1	$6,864,408	0	0.0%	$0	0.0%
Dept of Transportation	68	$2,912,510,888	39	57.4%	$234,861,971	8.0%
Hawaiʻi State Ethics Commission	1	$891,212	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	1	0.9%	$829,553	0.07%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	5	5.8%	$118,247,972	35.5%
Hawaiʻi Public Housing Authority	273	$933,255,767	34	12.5%	$35,788,719	3.8%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%
Hawaiʻi State Public Library System	53	$525,584,082	11	20.8%	$25,026,076	4.8%
Judiciary	41	$511,093,204	5	12.2%	$72,969,084	14.3%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	6	54.6%	$42,915,963	79.5%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawaiʻi	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawaiʻi	637	$5,000,692,783	19	3.0%	$442,505,696	8.9%
Total	**6,095**	**$24,780,556,017**	**642**	**10.5%**	**$2,199,021,620**	**8.9%**

Source: Hawaiʻi State Risk Management Office 2017; 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report
Note: Dept Department
RCV Replacement Cost Value

Approximately 39.2 miles of State roads could be chronically flooded with 3.2 feet of sea level rise; with the majority of these roads located in the City and County of Honolulu (19.7 miles). The flooding may cause these roads to be impassible which would jeopardize critical access to many communities, and eventually lead to permanent road closures.

Statewide, there is greater than 100 miles of State roads exposed to event-based coastal flooding in the 1%CFZ-3.2 hazard area. Many state roads serve as evacuation routes to higher ground. Not only will these roads be closed during coastal flood events and potentially isolating communities, the flood waters may accelerate the degradation of these roads leading to increased repair and replacement costs. The City and County of Honolulu has the greatest number of State road miles (51.3 miles) exposed to the 1%CFZ-3.2, followed by the Counties of Kauaʻi and Maui, respectively. Greater than 25% of the County of Kauai's State roads are located in the 1%CFZ-3.2 hazard area. Table 4.2-7 shows the length of State roads exposed to sea level rise by county. A complete list of State roads exposed is included in Appendix X.

Table 4.2-7. State Roads Located in the Sea Level Rise Hazard Areas by County

County	Total Length (miles)	Miles of State Road in the SLR-XA-3.2	Percent (%) of Total Length	Miles of State Road in the 1%CFZ-3.2	Percent (%) of Total Length
County of Kauaʻi	104.0	7.4	7.1%	27.0	25.9%
City and County of Honolulu	375.3	19.7	5.2%	51.3	13.7%
County of Maui	238.6	12.0	5.0%	20.1	8.4%
County of Hawaiʻi	378.7	0.2	0.1%	2.8	0.7%
Total	**1,096.5**	**39.2**	**3.6%**	**101.1**	**9.2%**

Source: State of Hawaiʻi DOT State Routes GIS layer 2017; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017
Notes:
1%CFZ 1% Annual Chance Coastal Flood Zone
GIS Geographic Information System
DOT Department of Transportation
SLR-XA-3.2 Sea Level Rise Exposure Area with 3.2 feet of sea level rise.
1%CFZ-3.2 1% Annual Chance Coastal Flood with 3.2 feet of sea level rise (V-zones only)

Critical Facilities

Sea level rise may result in the permanent loss of critical facilities including roads, airports, harbors, utility infrastructure, water/wastewater facilities and conveyance systems and other public service facilities with cascading impacts statewide. There are 33 critical facilities located in the SLR-XA-3.2 hazard area (see Table 4.2-8). The County of Maui has the greatest number of critical facilities (14) exposed with the majority of the facilities being water, waste, and wastewater systems. Table 4.2-9 summarizes the number and percentage of exposed critical facilities by core category. Water, waste, and wastewater systems have nearly 5% of their facilities located the SLR-XA-3.2 hazard area statewide. It is recognized that replacement cost value listed in Table 4.2-9 does not depict an accurate loss estimate; however, this was the best available data for the 2018 HMP Update. A more accurate reflection of loss to the SLR-XA-3.2 would be the combined value of the land and structure using tax-assessed data. In addition to land and structural loss, the loss of service by that critical facility would further increase the total loss as a result of sea level rise.

Table 4.2-10 summarizes the total number of critical facilities by core category located in the 1%CFZ-3.2 area by county. The City and County of Honolulu has the greatest number of critical facilities (121) within the hazard area with the majority of the facilities being water, waste, and wastewater systems. Table 4.2-11 summaries the number and percentage of exposed critical facilities by core category. Transportation services have 12.5% of their facilities within the hazard area.

Table 4.2-8. Critical Facilities Located in the SLR-XA-3.2 by County

County	Core Category of Critical Facilities										
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	Total in the SLR-XA-3.2
County of Kauaʻi	0	0	3	0	0	1	0	0	0	2	6
City and County of Honolulu	0	0	2	1	0	1	2	0	0	6	13
County of Maui	0	0	2	1	0	1	0	0	2	7	14
County of Hawaiʻi	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**0**	**7**	**2**	**0**	**3**	**2**	**0**	**2**	**15**	**33**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017

Table 4.2-9. Critical Facilities Located in the SLR-XA-3.2 by Core Category

Core Category	Total Number of Critical Facilities	Total Value	Number of Critical Facilities in SLR-XA-3.2	Percent (%) of Total Facilities	Value in the SLR-XA-3.2	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	0	0.0%	$0	0.0%
Communications	130	$523,848,060	0	0.0%	$10,739,055	2.1%
Emergency Services	149	$1,017,628,710	7	4.7%	$53,490,530	5.3%
Energy	90	$2,591,975,628	2	2.2%	$63,264,080	2.4%
Food & Agriculture	39	$829,869,410	0	0.0%	$0	0.0%
Government Facilities	100	$399,781,575	3	3.0%	$11,718,135	2.9%
Healthcare & Public Health	193	$3,399,521,375	2	1.0%	$8,734,005	0.3%
Mass Care Support Services	353	$11,497,547,155	0	0.0%	$0	0.0%
Transportation Services	56	$1,739,256,960	2	3.6%	$61,916,160	3.6%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	15	4.9%	$465,972,480	4.9%
Total	**1,475**	**$31,687,768,838**	**33**	**2.2%**	**$675,834,445**	**2.1%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017
Value Replacement Cost Value of state building; this does not include land value and may be underestimating the total loss.

Table 4.2-10. Critical Facilities Located in the 1%CFZ-3.2 by County

County	Core Category of Critical Facilities										Total in the 1%CFZ-3.2
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	1	1	6	3	2	2	1	7	2	11	36
City and County of Honolulu	7	20	11	19	1	9	5	9	1	39	121
County of Maui	0	3	4	0	0	4	4	3	8	17	43
County of Hawaiʻi	1	1	0	2	6	1	0	2	5	11	29
Total	**9**	**25**	**21**	**24**	**9**	**16**	**10**	**21**	**16**	**78**	**229**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017

Table 4.2-11. Critical Facilities Located in the 1%CFZ-3.2 by Core Category

Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in 1%CFZ-3.2	Percent (%) of Total Facilities	Value in the 1%CFZ-3.2	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	9	15.0%	$22,504,941	10.9%
Communications	130	$523,848,060	25	19.2%	$65,306,105	12.5%
Emergency Services	149	$1,017,628,710	21	14.1%	$104,301,910	10.3%
Energy	90	$2,591,975,628	24	26.7%	$693,960,408	26.8%
Food & Agriculture	39	$829,869,410	9	23.1%	$113,819,680	13.7%
Government Facilities	100	$399,781,575	16	16.0%	$62,863,955	15.7%
Healthcare & Public Health	193	$3,399,521,375	10	5.2%	$112,373,350	3.3%
Mass Care Support Services	353	$11,497,547,155	21	5.9%	$365,143,365	3.2%
Transportation Services	56	$1,739,256,960	16	28.6%	$496,129,920	28.5%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	78	25.6%	$2,430,743,040	25.6%
Total	**1,475**	**$31,687,768,838**	**229**	**15.5%**	**$4,467,146,674**	**14.1%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017

Critical transportation hubs and critical infrastructure located on the coast are exposed to the sea level rise hazard. The primary transportation arteries for the entry of people and goods to the State is the Daniel K. Inouye International Airport and Honolulu Harbor. The International Airport serves more than 19 million passengers and receives more than 228,000 tons of cargo annually. More than 14.6 million tons of commodities and an estimated 400,000 cruise ship passenger sailing pass through Honolulu Harbor each year. In addition, each island has critical points of entry for people and goods which are considered vulnerable to sea level rise if located along the coast.

Interruption of interisland and transoceanic shipping and travel would impact residents, visitors and all forms of economic activity (Hawaiʻi Climate Mitigation and Adaptation Commission 2017).

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, environmental assets and cultural resources by county. Similar to the analysis for state assets, a spatial exposure analysis was conducted. As noted above, vulnerability to SLR-3.2 is the potential permanent loss of assets and displacement of population located in the SLR-XA-3.2 hazard area. Vulnerability to the 1%CFZ-3.2 is the potential damage to assets as a result of event-based coastal flooding exacerbated by sea level rise.

Population

Climate Change

As the climate changes in the State of Hawaiʻi, residents will face natural hazard threats just as plants and animals will be impacted. With increased temperatures, vulnerable populations could face increased vulnerability to extreme heat and its associated illnesses such as heatstroke and cardiovascular and kidney disease. The State of Hawaiʻi may also see an increase in levels of vector-borne diseases, water-borne diseases such as cholera, fish poisoning, heat-related illnesses, mental health problems, respiratory diseases and other non-communicable diseases, and injury and death from tropical storms and cyclones. Inundation and flooding has led to contamination of surface water and groundwater. Polluted runoff associated with excessive stormwater can contain sewage from overflowing manholes or chemicals from commercial and industrial facilities and has already caused the closure of the beaches around the State of Hawaiʻi annually (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Additionally, climate change can threaten food and water security, infrastructure, and public health and safety. All of which is expected to increase human migration from low to high elevation islands and continental sites. This will make it increasingly difficult for residents to sustain the many unique customs, beliefs, and languages of the Pacific Islanders (National Climate Assessment 2014).

Sea Level Rise

People living and working in the SLR-XA-3.2 hazard area may be displaced as homes and businesses become flooded and permanently lost. According to the 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*, statewide, the loss of structures in this area may result in nearly 20,000 displaced residents, both homeowners and renters, in need of new homes statewide (Table 4.2-12). The greatest number of people that may be displaced by mid- to late century are located in the City and County of Honolulu (13,300 people). The people displaced would include a range of incomes and living situations.

Table 4.2-12. Estimated Population Displaced by Sea Level Rise (SLR-XA-3.2) by County

County	Total Population	Displaced Population	Percent (%) of Total Population
County of Kauaʻi	67,091	3,370	1.5%
City and County of Honolulu	953,207	13,300	<1%
County of Maui	154,924	2,160	<1%
County of Hawaiʻi	185,079	1,000	<1%
Total	**1,360,301**	**19,830**	**<1%**

Source: Hawaiʻi Climate Mitigation and Adaptation Commission 2017

Over 145,000 residents are vulnerable to temporary flooding from the 1%CFZ-3.2 if a severe coastal flood event impacts the entire state (Table 4.2-13). This represents the added risk of event-based coastal flooding from severe waves resulting from hurricanes and tropical cyclones that poses a potential for loss of human life and property and for severe and long-term economic disruption.

Table 4.2-13. 2010 U.S. Census Population Located in the 1%CFZ-3.2 by County

County	Population						
	Total Population	Population in 1%CFZ-3.2	Population Exposed as Percent (%) of Total	Population Over 65 in 1%CFZ-3.2	Population Over 65 Exposed as Percent (%) of Total	Population with Income <$30K/yr in 1%CFZ-3.2	Population with Income <$30K/year as Percent (%) of Total
County of Kauaʻi	67,091	10,710	16.0%	1,634	2.4%	3,702	5.5%
City and County of Honolulu	953,207	126,460	13.3%	18,105	1.9%	39,480	4.1%
County of Maui	154,924	6,373	4.1%	904	0.6%	1,680	1.1%
County of Hawaiʻi	185,079	2,405	1.3%	469	0.3%	1,482	0.8%
Total	**1,360,301**	**145,948**	**10.7%**	**21,112**	**1.6%**	**46,344**	**3.4%**

Source: U.S. Census 2010; Draft Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017
*The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaii. To convert households to residents, three people per househo*ld was used.

Land Use Districts

Table 4.2-14 shows the number of square miles and percent of total acres in each State Land Use District statewide; refer to Appendix X for results by County. Statewide, 35 square miles of land are exposed to 3.2 feet of sea level rise. Conservation Districts lands, which contain valuable environmental resources, have the most area exposed, statewide; however, the exposure accounts for less than 1% of the total Conservation District land in the State. Additional discussion of exposure and vulnerability of environmental resource areas can be found in the Environmental Resources section below. Urban District lands have the second highest area exposed accounting for 3.7% of total Urban District land in the State. This is significant as development in these areas would need to be adapted in place to chronic flood conditions or moved elsewhere, which may result in encroachment or conversion of agricultural or conservation district lands. The City and County of Honolulu has the greatest number of square miles of land in the SLR-XA-3.2 of any County and almost 60% of this area is in low lying Urban Districts, which are highly developed.

The 1%CFZ will expand with sea level rise meaning that more land area will be exposed to damaging wave impacts from a 1% Annual Chance Flood event. This is of particular concern for Urban Districts, which have the greatest share of developed land. With 3.2 feet of sea level rise, more than 13% of the State's Urban Districts are projected to be exposed to wave heights of more than 3 feet from a 1% Annual Chance Storm. It should be noted that this does not include exposure to wave heights of between 1.5 feet and 3 feet, which can also include significant structural damage.

Table 4.2-14. State Land Use Districts within the Sea Level Rise Hazard Areas

Land Use District	Total (square miles)	Square miles in SLR-XA-3.2	Percent (%) of Total Area	Square miles in 1%CFZ-3.2	Percent (%) of Total Area
Agricultural	2,942.8	9.0	0.3%	36.0	1.2%
Conservation	3,156.3	13.3	0.4%	29.8	0.9%
Rural	16.1	0.6	3.7%	2.2	13.3%
Urban	319.7	11.8	3.7%	42.0	13.2%
Total	**6,434.9**	**35.0**	**0.5%**	**110.0**	**1.7%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal, 2017
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
Notes: 1%CFZ-3.2 1% Annual Chance Coastal Flood Zone with 3.2 Feet of Sea Level Rise
GIS Geographic Information System
SLR Sea Level Rise
SLR-XA-3.2 Sea Level Rise Exposure Area with 3.2 Feet of Sea Level Rise

General Building Stock

To further assess what is at risk, each County's general building stock's exposure was examined. Table 4.2-15 summarizes buildings that may be permanently lost due to sea level rise. These vulnerable structures include residential structures, hotels and businesses. Due to the high concentration of development along the coast, the City and County of Honolulu has the greatest potential economic loss of the Counties.

To more fully understand the potential economic loss to 3.2 feet of sea level rise, both the value of the land and structure must be considered. According to the 2017 *Hawaii Sea Level Rise Vulnerability and Adaptation Report*, the value of projected flooded structures, combined with the land value projected to be flooded, amounts to over $19 billion across the State. The economic loss due to chronic flooding of roads, utilities and other public infrastructure was not analyzed, but will likely amount to a far greater loss. Utilities, such as water, wastewater and electrical systems, often run parallel underneath roadways, making lost road mileage a good indication of extent of lost utilities. This chronically flooded infrastructure would have significant impacts on local communities as well as reverberating effects around each island through loss of commerce, loss of access to emergency services, and increased traffic on other roads and highways. Repair and relocation of vulnerable roadways are already costly efforts for the State and Counties, which will only worsen as the sea level rises. Harbors and airports, often located in low-lying coastal areas in the State, face chronic flooding. For this reason, the economic loss due to flooded critical infrastructure is expected to be an order of magnitude greater than the potential economic loss from land and structures. Refer to the 2017 *Hawaii Sea Level Rise Vulnerability and Adaptation Report* for more detailed discussion on vulnerable areas by island.

Damages to buildings as a result of a 1% annual chance coastal flood event may also displace people from their homes, threaten life safety and impact a community's economy and tax base. Table 4.2-15 lists the estimated cost to repair or replace flooded structures and their contents in the 1%CFZ-3.2. Statewide, this would be greater than $125 billion, of which 94% would occur in the City and County of Honolulu. This figure does not include the cost of damage to roads or utilities, which would be considerable. Areas with the highest potential economic loss resulting from a flood event are low-lying urban areas.

Table 4.2-15. Estimated Potential Structure and Property Value (Structure and Land) Loss from Sea Level Rise (SLR-XA-3.2)

County	Number of Structures	Estimated Structure and Land Value Loss
County of Kauaʻi	940	$2,600,000,000
City and County of Honolulu	3,800	$12,900,000,000
County of Maui	1,553	$3,490,000,000
County of Hawaiʻi	130	$430,000,000
Total	**6,423**	**$19,420,000,000**

Source: *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017*

Table 4.2-16. Estimated General Building Stock Loss (Structure and Contents) to the 1%CFZ-3.2

County	Number of Structures Impacted	Potential Damages
County of Kauaʻi	5,360	$5,700,000,000
City and County of Honolulu	17,700	$120,000,000,000
County of Maui	2,830	$7,880,000
County of Hawaiʻi	470	$110,000,000
Total	**26,360**	**$125,817,880,000**

Source: *Draft 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*
Notes: 1% CFZ 1% Annual Chance Coastal Flood Zone
GIS Geographic Information System

Environmental Resources

The observed and projected influences of climate change on global and local ecosystems are diverse and often detrimental. Some of the changes likely to impact the State of Hawaii's ecosystems 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 among others (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Climate Change

Hawaiian ecosystems will be challenged by increasing frequency and severity of climate-related disturbances (for example, storms, flooding, drought, wildfire, invasive species, and ocean acidification) and continued pressure from anthropogenic influences, such as change in land use, pollution, fragmentation of natural systems, and overexploitation of resources. Evidence of many of these climate-related impacts has already been observed in the State of Hawaiʻi (University of Hawaiʻi at Mānoa Sea Grant College Program 2014). The following provides details on how the ecosystems in the State of Hawaiʻi may be impacted by climate change.

- **Open Ocean**—The physical, chemical, and biological characteristics of the ocean are shifting around the State of Hawaiʻi under the influence of climate change. The ocean is getting warmer and more acidic which has the potential to drive changes in circulation. This could disrupt the timing of feeding and spawning of marine species and reduce primary productivity and fish catches around the Hawaiian Islands. Acidification of the oceans threaten some calcifying plankton, corals, and other species. Ocean warming could also lead to a more favorable environment for pathogens and invasive species, threatening native and endemic species of the State of Hawaiʻi (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

- **Coral Reefs and Nearshore Habitats**—Coral reefs and other nearshore habitats face degradation from both climate change and localized anthropogenic influences, including but not limited to, sedimentation, direct physical impacts, overfishing, nutrient loading from runoff, and erosion. Warmer oceans are leading to increased coral bleaching events and disease outbreaks in coral reefs, as well as changed distribution patterns of tuna fisheries (Leong et al 2014). Hawaiian reefs experienced statewide bleaching events in 2014 and 2015. Ocean acidification can cause a variety of responses in marine organisms, including inhibited development of calcium carbonate shells or skeletons in corals, shellfish, and plankton, and impaired physiological functions of some reef fish. Changing precipitation patterns over the Hawaiian Islands influence the quantities and concentration of stormwater runoff that enters coastal waters. Ocean acidification will reduce coral growth and health. Warming and acidification, combined with existing stresses, will strongly affect coral reef fish communities (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).
- **Coasts and the Built Environment**—The coastline of the State of Hawaiʻi is comprised of a diverse mixture of environments, including sandy carbonate beaches, steep bluffs, densely-developed lowlands, lava benches, marshes and fishponds, many of which are eroding due to natural and anthropogenic causes (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).
- **Terrestrial Ecosystems**—A changing climate can alter the habitats and conditions of endemic Hawaiian species, such as the Hawaiian honeycreeper and the Haleakalā silversword. Warmer temperatures could lead to a shift in the habitat ranges of native plants like the Haleakalā silversword, which is only found at high elevations on Mount Haleakalā and has experienced a decline in population over the last 20 years that is connected to temperature increase. Endemic bird species, such as the Hawaiian honeycreeper, could decline in population due to the warming of high-elevation forests where risk of avian disease transmission was previously low. Ranges for pests, diseases, and invasive species may expand as a result of warming temperatures. The higher elevations in the State of Hawaiʻi are bearing the brunt of impacts and lower elevations are seeing new habitats emerge that previously did not exist in the archipelago (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).
- **Freshwater Resources**—Climate change can lead to a decrease in precipitation, streamflow, and groundwater levels and increase the number of and duration of droughts. All of these factors can impact the water table of the State of Hawaiʻi. Groundwater provides a majority of drinking water in the State of Hawaiʻi and a lower water table will reduce the amount of water available. If drought events continue to increase, dry areas could see more fire and problems with stressed water supplies (University of Hawaiʻi at Mānoa Sea Grant College Program 2014).

Sea Level Rise

The loss of natural and cultural resources statewide resulting from sea level rise is difficult to quantify; however, their loss would deeply cost the State. Sea level rise would take its toll on the State's world-famous beaches, including such iconic stretches of beaches such as Oahu's North Shore "Seven Mile Miracle," the beaches of Kauai's North Shore, and West Maui beaches (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Over the past century, 70% of the beaches in the State have eroded and over 13 miles of beach have been completely lost to erosion. This trend of beach erosion could be driven by local sea level rise. Shoreline retreat, averaging 1 foot per year (0.3 meters/year) statewide, and wetland migration and cliff collapse due to erosion are occurring now on many of the State of Hawaii's coastlines. Sea level rise can increase saltwater intrusion in aquifers and cause the groundwater table to rise, resulting in inundation of low-lying areas and infrastructure (University of Hawai'i at Mānoa Sea Grant College Program 2014).

Sea level rise and coastal inundation will change the coral reefs and nearshore habitats of the State of Hawai'i and may result in a shift or loss of ecosystems. Beach and wetland systems may not be able to adapt to rising sea levels and could be lost if not allowed to migrate landward. The loss of wetlands could reduce the coast's ability to buffer impacts from storms and flooding (University of Hawai'i at Mānoa Sea Grant College Program 2014).

Additionally, sea level rise has the potential to impact facilities that could release wastewater or hazardous materials and waste to nearshore waters and coastal habitats. Septic tanks, cesspools, and other on-site sewage disposal systems (OSDS) as well as other hazard materials/waste storage and disposal sites are located along the coast. The OSDS exposed to chronic flooding in the SLR-XA with 3.2 feet of sea level rise area would not only result in system failures to operate properly but would also degrade nearshore water quality. In the County of Hawai'i, the OSDS are located along many urban and rural shoreline areas, such as along the shoreline of Kapoho. Releases from these OSDS may change disease risk for coral reefs and negatively impacting nearby coral resources, such as those off the coast of Puakō (Hawai'i Climate Change Mitigation and Adaptation Commission 2017).

Environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks and reserves located in the assessed hazard areas are summarized in Table 4.2-16. It is important to note that wetlands and coral reefs provide protection from rising sea levels and damaging wave action (Carey 2018).

Table 4.2-17. Environmental Resources Located in the Sea Level Rise Hazard Areas

Environmental Asset	Total Square Miles of Asset	SLR-XA-3.2 Area	Percent (%) of Total Asset Area	1%CFZ-3.2 Area	Percent (%) of Total Asset Area
Critical Habitat[a]	915.2	1.6	0.2%	2.2	0%
Wetlands	260.0	15.7	6.1%	31.1	12%
Parks and Reserves	2,607.7	7.2	0.3%	17.7	1%
Total[b]	**3,837.6**	**79.3**	**2.1%**	**105.7**	**2.8%**

Source: State of Hawai'i GIS layers, State of Hawai'i GIS Program Geospatial Data Portal
Notes: 1% CFZ 1% Annual Chance Coastal Flood Zone
GIS Geographic Information System
SLR Sea Level Rise
SLR-XA Sea Level Rise Exposure Area
a. Critical habitat area mileage includes the combined area of coverage of individual critical habitat areas
b. Total square miles may be over reported as some environmental asset areas may overlap.
Reefs were excluded from the analysis because they are under water and thus 100% exposed to a flood hazard.

Cultural Assets

Many Native Hawaiian cultural resources would be impacted by sea level rise as well due to the number of cultural sites located within the SLR-XA-3.2. Cultural practices including fishing, gathering, and other cultural practices that require shoreline access would be impacted (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). Table 4.2-17 summarizes the Hawaiian Home Lands square miles vulnerable to sea level rise and exacerbated impacts from coastal event-based flood events due to sea level rise.

Table 4.2-18. Hawaiian Home Lands Vulnerable to Sea Level Rise

County	Area (in square miles)				
	Total Area	SLR-XA-3.2 Hazard Area	Hazard Area as Percent (%) of Total Area	1%CFZ-3.2 Hazard Area	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	32.0	0.1	0.5%	0.7	2.1%
City and County of Honolulu	10.9	0.1	0.6%	0.2	1.8%
County of Maui County	92.6	0.8	0.8%	1.8	1.9%
County of Hawaiʻi	190.3	0.1	0.1%	1.1	0.6%
Total	**325.8**	**1**	**0.3%**	**4**	**1.2%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal

Notes: 1%-CFZ-3.2 1% Annual Chance Coastal Flood Zone with 3.2 Feet of Sea Level Rise
GIS Geographic Information System
SLR Sea Level Rise
SLR-XA-3.2 Sea Level Rise Exposure Area with 3.2 Feet of Sea Level Rise

FUTURE CHANGES THAT MAY IMPACT STATE VULNERABILITY

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate.

Climate Change

Climate change, itself, is a factor of change that is already influencing vulnerability to many of the other hazards of concern. Impacts of climate change on both the probability of future events and their resulting impacts are discussed in the hazard profile and vulnerability assessment sections of each hazard of concern in the 2018 HMP Update. The extent to which climate change will be a factor of change in vulnerability for the State is yet to be determined. Two major factors will influence its impacts including whether or not global, human-caused greenhouse gas emissions will be reduced enough to avoid catastrophic impacts to the climate system and the extent to which feedback loops that are already occurring and little understood will exacerbate conditions.

Sea Level Rise

Sea level rise areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.2- below; refer to Section 3 for more information on projected development areas). The results of this assessment indicate that only small portions of these areas are likely to be lost to chronic flooding from 3.2 feet of sea level rise; however, substantial portions of these areas are located in areas that will be exposed to wave action during a 1% Annual Chance Flood event with 3.2 feet of sea level rise. In the City and County of Honolulu, 18.6% of the Hawaii Community Development Authority District Area and 8.1% of the Enterprise Zones would be exposed to these damaging waves. In the County of Kauai, 9.9% of the Enterprise Zone's total area is exposed. As development is considered in these areas, care should be taken to avoid further developing land that will be lost to sea level rise, to integrate appropriate flood mitigation into development in areas that are currently outside of flood zones or not currently exposed to wave action, and to allow enough room for the migration of coastal resources inland as the shoreline moves landward.

Table 4.2-19. HCDA Community Development Districts, Enterprise Zones, and Maui Development Projects Within Sea Level Rise Hazard Areas

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
SLR-XA-3.2 Hazard Area									
County of Kauaʻi	-	-	-	-	-	-	252.3	6.4	2.5%
City and County of Honolulu	7.4	0.4	5.0%	-	-	-	288.3	6.0	2.1%
County of Maui	-	-	-	27.6	0.1	0.2%	1,016.7	8.2	0.8%
County of Hawaiʻi	-	-	-	-	-	-	1,286.6	3.2	0.3%
Total	**7.4**	**4**	**5.0%**	**27.6**	**0.1**	**0.2%**	**2,844**	**24**	**0.8%**
1%CFZ-3.2 Hazard Area									
County of Kauaʻi	-	-	-	-	-	-	252.3	25.1	9.9%
City and County of Honolulu	7.4	1.4	18.6%	-	-	-	288.3	23.3	8.1%
County of Maui	-	-	-	27.6	0.1	0.3%	1,016.7	15.7	1.5%
County of Hawaiʻi	-	-	-	-	-	-	1,286.6	13.6	1.1%
Total	**7.4**	**1.4**	**18.6%**	**27.6**	**0.1**	**0.3%**	**2,844**	**78**	**2.7%**

Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (2) Maui Development Projects GIS layer from Maui County Planning Department (3) Enterprise Zones from Community Economic Development Program, DBEDT

Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal

Notes: 1%CFZ-3.2 — 1% Annual Chance Coastal Flood Zone with 3.2 Feet of Sea Level Rise
GIS — Geographic Information System
SLR — Sea Level Rise
SLR-XA-3.2 — Sea Level Rise Exposure Area with 3.2 Feet of Sea Level Rise

SECTION 4. RISK ASSESSMENT

4.3 Chronic Coastal Flood

2018 HMP Update Changes

- The flood hazard profile is now divided into two separate hazards: chronic coastal flood and event-based flood. This profile describes the chronic coastal flooding hazard in the State of Hawaiʻi and includes passive inundation, annual high waves, coastal erosion, and tidal flooding/King tides with sea level rise.
- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Chronic flooding events that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update.
- New and updated figures from federal and state agencies are incorporated.
- Included analysis on chronic coastal flood per county for exposure to geocoded State assets, critical facilities, population, general building stock, and environmental/cultural assets.

4.3.1 Hazard Profile

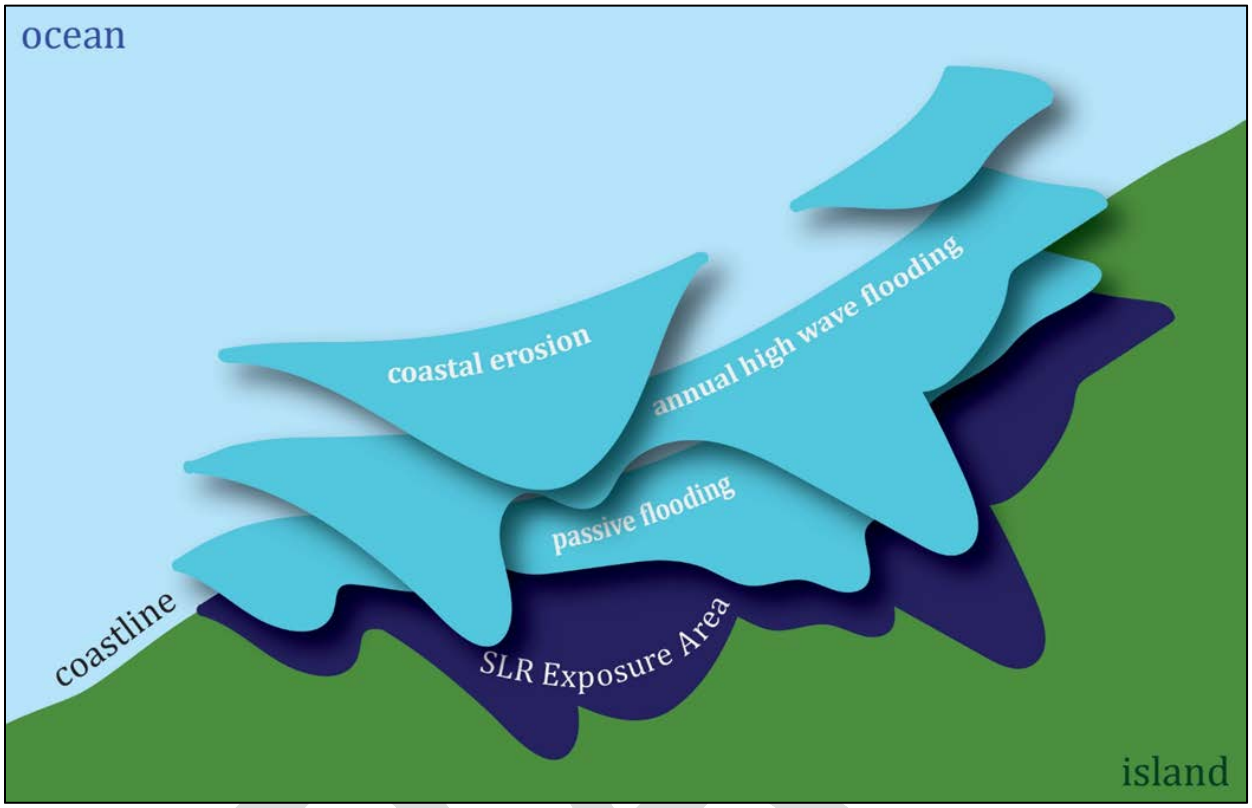
Chronic coastal flooding is occurring in the State of Hawaiʻi now and will continue to worsen as sea level continues to rise. The 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* defines chronic coastal flooding as the Sea Level Rise Exposure Area (SLR-XA), or the area exposed to potential chronic (e.g., permanent) coastal flooding and land loss based on modeling passive flooding, annual high wave flooding, and coastal erosion (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). Refer to Figure 4.3-1 for a schematic diagram of the SLR-XA.

How is Chronic Coastal Flooding Defined for the 2018 HMP Update?

Chronic coastal flooding is defined as the combined effects of annual high wave flooding, passive flooding, and coastal erosion that are being exacerbated by sea level rise. The SLR-XA with 1.1 feet of sea level rise (SLR-XA-1.1), as defined in the 2017 Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, approximates current or near-term exposure to chronic coastal flooding in the State of Hawaiʻi.

The individual components of chronic coastal flooding were modeled with 1.1 feet of sea level rise using the Intergovernmental Panel on Climate Change (IPCC) projection for the year 2050 and are depicted as the sea level rise exposure area (SLR-XA) (see detailed methodology in *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* (Hawaiʻi Climate Mitigation and Adaptation Commission 2017). For the 2018 HMP Update, chronic coastal flooding is assessed using the SLR-XA with 1.1 feet of sea level (SLR-XA-1.1) which represents both the current and near-term exposure area to chronic coastal flooding. It should be noted that chronic coastal flooding represented by the SLR-XA-1.1 for the Islands of Molokaʻi and Hawaiʻi is based on modeling passive flooding only due to limitations in data (Hawaiʻi Climate Mitigation and Adaptation Commission 2017).

Figure 4.3-1. Chronic Coastal Flooding as the Cumulative Impact of Passive Flooding, Annual High Wave Flooding, and Coastal Erosion



Source: Hawai'i Climate Mitigation and Adaptation Commission 2017

This section provides general information on the chronic coastal flood hazard which includes passive flooding, annual high waves, coastal erosion, and tidal flooding/King tides. Flooding caused by dam failure is discussed in Section 4.4 (Dam Failure), event based flooding is discussed in Section 4.7 (Event-Based Flood), and storm surge is discussed in Section 4.11 (Hurricane). The assessment of mid- to late century sea level rise on chronic coastal flooding is discussed in Section 4.2 (Climate Change and Sea Level Rise).

Hazard Description

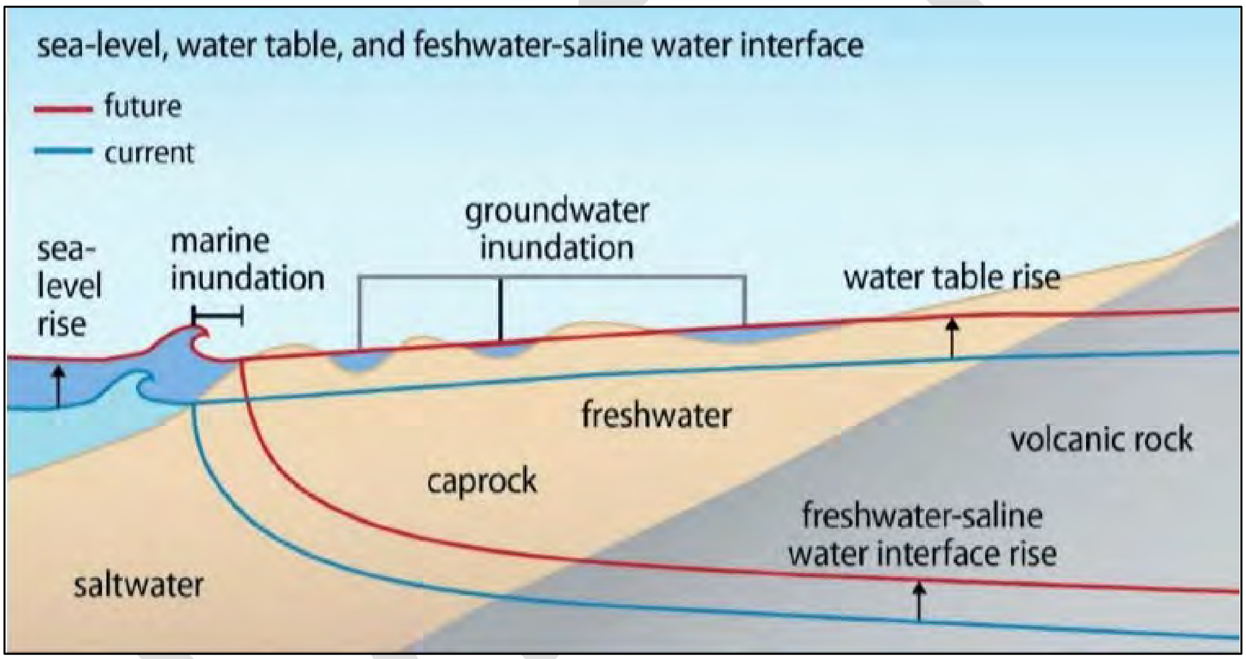
The SLR-XA-1.1 represents the present-day or near-term exposure to chronic coastal flooding, defining the State's vulnerability to chronic coastal flooding (Hawai'i Climate Mitigation and Adaptation Commission 2017). The latest scientific literature suggests that 1.1 feet of sea level rise could be reached intermittently in the State of Hawai'i over the next couple of decades, and sustained before mid-century. Long-term records from tide stations around the State of Hawai'i are already showing that the sea level is rising around the islands (refer to Figure 4.2-6 in the Climate

Change section). Coastal areas are already experiencing an increase in frequency of chronic coastal flooding components (passive inundation, high wave flooding, coastal erosion, and tidal/King tide flooding).

Passive Flooding

Passive flooding, also known as hydrostatic flooding, is depicted by bathtub modeling. Passive flooding includes marine flooding over the shoreline by stillwater flow into the lands that lie below the water level. The model also depicts low-lying areas indirectly flooded by sea level rise through water table rise. Passive flooding is exacerbated by rainfall as it prevents drainage and as such, runoff and marine waters combine to produce larger impacts. Passive flooding represents the simplest projection and provides an initial assessment of low-lying areas susceptible to flooding by sea level rise. Passive flooding includes areas that are hydrologically connected to the ocean (marine flooding) and low-lying areas that are not hydrologically connected to the ocean (groundwater) (Figure 4.3-2) (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

Figure 4.3-2. Schematic Diagram Showing Passive Marine and Groundwater Flooding



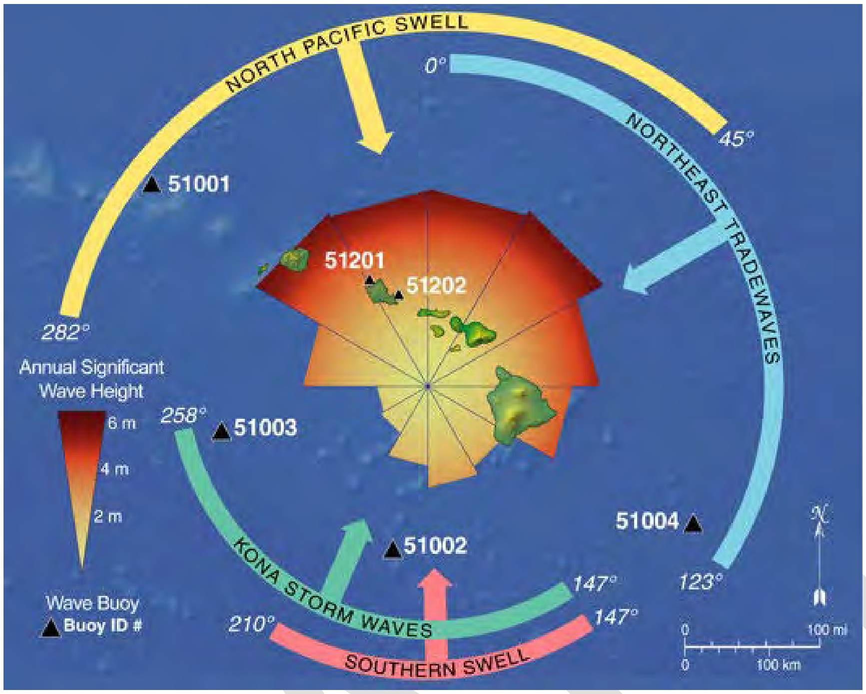
Source: Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017

Annual High Wave Flooding

Storms or high winds over the open ocean can generate large waves that trigger high surf in coastal areas. High surf typically impacts the shore in “sets” of three to five waves between lulls. Any wave can be significantly larger than the previous one and can catch beachgoers off guard. Although general forecasts can be made about surf conditions, the timing of individual waves can never be predicted (Pacific Disaster Center [PDC] 2017).

Each year, waves that reach Hawaii’s shorelines originate from four primary sources: north Pacific swell, trade wind swell, south swell, and Kona storms. Figure 4.3-3 illustrates the regions of influence and a wave rose depicting annual swell heights and direction.

Figure 4.3-3. State of Hawaiʻi Dominant Swell Regimes



Source: Vitousek et al. 2009

Hazards associated with high waves include debris overwash, flooding, erosion, high wave energy and turbulence in the nearshore zone, and strong currents. Because the contact between deep water and the shallow margins around the Hawaiian Islands is abrupt, surface waves can grow very tall, very quickly (USGS 2002). High waves in Hawaiʻi are also generated by approaching storms, including tropical storms and hurricanes in the summer and fall, as well as winter Kona storms. These types of wave events are discussed in Section 4.7 (Event-Based Flood) and Section 4.11 (Hurricanes).

Coastal Erosion

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. It is generally associated with storm surges, hurricanes, windstorms, and flooding hazards. Coastal erosion may be exacerbated by human activities such as boat wakes, shoreline hardening, and dredging. Coastal erosion describes the landward movement and loss of the abutting land in the process. Natural recovery after erosive episodes can take months or years. If a dune or beach does not recover quickly enough via natural processes, coastal and upland properties may be exposed to further damage in subsequent events.

Beach erosion occurs when waves and currents remove sand from a beach system. The loss of sand causes the beach to become narrower and lower in elevation. Storm waves carry the sand offshore, depositing and storing the sediment in large sandbars. In weeks and months following the storm, the sand is returned to the beach by calm-weather waves. Beach erosion threatens coastal properties and infrastructure. A series of storms can cause significant shoreline retreat, leaving coastal properties more vulnerable to future storms (USGS 2016).

Seasonal coastal erosion (or episodic coastal erosion) occurs when beaches and other coastal areas are exposed to seasonally high waves. In the State of Hawaiʻi, seasonal erosion is more severe on beaches that lack fringing reefs. On these beaches a single, unusually large wave event or high wave season can cause severe coastal erosion. The vegetation line may retreat as much as 60 or more feet, but if the erosive event is followed by a long period of normal wave conditions, the shoreline can recover, often accreting back to its pre-event location (Hawaiʻi State HMP 2013).

Sources of Erosion

The following provides details regarding the different sources of coastal erosion that may impact the State of Hawaiʻi.

High Waves and Strong Currents

High waves and strong currents will cause a beach to change shape. To absorb the additional wave energy, beaches and dunes give up sand to the waves which carry it seaward and drop it on the bottom. This raises the seafloor and flattens the overall beach profile. Waves then shoal and break further offshore, minimizing their erosive effects. Beaches recover from these changes when smaller waves move the sand back onto the beach and winds blow it into the dunes (Hawaiʻi Institute of Geophysics and Planetology 2005).

Coastal Armoring

Coastal managers and property owners often attempt to stabilize coastal land and protect infrastructure along the coast by building shoreline armoring structures to hold back the ocean and prevent the loss of sediment. These structures include seawalls and breakwaters.

- Seawalls are vertical or near vertical shore-parallel structures designed to prevent upland erosion and storm surge flooding. They are generally massive concrete structures placed along a stretch of shoreline.
- Breakwaters are common along the shorelines of Hawaiʻi. They are constructed to protect harbors, marinas and boat basins from the effects of weather and longshore drift. They reduce the intensity of wave action in inshore waters and reduce coastal erosion. However, they have the potential to cause sediment deficiencies along adjacent beaches because they interfere with patterns of sand flow and accumulation.

Coastal armoring is both beneficial and detrimental. Armored shorelines can prevent sandy beaches, wetlands, and other intertidal areas from moving inland as the land erodes or sea levels rise, but they also have the potential to eliminate habitat for marine organisms and beach front for the public by restricting the natural movement of sediments. If coastal armoring is being used, it is important to use a site-specific stabilization method that balances the needs of the public and the needs of the natural system (NOAA 2017).

Dune Leveling and Grading

Coastal dunes are critical to beach survival and provide protection from high waves, rising sea levels and strong storms. Dunes are one of the most important storage sites for sand. However, in the State of Hawaiʻi, many dunes have been flattened and mined. Grading of dunes with soil to support short-grass lawns is a source of silt accumulation in coastal waters during erosion events, and acts to compact and trap dune sands such that the adjacent beach experiences deflation, or a lowering of elevation due to sand removal by waves without replacement by dune sand. Deflated beaches fronting filled dunes provide poor erosion buffering capabilities and are themselves a degraded environment with little to offer the normal coastal ecosystem and its host of organisms with beach-dependent life stages (including turtles, various marine larvae, and certain reef fishes) (Hawaiʻi State HMP 2013).

Sand Mining

Sand mining is a presently outlawed, historic practice that refers to the process of collecting large amounts of coastal sands to produce building materials. The beaches in the State of Hawaiʻi, especially the beaches on the Island of Maui, were subjected to sand mining for lime processing which was then baked to produce lime for use as a building material. Sand mining is in large part responsible for the retreat of both the vegetation line and the beach foreshore over recent decades along these beaches. Besides loss of vegetation and beach foreshore, sand mining impacts beaches negatively by decreasing sand volumes, steepening the morphology of the shoreline, and reducing the ability of beach profiles to respond to seasonal wave stresses (Hawaiʻi State HMP 2013).

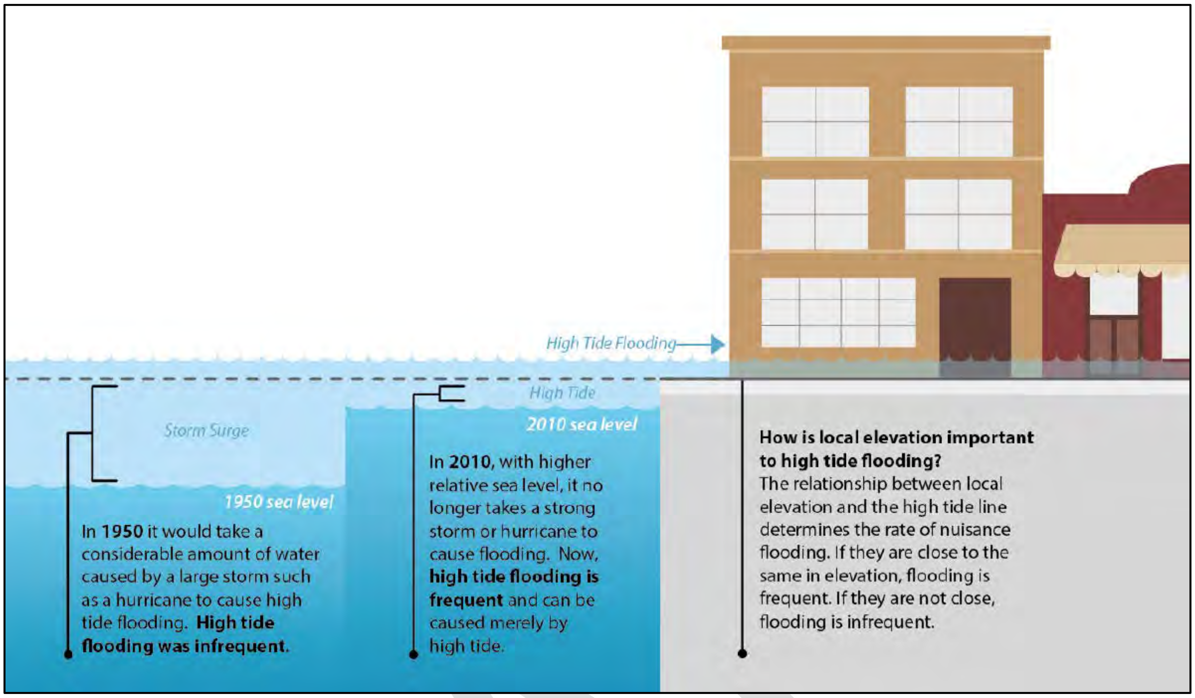
Canalization

Many streams that flow intermittently from Hawaiian mountain ranges to the coast are subject to flash flooding during heavy rainfall events. To prevent coastal zone flooding, the most hazardous of these streams have been canalized into concrete canals or gutters so that flooding is contained. Where canals and similar infrastructure open onto the coastal zone, the channel mouths tend to trap sand that is moving along the shoreline. The buildup of sand within the channel mouths increases the upstream flood hazard and creates a sand deficiency on the adjacent beach. Public works departments often clear these accumulations and dispose of the sand in various ways, including trucking it off-site to be used elsewhere (i.e. golf courses). Unless these sands are returned to the immediate beach area, the long-term dredging and clearing is nothing less than a sand mining effort and it will have a similar detrimental impact on the adjacent beach. This process has the potential to reduce available sand volumes and create chronic erosion where none previously existed. By placing cleared sands onto adjacent beaches, it is important to be aware of prevailing sediment transport patterns so that returned sand can function in a manner that will provide nourishment. To ensure proper adjacent beach replenishment, it is necessary to conduct reviews of the ambient littoral processes and develop schedules of transport direction around each channel mouth, with guidelines on the placement of returned sand (Hawaiʻi State HMP 2013).

Tidal Flooding/King Tides

Tidal flooding, also known as sunny day flooding or high tide flooding, is the temporary inundation of low-lying areas during exceptionally high tide events, and causes public inconvenience (Figure 4.3-4). King tides is a non-scientific term used to describe exceptionally high tides, when high tides are higher than normal. In the State of Hawaiʻi, higher-than-normal king tides occur during a full moon. These alignments in space and time are fairly predictable, and so are King tides (NOAA 2015; University of Hawaiʻi Sea Grant 2018).

Figure 4.3-4. High Tide Flooding



Source: *NOAA 2018*
Notes: *National Oceanic and Atmospheric Administration*

LOCATION

Chronic coastal flooding is occurring throughout the Hawaiian Archipelago in the main Hawaiian Islands and Northwestern Hawaiian Islands. Maps showing the location of chronic coastal flooding in the main Hawaiian Islands, depicted as the SLR-XA-1.1, as well as the individual component hazards, can be found on the Hawaiʻi Sea Level Rise Viewer located at: http://www.pacioos.hawaii.edu/shoreline/slr-hawaii/.

Areas that are more susceptible to chronic coastal flooding include low-lying areas along the coast as well as inland areas which are susceptible to groundwater flooding with sea level rise. Inland areas are also flooded because storm drains, that typically flow to the ocean, are backed up during high tides. The north and south shores of all the islands are subject to annual high wave events. The north shores of all islands are subject to extraordinary wave heights each winter, ranging between 20 and 40 feet due to north and northwestern swells. The south shore, on average, sees waves of 4 to 8 feet each summer from south and southwestern swells. High waves in Hawaiʻi are also generated by approaching storms, including tropical storms and hurricanes in the summer and fall, as well as winter Kona storms. Strong trade wind events also stir up high waves that influence the east-facing shorelines. Annual high waves from both north and south swells are common in the Hawaiian coastal zone and pose a significant hazard, especially where they break at the shoreline (USGS 2002).

The extent of chronic coastal flooding varies by county. Table 4.3-1 shows the hazard area in square miles and the percent of the total area located in the chronic coastal flood hazard area based on the SLR-XA-1.1. The City and County of Honolulu have the largest percent (1.4%) of land in the chronic coastal flood hazard area.

Table 4.3-1. Chronic Coastal Flood Hazard Area (SLR-XA-1.1) by County

County	Area		
	Total Area (square miles)	Chronic Coastal Flood Area (square miles)	Hazard Area as % of Total Area
County of Kauaʻi	630.3	4.6	0.7%
City and County of Honolulu	600.2	5.7	0.9%
County of Maui	1,174.6	4.7	0.4%
County of Hawaiʻi	4,027.8	3.4	0.1%
Total	**6,432.9**	**18.3**	**0.3%**

Source: *Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017*
Note: Total area for each County calculated using coastline spatial layer downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal

EXTENT

The severity of any flood depends upon the type, cause, duration, and existing conditions (i.e., drainage design and pathways for water to exit). Flooding from severe rain events coupled with high tide flooding increases the severity chronic coastal flooding.

Warning Time

As defined, chronic coastal flooding is a continuum of daily, monthly, and annual occurrences. Warning times for high wave and tide events are available as high surf advisories and high tide advisories.

The National Weather Service (NWS) Honolulu Forecast Office uses the criteria for the issuance of high surf advisories and warnings in coordination with civil defense agencies and water safety organizations in the State of Hawaiʻi (Table 4.3-2). Offshore wave sensors help provide adequate warning to approaching high waves with damaging potential throughout the State of Hawaiʻi. The NWS Honolulu Forecast Office issues a surf forecast for the State of Hawaiʻi. Surf heights are forecast heights of the face, or front, of waves. It is based on the significant wave height, the average height of the one-third largest waves, at the locations of the largest breakers. Some waves may be more than twice as high as the significant wave height.

Table 4.3-2. High Surf Advisory/Warning Criteria

Location	Advisory	Warning
North-Facing Shores	15 feet	25 feet
West-Facing Shores - Island of Hawaiʻi	8 Feet	12 Feet
West-Facing Shores - Remaining Islands	12 Feet	20 Feet
South-Facing Shores	8 Feet	15 Feet
East-Facing Shores	8 Feet	15 Feet

Source: NWS 2016
Notes: All surf height observations and forecasts are for the full-face surf height, from the trough to the crest of the wave.
NWS National Weather Service

High tide flooding and King tides are fairly predictable due to their occurrence during new or full moons. NOAA's tide predictions for the State of Hawaiʻi, are based on the astronomical tide calendar and takes into account the gravitational pull of the moon and sun on the Earth's oceans. Using this information helps provide predictions as to when high tide flooding and King tides may occur and impact low-lying and coastal areas (NOAA 2015).

Previous Occurrences and Losses

The 2013 HMP discussed specific coastal erosion and high wave flooding events that occurred in the State of Hawaiʻi through 2012. For this 2018 HMP Update, high wave flooding, coastal erosion, and tidal flooding/King tides were summarized between January 1, 2012, and December 31, 2017. For events prior to 2012, please refer to Appendix X. Table 4.3-3 includes details regarding major chronic coastal flooding that occurred in the State between 2012 and 2017. Major events include those that resulted in losses or fatalities, as reported by NOAA NCEI, events that resulted in the activation of the State and/or County Emergency Operations Center (EOC), and/or events that led to a FEMA disaster declaration.

With flood documentation for the State of Hawaiʻi being extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.3-3 may not include all events that have occurred in the State and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP Update.

Table 4.3-3. Chronic Coastal Flooding Events in Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
January 3, 2012	High Surf	Honolulu	The County and City of Honolulu partially activated their EOC and opened shelters due to high surf.
November 4 to 7, 2012	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A combination of swells generated surf of 15 to 25 feet along the north-facing shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi; 8 to 14 feet along the west-facing shores of the Islands of Niʻihau, Kauaʻi, and Molokaʻi; and 6 to 10 feet along the east-facing shores of the Islands of Oʻahu and Hawaiʻi. Lifeguards rescued several individuals who were overwhelmed by the dangerous surf.
December 24 to 26, 2012	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A swell from a powerful low, far northwest of the islands generated surf of 15 to 25 feet along the north- and west-facing shores of the Islands of Niʻihau, Kauaʻi, and Molokaʻi; and the north-facing shores of the Islands of Oʻahu and Maui; and 10 to 15 feet along the west-facing shores of the Island of Oʻahu and north-facing shores of the Island of Hawaiʻi. At least three people required assistance by paramedics after getting caught in the surf. Lifeguards performed numerous rescues and provided warnings to beach goers to stay away from the water.
January 17 to 22, 2013	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A swell from a powerful low, far northwest of the islands generated surf of 15 to 30 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; 10 to 20 feet along the west-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; 10 to 15 feet along the west-facing shores of the Island of Hawaiʻi; and 8 to 12 feet along the west-facing shores of the Islands of Lānaʻi and Kahoʻolawe. On the Island of Kauaʻi, there were two fatalities associated with this high surf event. Two men were swept away by the large waves on the north shore of the Island of Kauaʻi on January 18. On the Island of Oʻahu alone, lifeguards reported more than 2,000 safety actions as a result of this high surf event. Many beaches were closed for a time because of the rough conditions, and several roadways near the shoreline on the individual isles became covered with debris from waves breaking beyond the beach areas.
April 4 to 6, 2013	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A swell from a powerful low, far northwest of the islands produced surf of 15 to 25 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 10 to 20 feet along the west-facing shores of the Islands of Oʻahu, Molokaʻi and Maui, and the north-facing shores of the Island of Hawaiʻi. Lifeguards issued more than 1,000 warnings during the episode, and conducted several rescues of individuals overwhelmed by the pounding surf.
May 16 to 22, 2013	High Surf	Kauaʻi, Maui and Hawaiʻi	A series of swells from the southern hemisphere generated surf of 6 to 10 feet along the south shores of all islands. Lifeguards were busy throughout the high surf episode. They provided many rescues, and warnings to inexperienced swimmers and surfers. On the Island of Maui, with the high surf, three sailing vessels broke free from their moorings and washed aground near Mala Wharf in Lahaina.

Date(s) of Event	Event Type	Counties Affected	Description
June 4 to 6, 2013	High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	A long period swell from the southern hemisphere generated surf of 6 to 12 feet along the south-facing shores of all the main Hawaiian Islands. In a few instances, water from the high surf flowed over adjacent roads and deposited sand and other debris. Lifeguards rescued more than 100 surfers and swimmers and issued hundreds of warnings. One surfer died from injuries suffered at Ala Moana Bowls on the Island of Oʻahu on June 6. Another surfer sustained serious injuries while surfing at Sandy Beach.
October 20 to 21, 2013	High Surf	Kauaʻi, Honolulu, and Maui	A swell from a strong low, far northwest of the islands generated surf of 15 to 20 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi; and 10 to 15 feet along the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui. On October 21, three individuals were injured when they were swept away on a wave from the Shark's Cove reef area on the Island of Oʻahu's north shore. Ocean safety officials performed rescues, assists and preventative actions.
October 28 to 29, 2013	High Surf	Kauaʻi, Honolulu, and Maui	A swell from a strong low generated surf of 15 to 20 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi; and 10 to 15 feet along the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui. Ocean safety officials were busy with rescues, assists and preventative actions.
November 13 to 15, 2013	High Surf	Hawaiʻi, Kauaʻi, and Honolulu	A swell from a powerful low north of the islands, in combination with a strong high far to the northwest, generated surf of 20 to 30 feet along the north-facing shores, and 10 to 20 feet along the east-facing shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi. On November 13, a surfer was lost in the churning waters on the north shore of the Island of Oʻahu at Chun's Reef. On the Island of Maui, the parking and pavilion areas of Baldwin Park in Pāʻia were closed due to flooding from high surf wash up. Bayfront Highway on the Island of Hawaiʻi was closed due to the high surf.
December 19 to 22, 2013	High Surf	Kauaʻi, Honolulu, Maui, and Hawaiʻi	A swell from powerful low, far northwest of the islands produced surf of 20 to 30 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; 15 to 25 feet along the west-facing shores of the Island of Hawaiʻi; and 10 to 15 feet along the west-facing shores of the Islands of Oʻahu, Molokaʻi, Lānaʻi, and Kahoʻolawe. Lifeguards issued over 4,800 warnings and rescued or assisted more than 50 people on the Island of Oʻahu. Two people were injured by the high surf. Additionally, on the Island of Hawaiʻi, two boating facilities were damaged by high waves.
October 9 to 11, 2014	High Surf	Kauaʻi, Honolulu and Maui	A swell from a strong low, far northwest of the islands generated surf of 10 to 20 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi; the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 8 to 14 feet along the west-facing shores of the Islands of Oʻahu and Molokaʻi. One person was injured when they were caught in the shore-break at Waimea Bay on the Island of Oʻahu's North Shore. Ocean safety personnel performed 1,120 preventative actions, just on North Shore beaches alone.
July 25 to 28, 2015	High Surf	Honolulu	A swell from the southern hemisphere generated surf of 8 to 15 feet along the south-facing shores of all the islands. This was unusually high surf that led to lifeguards performing 3,000 preventative actions and 39 rescues on south and west shores of just the Island of Oʻahu alone. There were two deaths associated with this event.

Date(s) of Event	Event Type	Counties Affected	Description
October 27 to 31, 2015	High Surf	Maui, Honolulu, and Hawaiʻi	A swell from a powerful low far northwest of the State of Hawaiʻi generated surf of 15 to 25 feet along the north-facing shores of all the islands except Lānaʻi; 10 to 20 feet along the west-facing shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, Molokaʻi, and Maui; and 8 to 12 feet along the west-facing shores of the Island of Hawaiʻi. A large wave near Kaʻena Point on the Island of Oʻahu swept three men into the water on October 27. One man died and the other two were injured. On the Island of Kauaʻi on the same day, a 33-foot sailing vessel ran aground in the high surf after its motor failed. The vessel beached on the west side of Hanalei Bay at Waipā. The boat's owner injured himself trying to leave the boat.
December 5 to 7, 2015	High Surf	Kauaʻi, Honolulu, and Maui	A swell from a powerful low, far northwest of the islands generated surf of 20 to 35 feet along the north-facing, and 10 to 20 feet along the west-facing, shores of the Islands of Niʻihau, Kauaʻi, Oʻahu, and Molokaʻi. Surf reached 20 to 35 feet along the north-facing shores of the Island of Maui as well. Lifeguards and other ocean safety officials provided assistance to surfers and other beachgoers in the rough conditions. One surfer nearly drowned at the Banzai Pipeline on the Island of Oʻahu's North Shore due to dangerous surf.
February 21 to 29, 2016	High Surf and Coastal Erosion	Kauaʻi, Honolulu, Maui, and Hawaiʻi	Large swells from the northwest generated surf of 20 to 40 feet, with sets as high as 55 feet, on the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 15 to 25 feet, with sets as high as 35 feet, on the west-facing shores of the Islands of Oʻahu and Molokaʻi, and the north-facing shores of the Island of Hawaiʻi; and 8 to 12 feet along the west-facing shores of the Islands of Maui and Hawaiʻi. The large surf also caused beach erosion and damaged roadways, inundated parking areas of coastal recreation areas, and closed beaches. One person was swept out to sea as a large wave broke where the person was taking pictures on the Island of Kauaʻi.
November 6 to 12, 2016	High Surf	Kauaʻi, Honolulu, Maui, and Hawaiʻi	A swell from a powerful low far northwest of the islands produced surf of 25 to 40 feet along the north- and west-facing shores of the Islands of Niʻihau, Kauaʻi, and Molokaʻi; and the north-facing shores of the Islands of Oʻahu and Maui; and 20 to 30 feet along the west-facing shores of the Island of Oʻahu and the north-facing shores of the Island of Hawaiʻi. One man drowned on November 8 on the north shore of the Island of Kauaʻi.
January 28 to 31, 2017	High Surf	Kauaʻi, Maui and Honolulu	Swells from powerful lows far northwest of the islands produced surf of 15 to 30 feet along the north- and west-facing shores of the Islands of Niʻihau and Kauaʻi, and the north-facing shores of the Islands of Oʻahu, Molokaʻi, and Maui; and 10 to 20 feet along the west-facing shores of the Islands of Oʻahu and Molokaʻi. A young woman drowned in the high surf on the Island of Kauaʻi on January 30.
May 5 to 26, 2017	King Tide / High Surf	Kauaʻi, Maui, Hawaiʻi, and Honolulu	The State of Hawaiʻi EOC was partially activated due to King tides and high surf.

Sources: FEMA 2017, NOAA-NCEI 2017, Storm Prediction Center 2017, State of Hawaiʻi 2017
EOCEmergency Operations Center
FEMA Federal Emergency Management Agency
Mph Miles Per Hour

NCEI *National Centers for Environmental Information*
NOAA *National Oceanic and Atmospheric Administration*

FEMA Disaster Declarations

Between 1954 and 2017, FEMA included the State of Hawaiʻi in five chronic coastal-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storms, high wave flooding, flooding, heavy rains, and land/mudslides. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2017). During the 2018 HMP Update performance period, the State has not had any declared disasters or emergencies related to the chronic coastal flood hazard. For details regarding all declared disasters, refer to Section 4.0 (Risk Assessment).

PROBABILITY OF FUTURE HAZARD EVENTS

Over time, recurring flooding at the highest tides in low-lying areas leads to chronic flooding and then to permanent flooding and permanent loss. Overall, the probability of future chronic coastal flooding will increase with increasing sea level rise and punctuated by severe flood events.

Coastal erosion exacerbates flooding and inundation resulting in the permanent loss of beaches and dry land which will become submerged at increasing rates due to sea level rise. Shoreline recession and beach loss due to coastal erosion is already a severe problem along the State of Hawaii's coastline, threatening shorefront development and infrastructure. Statewide, 70% of the State of Hawaii's shorelines have retreated over years to decades (Hawaiʻi Climate Adaptation Portal 2017). The return period of an episodic erosion event is directly related to the return period of a coastal storm, hurricane or tropical storm.

High wave flooding events occur frequently on the coasts of all islands in the State of Hawaiʻi. Events that actually cause damage to property or loss of human life are far less common. During the time period from January 1, 2012, to December 31, 2017, high surf conditions and impacts existed continuously in the State of Hawaiʻi. Based on the history of high wave flooding in the State, the State of Hawaiʻi can expect high wave flooding events on an ongoing basis, with an increase in events during coastal storms.

The probability of tidal flooding/King tides is linked to both the lunar cycle and proximity to a tidal area. Low-lying areas in the State of Hawaiʻi have the highest probability of experiencing regular flooding from tides and King tides. As the sea level rises, these areas will become more vulnerable to regular flooding from daily and monthly high tides and King tides. The greatest potential for flooding from King tides occurs for a couple of days around the new moons (University of Hawaiʻi Sea Grant 2018).

Potential Impacts of Climate Change on Probability of Future Events

The frequency, extent and severity of chronic coastal flooding will increase with sea level rise. The sea level rise is expected to increase over 3 feet within the 21st Century. For the 2018 HMP update, mid- to late century sea level rise on chronic coastal flooding was assessed using the SLR-XA with 3.2 feet of sea level rise (SLR-XA-3.2). Statewide impacts are discussed further in Section 4.2 (Climate Change and Sea Level Rise). Overall, the loss of land and structures will take the form of incrementally eroding beaches, waterfront property inundated by increasingly high tides and by seasonal waves that reach farther inland, and low-lying areas becoming wetlands because of rising water tables and reduced drainage. The estimated total amount of land loss is less than 1% of the State's total land area; however, much of this land is located in high density urban, commercial, and industrial districts leading to great potential economic loss for the State (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

4.3.2 Vulnerability Assessment

To assess the State's risk to the chronic coastal flood hazard, the SLR-XA-1. 1, developed for the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report,* was used. Overall, vulnerability to chronic coastal flooding is assessed as chronic flooding with the potential permanent loss of assets and displacement of population located in the SLR-XA-1.1 hazard area.

Chronic Coastal Flood Hazard Area Definition

SLR-XA 1.1 – *To assess vulnerability to chronic coastal flooding the area generated by modeling of passive flooding, annual high wave flooding and coastal erosion (known as the SLR-XA) with 1.1 feet of sea level rise was used. The hazard area is called SLR-XA-1.1.*

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the chronic coastal flooding hazard.

State Assets

The exposure analysis determined there are 8 state buildings located in the chronic coastal hazard area; of which the greatest number are in the City and County of Honolulu (6 buildings with a replacement cost value of $30 million). The majority of these buildings (six) are occupied by the Department of Human Services and Department of Land and Natural Resources. Over time, recurring flooding at these locations may lead to the permanent loss of these structures. Only replacement cost value was available for state buildings; this was the best available data and therefore, this value is reported as the estimated total loss. However, a more accurate reflection of loss to the chronic coastal flood hazard would be the combine value of the land and structure. Table 4.3-4 summarizes the state buildings located in the chronic coastal flood area by county. Table 4.2-5 summarizes the state buildings by state agency.

Table 4.3-4. State Buildings Loss to the SLR-XA-1.1 by County

County	Total Number of State Buildings	Total Value	Located in the SLR-XA-1.1			
			Number	% of Total	Total Value	% of Total
County of Kauaʻi	531	$957,679,537	0	0%	$0	0%
City and County of Honolulu	3,472	$16,750,785,426	6	<1%	$30,412,601	<1%
County of Maui	831	$2,862,316,819	2	<1%	$370,372	<1%
County of Hawaiʻi	1,261	$4,209,774,236	0	0%	$0	0%
Total	**6,095**	**$24,780,556,017**	**8**	**<1%**	**$30,782,973**	**<1%**

Source: Hawaiʻi State Risk Management Office 2017
Value = Replacement Cost of the building; does not include land value which may be underestimating the loss due to the SLR-XA-1.1

Table 4.3-5. State Building Loss to the SLR-XA-1.1 by Agency

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-1.1	Percent (%) of Total Buildings	Value in the SLR-XA-1.1	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	0	0.00%	$0	0.00%
Dept of Agriculture	70	$133,065,375	1	1.43%	$2,040,456	1.53%
Dept of Attorney General	15	$95,151,863	0	0.00%	$0	0.00%
Dept of Budget & Finance	16	$26,624,294	0	0.00%	$0	0.00%
Dept of Business, Economic Development and Tourism	25	$612,574,032	0	0.00%	$0	0.00%
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.00%	$0	0.00%
Dept of Defense	69	$246,099,477	0	0.00%	$0	0.00%
Dept of Education	4,090	$9,604,111,443	0	0.00%	$0	0.00%
Dept of Hawaiian Home Lands	12	$100,471,477	0	0.00%	$0	0.00%
Dept of Health	44	$387,068,440	0	0.00%	$0	0.00%
Dept of Human Resources Development	1	$5,523,320	0	0.00%	$0	0.00%
Dept of Human Services	130	$420,004,555	2	1.54%	$2,839,820	0.68%
Dept of Labor and Industrial Relations	22	$79,322,626	0	0.00%	$0	0.00%
Dept of Land and Natural Resources	90	$98,666,185	2	2.22%	$370,372	0.38%
Dept of Public Safety	154	$427,884,909	0	0.00%	$0	0.00%
Dept of Taxation	1	$6,864,408	0	0.00%	$0	0.00%
Dept of Transportation	68	$2,912,510,888	1	1.47%	$3,368,912	0.12%
Hawai'i State Ethics Commission	1	$891,212	0	0.00%	$0	0.00%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	0	0.00%	$0	0.00%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	0	0.00%	$0	0.00%
Hawaiʻi Public Housing Authority	273	$933,255,767	1	0.37%	$5,340,000	0.57%
Hawaiʻi State Legislature	2	$43,024,855	0	0.00%	$0	0.00%
Hawaiʻi State Public Library System	53	$525,584,082	0	0.00%	$0	0.00%
Judiciary	41	$511,093,204	0	0.00%	$0	0.00%

Agency	Total Number of State Buildings	Total Value	Number of State Buildings in SLR-XA-1.1	Percent (%) of Total Buildings	Value in the SLR-XA-1.1	Percent (%) of Total Value
Legislative Reference Bureau	1	$2,686,408	0	0.00%	$0	0.00%
Office of Hawaiian Affairs	11	$53,991,251	0	0.00%	$0	0.00%
Office of the Auditor	2	$1,789,788	0	0.00%	$0	0.00%
Office of the Governor	1	$2,686,408	0	0.00%	$0	0.00%
Office of the Lieutenant Governor	2	$3,977,640	0	0.00%	$0	0.00%
Office of the Ombudsman	1	$1,620,944	0	0.00%	$0	0.00%
Research Corporation of the University of Hawai'i	3	$3,713,497	0	0.00%	$0	0.00%
University of Hawai'i	637	$5,000,692,783	1	0.16%	$16,823,413	0.34%
Total	**6,095**	**$24,780,556,017**	**8**	**0.13%**	**$30,782,973**	**0.12%**

Source: Hawaiʻi State Risk Management Office 2017
Value = Replacement Cost of facility; does not include land value which may be underestimating the loss due to the SLR-XA-1.1

Roads provide a vital transportation link between populated areas on the Hawaiian Islands. Approximately 15 miles of state roads are located within the SLR-XA-1.1 hazard area. These state roads will become potentially impassable, jeopardize critical access and isolate communities. Loss of road use may result in regional issues such as loss of commerce and increased traffic on other roads and highways. Utility lines commonly follow roads and those located underground may be impacted resulting in disruption of services.

Table 4.3-6 shows the length of state roads in the hazard area by county. The City and County of Honolulu has the greatest length of roads (6.4 miles) exposed, followed by the County of Maui (4.8 miles) and County of Kauai (3.8 miles). A complete list of state roads exposed to the chronic coastal flood hazard is included in Appendix X.

Table 4.3-6. State Road Exposure to the SLR-XA-1.1 by County

County	Length (in miles)		
	Total Length	Length of Road in the SLR-XA-1.1	Percentage (%) of Total Length
County of Kauaʻi	104.0	3.8	3.6%
City and County of Honolulu	375.3	6.4	1.7%
County of Maui	238.6	4.8	2.0%
County of Hawaiʻi	378.7	0.2	0.1%
Total	**1,096.5**	**15.2**	**1.4%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017
Notes: GIS Geographic Information System
SDOT State Department of Transportation

Critical Facilities

Table 4.3-7 summarizes the total number by core category of critical facilities located in the chronic coastal flooding by county. The County of Maui has 5 critical facilities located in the chronic coastal flood hazard area; three facilities are categorized as water, waste and wastewater system facilities; one is a communication facility and one is an emergency service critical facility. Table 4.3-8 summaries the critical facilities exposure by core category. Overall, the emergency services category has the greatest exposure (2.4% of total value) to the chronic coastal flood hazard. Similar to state buildings, only replacement cost value of the facility was available for critical facilities and does not include the value of the land; therefore, this value is reported as the total loss. However, a more accurate reflection of loss to the chronic coastal flood hazard would be the combine value of the land and structure using tax-assessed data. Further, the loss of service of that critical facility would increase the total loss from the hazard.

Table 4.3-7. Critical Facilities by County Located in the SLR-XA-1.1

County	Number of Critical Facilities by Core Category										Total in the SLR-XA-1.1
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	0	0	0	0	0	0	0	0	0	0	0
City and County of Honolulu	0	0	2	0	0	0	0	0	0	1	3
County of Maui	0	1	1	0	0	0	0	0	0	3	5
County of Hawaiʻi	0	0	0	0	0	0	0	0	0	0	0
Total	**0**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**4**	**8**

Source: *Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2*

Table 4.3-8. Critical Facilities by Core Category Located in the SLR-XA-1.1

Category	Total Number of Critical Facilities	Total Value	Number of Critical Facilities in SLR-XA-1.1	Percent (%) of Total Facilities	Value in the SLR-XA-1.1	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	0	0.0%	$0	0.0%
Communications	130	$523,848,060	1	0.8%	$8,332,280	1.6%
Emergency Services	149	$1,017,628,710	3	2.0%	$24,455,750	2.4%
Energy	90	$2,591,975,628	0	0.0%	$0	0.0%
Food & Agriculture	39	$829,869,410	0	0.0%	$0	0.0%
Government Facilities	100	$399,781,575	0	0.0%	$0	0.0%
Healthcare & Public Health	193	$3,399,521,375	0	0.0%	$0	0.0%
Mass Care Support Services	353	$11,497,547,155	0	0.0%	$0	0.0%
Transportation Services	56	$1,739,256,960	0	0.0%	$0	0.0%

Category	Total Number of Critical Facilities	Total Value	Number of Critical Facilities in SLR-XA-1.1	Percent (%) of Total Facilities	Value in the SLR-XA-1.1	Percent (%) of Total Value
Water, Waste, & Wastewater Systems	305	$9,481,445,760	4	1.3%	$123,832,320	1.3%
Total	**1,475**	**$31,687,768,838**	**8**	**0.5%**	**$156,620,350**	**0.5%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2
Value = Replacement Cost of the facility; does not include land value which may be underestimating the loss due to the SLR-XA-1.1

Critical transportation hubs and critical infrastructure located on the coast are exposed to chronic coastal flooding. As summarized in Section 4.2 (Climate Change), the primary transportation arteries for the entry of people and goods to the State is the Daniel K. Inouye International Airport and Honolulu Harbor. In addition, each island has critical points of entry for people and goods which are considered vulnerable to chronic coastal flooding if located along the coast. Interruption of interisland and transoceanic shipping and travel would impact residents, visitors and all forms of economic activity (Hawaiʻi Climate Mitigation and Adaptation Commission 2017).

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental assets and cultural resources by county. Similar to the analysis for state assets, a spatial exposure analysis was conducted. As noted above, vulnerability to chronic coastal flooding is assessed as chronic flooding with the potential permanent loss of assets and displacement of population located in the SLR-XA-1.1 hazard area.

Population

People living and working in the chronic coastal flood hazard area may be displaced as homes and businesses become flooded and permanently lost. According to the 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report*, statewide, an estimated 4,160 people may be displaced as a result of the potential permanent loss to structures and land in the SLR-XA-1.1 hazard area (Table 4.2-9). The analysis indicates that the City and County of Honolulu has the greatest number of people that may be displaced, and County of Kauaʻi has the greatest percent population that may be displaced (1.5%).

Table 4.3-9. Estimated Population Displaced by the Chronic Coastal Flood Hazard

County	Total Population	Displaced Population	Percent (%) of Total Population
County of Kauaʻi	67,091	1,000	1.5%
City and County of Honolulu	953,207	2,000	<1%
County of Maui	154,924	710	<1%
County of Hawaiʻi	185,079	450	<1%
Total	**1,360,301**	**4,160**	**<1%**

Source: Hawaiʻi Climate Mitigation and Adaptation Commission 2017

According to the 2013 HMP, 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 Hawaiian Islands.

Land Use Districts

Table 4.3-10 shows the number of square miles in each State Land Use District statewide exposed to the chronic coastal flood hazard areas; refer to Appendix X for results by County. Conservation District lands will experience the greatest total loss of area from chronic coastal flooding in the near-term. Conservation District Lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the subsection below. Urban District areas, where populations and development are concentrated, will lose the greatest percentage of total land area to chronic coastal flooding in the near-term. The loss of land will be greatest in the City and County of Honolulu where 2.8 square miles or 1.7% of the Urban District lands will be lost if no adaptation measures are taken. In the County of Maui 1.2 square miles or 2.8% of Urban District lands will be lost.

Table 4.3-10. State Land Use Districts Located in the SLR-XA-1.1

Land Use District	Total (square miles)	Square Miles in the SLR-XA-1.1	% of Total Area
Agricultural	2,942.8	3.0	0.1%
Conservation	3,156.3	9.9	0.3%
Rural	16.1	0.2	1.4%
Urban	319.7	5.3	1.7%
Total	**6,434.9**	**18.4**	**0.3%**

Source: Hawaiʻi Climate Mitigation and Adaptation Commission 2017; State Land Use Commission, 2016
Notes: Total area calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal.
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
GIS Geographic Information System

General Building Stock

The 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* calculated the estimated potential loss to both structure and land by island; as both the structures and land may become permanently inundated due to the chronic coastal flood hazard over time. These calculations were totaled by county with an estimated economic loss of $6.9 billion statewide.

Table 4.3-6. Estimated Structure and Property Value (Structure and Land) Loss from SLR-XA-1.1 by County

County	Number of Structures in the SLR-XA-1.1	Estimated Structure and Land Value Located in the SLR-XA-1.1
County of Kauaʻi	170	$763,000,000
City and County of Honolulu	650	$4,100,000,000
County of Maui	732	$1,839,000,000
County of Hawaiʻi	30	$195,000,000
Total	**1,582**	**$6,897,000,000**

Source: Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report, 2017

Environmental Resources

The loss of natural resources statewide is difficult to quantify; however, their loss would deeply cost the State. Parks and beaches play a critical role in recreation, employment and the local economy. In addition, wetland areas and coastal habitats are vital to the environment and may be altered through chronic coastal flood conditions. As discussed in Section 4.2 (Climate Change and Sea Level Rise), chronic coastal flooding has the potential to impact facilities that could release wastewater or hazardous materials and waste to nearshore waters and coastal habitats. Septic tanks, cesspools, and other on-site sewage disposal systems (OSDS) as well as other hazard materials/waste storage and disposal sites are located along the coast.

Environmental resource areas, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands and parks and reserves are vulnerable to chronic coastal flooding. The area of each environmental asset located in the SLR-XA-1.1 hazard area was calculated and summarized by county (Table 4.3-7).

Table 4.3-7. Environmental Resources Located in the SLR-XA-1.1

Environmental Asset	Total Square Miles of Asset	Asset Area in the SLR-XA-1.1	Percent (%) of the Total Asset Area
Critical Habitat[a]	915.2	1.2	0.1%
Wetlands	260.0	9.8	3.8%
Parks and Reserves	2,607.7	4.3	0.2%
Total[b]	**3,837.6**	**70.1**	**1.8%**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; HWMO 2013
a. Critical area mileage includes the combined area of coverage of individual critical habitat areas
b. Total square miles may be over reported as some environmental asset areas may overlap.
Sq. Mi. = Square miles.
Reefs were excluded from the analysis because they are under water and thus 100% exposed to a flood hazard.

Cultural Assets

Coastal portions of the Hawaiian Home Lands are vulnerable to chronic coastal flooding which may displace Native Hawaiian families that live in this area. Table 4.3-8 summarizes the area of the Hawaiian Home Lands located in the chronic coastal flood hazard area. In addition, many Native Hawaiian cultural and historical resources are located near the shoreline and threatened by flooding and beach erosion. This includes fishing and cultural practices that take place along the shore. The 2017 *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* summarizes cultural sites located in the SLR-XA-1.1 hazard area.

Table 4.3-8. Hawaiian Home Lands Located in the SLR-XA-1.1

County	Area (in square miles)		
	Total Area	Asset Area in the SLR-XA-1.1	Percent (%) of Total Area
County of Kauaʻi	32.0	< 1	< 1%
City and County of Honolulu	10.9	< 1	< 1%

County	Area (in square miles)		
	Total Area	Asset Area in the SLR-XA-1.1	Percent (%) of Total Area
County of Maui	92.6	< 1	< 1%
County of Hawaiʻi	190.3	< 1	< 1%
Total	**325.8**	**< 1**	**< 1%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal 2017
Note: GIS Geographic Information System

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Chronic coastal flood areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.3-9 below; refer to Section 3 for more information on projected development areas). Only very small amounts of the HCDA Community District Areas and Maui Development Projects intersect with these areas. Larger portions of the Enterprise Zone areas in each county are exposed; however, exposure is still less than 1% of the total area of these zones. Care should be taken to not increase development in these Chronic Coastal Flood Areas as the incidence of flooding and/or erosion will increase over time. It is likely; however, that existing rules and regulations in the State, such as shoreline setback regulations (see Section 5 for more information) already prohibit or strictly regulate most new development in these areas. It is possible that chronic flooding conditions may exist outside of existing regulated areas if chronic flooding is a result of stormwater system failure due to higher than design level tidal flooding or in very flat areas where chronic flooding may extent further inland. Potential or projected development exposed to risk from long-term coastal flooding as it will be further exacerbated by climate change is discussed in Section 4.2 (Climate Change and Sea Level Rise).

Table 4.3-9. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located the SLR-XA-1.1

County	Area (in square miles)								
	HCDA Community Development Districts	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kauaʻi	-	-	-	-	-	-	252.3	2.7	1.1%
City and County of Honolulu	7.4	0.1	1.7%	-	-	-	288.3	2.4	0.8%
County of Maui	-	-	-	27.6	0.0	0.1%	1,016.7	4.0	0.4%

County	Area (in square miles)								
	HCDA Community Development Districts	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Hawaiʻi	-	-	-	-	-	-	1,286.6	2.5	0.2%
Total	**7.4**	**0.1**	**1.7%**	**27.6**	**0.0**	**0.1%**	**2,844**	**12**	**0.4%**

Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (HCDA) (2) Maui Development Projects GIS layer from County of Maui Planning Department (3)
Enterprise Zones from Community Economic Development Program, DBEDT

SECTION 4. RISK ASSESSMENT

4.4 Dam Failure

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- The total number of dams and reservoirs differ from the 2013 State HMP. Updated data (Department of Land and Natural Resources' [DLNR] Dam Inventory System) was used to determine the total number of dams and reservoirs in each county.
- Dam failure events that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update.
- New and updated figures from federal, state and local agencies are incorporated.
- Analyzed state asset exposure to statewide dam inundation areas. Assessed local vulnerability utilizing three dam inundation areas per county.

4.4.1 Hazard Profile

Dams and reservoirs in the State of Hawaiʻi were predominately developed by the agriculture industry in the early 1900s. Today, dams and reservoirs continue to be used by the agriculture industry, in addition to providing storage for drinking water, flood control, hydropower, recreation and other purposes. The Hawaiʻi Dam Safety Program was started in 1987 when the statues were passed by the legislature and was followed up in 1989 with the Hawaiʻi Administrative Rules that were set up by DLNR. Most existing dams were built by private plantation owners in the early 1900s for irrigation and not for flood control; there were no regulatory construction standards at that time.

Key Terms

Dam - *An artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or water control (FEMA 2014).*

State-Regulated Dam - *Any artificial barrier that can or does impound or divert water and is 25 feet or more in height or impounds 50 acre-feet or more (Hawaiʻi Administrative Rules, Chapter 190.1.)*

Dam Failure - *An uncontrolled release of impounded water.*

Only dams that meet a certain jurisdictional size criteria (height and volume) are regulated by the State's Dam and Reservoir Safety Program. Regulated dams are identified as having artificial barriers which are 25 feet or more in height or have an impounding capacity of 50 acre-feet (approximately 17 million gallons) or more.

This section provides general information on the dam failure hazard. Flooding caused by chronic coastal flooding is discussed in Section 4.2 (Chronic Coastal Flood), event based flooding is discussed in Section 4.6 (Event-Based Flood), and storm surge is discussed in Section 4.10 (Hurricane).

Hazard Description

A dam is an artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or water control (FEMA 2014). A dam impounds water in the upstream area, or reservoir. The amount of water impounded is measured in acre-feet referring to the volume of water that covers an acre of land to a depth of one foot (FEMA 1997). In the State of Hawaiʻi, there are three types of dams:

- **Detention** dams are constructed to retard and minimize the effects of flood runoff. These types of dams are used to store all or a portion of an anticipated flood runoff. The floodwater stored by the dam is released at a rate that does not exceed the carrying capacity of the channel downstream.
- **Storage** dams are constructed to impound water during periods of surplus supply for use during periods of drought. This water is for crop irrigation, livestock watering, and municipal and industrial water supply. Lake Wilson and Nuʻuanu Reservoir on the island of Oʻahu are examples of local dams constructed for storage.
- **Diversion** dams are constructed to provide hydraulic head for diverting water from streams and rivers into ditches, canals, or other water conveyance, and are typically very small (Hawaiʻi State HMP 2013).

Dam failures can result from natural events, human-induced events, or a combination of the two. Dam failures typically occur when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion (piping) through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled waters that rush downstream damaging or destroying anything in its path (FEMA 1997). Dam failures can result from one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- 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 maintenance and upkeep (FEMA 2017b)

Location

The State of Hawaiʻi has a total of 132 dams and reservoirs, of which 123 have a classification of ʻhigh hazardʼ. An inventory of dams, by county, is listed in Appendix X. Table 4.4-1 summarizes the number of dams in each county. A majority of the dams and reservoirs (56 total) are located in the County of Maui, followed by the County of Kauaʻi with 53 dams and reservoirs. Table 4.4-2 summarizes the total square miles of dam failure inundation area statewide by county. The Counties of Maui and Kauaʻi have the greatest inundation area, followed by the City and County of Honolulu.

Table 4.4-1. Total Number of Dams and Reservoirs in each County

County	Total Number of Dams and Reservoirs
County of Kaua'i	53
City and County of Honolulu	13
County of Maui	56
County of Hawai'i	10
Total	**132**

Source: State of Hawai'i DLNR Engineering Division – Dam Safety 2018

Table 4.4-2. Total Square Miles of Dam Failure Inundation Area in each County

County	Total County Area (square miles)	Total Square Miles of Dam Failure Inundation Area	Percent (%) of Total Area
County of Kaua'i	630.3	13.8	2.2%
City and County of Honolulu	600.2	7.8	1.3%
County of Maui	1,174.6	24.1	2.1%
County of Hawai'i	4,027.8	7.5	0.2
Total	**6,432.9**	**53.2**	**0.8%**

Source: PDC 2018
Note: Area was calculated based upon the spatial layer provided by PDC. All dam failure inundation areas were merged for each county to remove overlap.

Extent

It is common practice among federal and state dam safety offices to classify a dam according to the potential impact a dam failure (breach) or misoperation (unscheduled release) would have on upstream and/or downstream areas or at locations remote from the dam. The hazard potential classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. Improbable loss of life exists where persons are only temporarily in the potential inundation area.

The State of Hawai'i classifies dams and reservoirs in a three-tier hazard rating system based on two factors: the amount of water impounded and the density, type, and value of development and infrastructure located downstream. The hazard potential classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. Improbable loss of life exists where persons are only temporarily in the potential inundation area. The hazard potential categories are listed below and summarized in Table 4.4-3.

Table 4.4-3. Dam Hazard Potential Classification

Category	Loss of Life	Property Damage	Hazard Description
Low	None expected	Low and generally limited to owner property	Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and in low economic and/or environmental losses. Losses are principally limited to the owner's property.
Significant	None expected	Yes	Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss

Category	Loss of Life	Property Damage	Hazard Description
			of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in the predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
High	Probable, one or more expected	Yes (but not necessary for this classification)	Dams assigned the high hazard potential are those where failure or misoperation will probably cause loss of human life.

Source: DLNR 2017

Warning Time

Warning time for dam failure varies depending on the cause of the failure. In events of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure because of earthquake, there may be no 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. Concrete gravity dams also tend to have a partial breach as one or more monolith sections are forced apart by escaping water. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers [USACE] 1997).

High and significant hazard dam owners are required to prepare and maintain an Emergency Action Plans (EAP). The EAP is to be used in the event of a potential dam failure or uncontrolled release of stored water. Owners are also required to have established protocols for flood warning and response to imminent dam failure in the flood warning portion of its adopted emergency operations plan. These protocols are tied to the EAPs also created by the dam owners. These documents are customarily maintained as confidential information, although copies are required to be provided to DLNR. The DLNR has an EAP for every regulated dam in the State of Hawaiʻi (DLNR 2017).

Previous Occurrences and Losses

The 2013 HMP discussed specific dam failure events that occurred in the State of Hawaiʻi through 2012. For this 2018 HMP Update, dam failure events were summarized between January 1, 2012, and December 31, 2017. For events prior to 2012, please refer to Appendix X. Between 2012 and 2017, no dam failure incidents occurred in the State of Hawaiʻi.

FEMA Disaster Declarations

Between 1954 and 2017, the State of Hawaiʻi was not included in any dam failure-related federal disasters (DR) or emergencies (EM) by FEMA (FEMA 2017).

Probability of Future Hazard Events

Causes for dam failure can be controlled through proper design, proper construction, regular inspections by qualified personnel, and a commitment to strong enforcement in order to correct identified deficiencies. The risk to downstream life and property can also be substantially reduced with effort to limit some types of development adjacent to streams and rivers. As these water control structures continue to age, the likelihood or probability of failure increases.

Since the 2006 breach of the Ka Loko Dam, the State of Hawaiʻi has increased their monitoring procedures and the probability of a dam failure has been significantly reduced statewide. A major dam failure event is considered rare; however, there is the potential for a dam failure to occur during or after extreme rainfall events, earthquakes, or landslides. Additionally, there is a risk of a dam failure should an event occur beyond those that the dam was designed to withstand. Overall, the probability of any type of dam failure is low due to dam safety regulations and oversight.

Potential Impacts of Climate Change on Probability of Future Events

Small changes in rainfall and runoff may have significant impacts for water resource systems, such as dams. 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 or its entire designed margin of safety, also known as freeboard. Loss of designed margin of safety may cause floodwaters to more readily overtop the dam or create unintended loads. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

Additionally, 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 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 spillway flows.

It is projected that the State will experience increased drought and heavy rain events causing an increasing flash flooding, infrastructure damage, runoff, and sedimentation (University of Hawaiʻi at Mānoa Sea Grant College Program 2014). In addition to a warming climate, the State of Hawaiʻi has experienced the impacts of El Niño and La Niña. El Niño leads to increase rainfall, flooding, and sediment runoff, which may lead to an increase risk of a dam failure as some dams may not be designed to withstand an increase in rain totals (NOAA 2018). For specific details regarding climate change, refer to Section 4.1 (Climate Change and Sea Level Rise).

4.4.2 Vulnerability Assessment

A DNLR-led study was conducted on 140 dams in the State and reported potential impacts of each dam's failure. This study was not available for the vulnerability assessment. For the 2018 HMP Update, the total number of state assets located in all spatially-delineated dam failure inundation areas was examined. However, it is important to note that it is highly unlikely that all dams would fail at the same time.

To assess local vulnerability, both the local HMPs were consulted and the HI-EMA Mitigation Section asked each County to select three dams they would like included in the risk assessment. The dam failure inundation areas for these 12 dams were provided by the PDC. Due to the limited number of dams evaluated to assess local vulnerability, the assessment below does not fully represent each county's total exposure nor vulnerability. The areas exposed to flooding from a dam failure would only experience serious flooding or flood damage if there was a dam failure.

The 12 dams selected to assess local vulnerability are listed below. Table 4.4-1. inundation area for these 12 dams. Refer to Appendix X which display the dam failure inundation areas.

- County of Kaua'i – Waita Reservoir (HI00099), Huinawai Reservoir (HI00104), Kapaia Reservoir (HI00012)
- City and County of Honolulu – Wahiawa Dam (HI00017), Kaneohe Dam (HI00124), Nuuanu Dam No. 4 (HI00001)
- County of Maui – Horner Reservoir (HI00054), Kualapuu Reservoir (HI00041), Wailuku Water Reservoir 6 (HI00150)
- County of Hawaiʻi – Waikoloa Reservoir No. 1 (National ID HI00040), Waikoloa Reservoir No. 2 (HI00122), Waikoloa Reservoir No. 3 (HI00136)

Table 4.4-4. Dam Failure Inundation Area for the 12 Selected Dams by County

County	Area		
	Total Area (square miles)	Dam Failure Inundation Area (square miles)	Percent (%) of Total Area
County of Kauaʻi	4,027.8	3.9	0.6%
City and County of Honolulu	600.2	0.6	0.1%
County of Maui	630.3	8.5	0.7%
County of Hawaiʻi	1,174.6	5.3	0.1%
Total	**6,432.9**	**18.3**	**0.3%**

Source: Pacific Disaster Center 2017
Note: These results do not represent the total dam failure inundation area statewide; and only reflect the 12 dams analyzed. There are overlapping dam failure inundation areas in the Counties of Kauaʻi and Hawaiʻi.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the dam failure hazard.

State Assets

For the purposes of this risk assessment, an asset is considered potentially vulnerable if it is in an identified hazard area. To assess the vulnerability of the state buildings, GIS software was used to overlay the statewide dam inundation hazard area with the buildings. Table 4.4-5 and Table 4.4-6 summarize the state buildings located in the statewide dam failure inundation area per county and state agency, respectively. The spatial analysis indicates that there are 232 state buildings (3.8%) vulnerable to dam failure statewide. Of these, the greatest number are in the City and County of Honolulu (102 buildings with a replacement cost value of $673 million. The majority of these buildings are occupied by the Department of Education and Department of Transportation.

Table 4.4-5. State Buildings Exposure to Statewide Dam Failure Inundation Areas by County

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Total Value of State Buildings in the Hazard Area	Percent (%) of Total Value
County of Kauaʻi	531	$957,679,537	18	3.4%	$13,195,343	1.4%
City and County of Honolulu	3,472	$16,750,785,426	102	2.9%	$673,908,023	4.0%
County of Maui	831	$2,862,316,819	79	9.5%	$127,452,761	4.5%

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Total Value of State Buildings in the Hazard Area	Percent (%) of Total Value
County of Hawaiʻi	1,261	$4,209,774,236	33	2.6%	$34,772,378	8.3%
Total	**6,095**	**$24,780,556,017**	**232**	**3.8%**	**$1,162,328,505**	**4.7%**

Note: Total Value = Replacement cost value of the structure and contents
Source: Hawaiʻi State Risk Management Office 2017; Pacific Disaster Center 2017

Table 4.4-6. State Buildings Exposure to Statewide Dam Failure Inundation Areas by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	2	3.0%	$11,709,702	1.2%
Dept of Agriculture	70	$133,065,375	7	10.0%	$13,966,868	10.5%
Dept of Attorney General	15	$95,151,863	1	6.7%	$1,133,204	1.2%
Dept of Budget & Finance	16	$26,624,294	1	6.3%	$4,210,917	15.8%
Dept of Business, Economic Development & Tourism	25	$612,574,032	0	0.0%	$0	0.0%
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.0%	$0	0.0%
Dept of Defense	69	$246,099,477	2	2.9%	$7,745,320	3.1%
Dept of Education	4,090	$9,604,111,443	130	3.2%	$468,961,028	4.9%
Dept of Hawaiian Home Lands	12	$100,471,477	0	0.0%	$0	0.0%
Dept of Health	44	$387,068,440	0	0.0%	$0	0.0%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%
Dept of Human Services	130	$420,004,555	9	6.9%	$18,603,114	4.4%
Dept of Labor & Industrial Relations	22	$79,322,626	0	0.0%	$0	0.0%
Dept of Land & Natural Resources	90	$98,666,185	4	4.4%	$2,939,792	3.0%
Dept of Public Safety	154	$427,884,909	0	0.0%	$0	0.0%
Dept of Taxation	1	$6,864,408	0	0.0%	$0	0.0%
Dept of Transportation	68	$2,912,510,888	10	14.7%	$55,065,292	1.9%
Hawai'i State Ethics Commission	1	$1,223,962,810	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	106	$333,526,064	2	1.9%	$2,979,553	0.2%
Hawaiʻi Housing Finance & Development Corporation	86	$933,255,767	0	0.0%	$0	0.0%
Hawaiʻi Public Housing Authority	273	$891,212	28	10.3%	$120,813,608	12.9%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in the Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Hawai'i State Public Library System	53	$525,584,082	5	9.4%	$22,596,333	4.3%
Judiciary	41	$511,093,204	1	2.4%	$2,265,282	0.4%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	2	18.2%	$25,998,989	48.2%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawai'i	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawai'i	637	$5,000,692,783	28	4.4%	$403,339,505	8.1%
Total	**6,095**	**$24,780,556,017**	**232**	**3.8%**	**$1,162,328,505**	**4.7%**

Source: Hawaiʻi State Risk Management Office 2017; Pacific Disaster Center 2017
Notes: Dept Department

There are portions of state roads that are exposed to flood waters should a dam failure occur. Flood waters can undermine or fully submerge roads for a period of time resulting in closures and cutting off critical access to communities. In addition, the flood waters can degrade the integrity of the roads. Sometimes the damage is apparent – a road that washes away, a sinkhole that appears, a bridge that crumbles, but often the damage is less obvious on the surface. Table 4.4-7 shows the length of state road in the dam inundation areas by county. Maui County has the greatest length of state road (5.4 miles) exposed to the dam inundation areas that were analyzed. A complete list of state roads is included in Appendix X.

Table 4.4-7. State Road Exposure to Statewide Dam Failure Inundation Areas by County

County	Length (in miles)		
	Total Length	Length of Road in the Hazard Area	Percentage (%) of Total Length
County of Kauaʻi	104.0	3.1	2.9%
City and County of Honolulu	375.3	10.7	2.9%
County of Maui	238.6	15.6	6.5%
County of Hawaiʻi	378.7	0.6	0.2%
Total	**1,096.5**	**30.0**	**2.7%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017; Pacific Disaster Center 2017
Note: Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.

Critical Facilities

Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads 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. Utility infrastructure is also vulnerable; interruption of services may not only impact vulnerable populations but may also impact facilities that need to be in operation during a disaster.

Table 4.4-8 summarizes the total number of critical facilities by core category located in the dam failure inundation areas statewide by county. City and County of Honolulu has the greatest number of critical facilities (43) within the analyzed dam inundation areas with the majority of the facilities being categorized as Energy. Table 4.4-9 summarizes the number and percentage of exposed critical facilities by core category. Commercial facilities have 34.2% of their facilities within the analyzed dam inundation areas.

Table 4.4-8. Critical Facilities Exposure to Statewide Dam Failure Inundation Areas by County

County	Category of Critical Facilities										Total in the Hazard Area
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	0	0	2	0	0	0	0	1	0	0	3
City and County of Honolulu	2	6	5	13	0	3	3	5	0	6	43
County of Maui	2	4	2	3	0	4	2	5	8	9	39
County of Hawaiʻi	1	0	0	0	2	0	1	1	0	1	6
Total	**5**	**10**	**9**	**16**	**2**	**7**	**6**	**12**	**8**	**16**	**91**

Source: Pacific Disaster Center 2017; Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2
Notes: Hazus Hazards-U.S.

Table 4.4-9. Critical Facilities Exposure to Statewide Dam Failure Inundation Areas by Core Category

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	5	8.33%	$70,681,201	34.2%
Communications	130	$523,848,060	10	7.69%	$35,770,200	6.8%
Emergency Services	149	$1,017,628,710	9	6.04%	$59,703,090	5.8%
Energy	90	$2,591,975,628	16	17.78%	$475,256,573	18.3%
Food & Agriculture	39	$829,869,410	2	5.13%	$63,264,080	7.6%
Government Facilities	100	$399,781,575	7	7.00%	$27,409,085	6.9%
Healthcare & Public Health	193	$3,399,521,375	6	3.11%	$41,400,713	1.2%
Mass Care Support Services	353	$11,497,547,155	12	3.40%	$398,512,675	3.5%
Transportation Services	56	$1,739,256,960	8	14.29%	$247,664,640	14.2%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	16	5.25%	$496,930,560	5.2%
Total	**1,475**	**$31,687,768,838**	**91**	**6.17%**	**$1,916,592,816**	6.1%

Source: Pacific Disaster Center 2017; Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2
Notes: Hazus Hazards-U.S.

ASSESSMENT OF LOCAL VULNERABILITY AND POTENTIAL LOSSES

The local HMPs were reviewed to integrate risk assessment results into the 2018 HMP Update; a summary of information available is below.

- **County of Kauaʻi –** The County HMP included dam risk assessment maps in an appendix. Exposure and potential loss estimates were not available in the main plan (County of Kauaʻi 2015).
- **City and County of Honolulu -** The two dams for which failure is considered to have the greatest impact, due to their high populations downstream of the dams, are the Nuuanu Reservoir dam and the Kaneohe Dam (City and County of Honolulu 2012).
- **County of Maui** - The Maui County HMP conducted an exposure analysis using dam failure evacuation area mapping for all state-regulated dams. The building exposure (in dollars) for each evacuation area was analyzed by overlaying each evacuation area on the general building stock inventory used. Exposure estimates for each evacuation area are listed by dam. In total, there is over $25 billion in building value (structure and contents) exposed to the dam failure hazard in Maui County. Three dams were chosen for a more in-depth exposure and vulnerability analysis: Horner Reservoir and Wailuku Water 6 on Maui and Kualapuu on Molokai. These dams were selected because they represent the largest, non-overlapping exposure areas on each island (Maui County 2015).
- **County of Hawaiʻi** - Dam failure scenarios were modeled for all registered dams in the county and impacts to population, transportation, building infrastructure and critical facilities were considered. These results are not reported in the public plan, and are for official use only (County of Hawaiʻi 2015).

Because not all local HMPs quantified dam failure impacts, the HI-EMA Mitigation Section asked each County to identify three dams they would like included in the 2018 HMP Update. This section provides a summary of vulnerability and potential losses to population, general building stock, environmental assets and cultural resources by county for the 12 dams selected for analysis. Similar to the analysis for state assets, a spatial exposure analysis was conducted and the results are summarized below.

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 who would not have adequate warning from the emergency warning system (e.g., television or radio); this would include residents and visitors/tourists. The population adversely affected by a dam failure may also include those beyond the disaster area that rely on the dam for providing potable water.

Floods created from a dam failure and their aftermath present numerous threats to public health and safety including exposure to unsafe food, contaminated drinking and washing water, mosquitoes, animals, mold and mildew. For more detailed descriptions of these and additional threats to public health and safety, refer to Section 4.7 (Event-Based Flood). Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to dam failure events.

The population exposed to a dam failure for the 12 dams chosen for further analysis is summarized in Table 4.4-10. Maui County has the greatest number of people located in the dam failure inundation hazard area assessed. This analysis does not include all dams statewide, and does not include the number of tourists and visitors in the State; therefore, this estimate may be underestimating exposure and vulnerability.

Table 4.4-10. 2010 U.S. Census Population Located in the 12 Dam Failure Inundation Areas by County

County	Total Population	Population in Hazard Area	Population Exposed as Percent (%) of Total	Population Over 65 in Hazard Area	Population Over 65 Exposed as Percent (%) of Total Population	Population with Income <$30K/year in Hazard Area	Population with Income <$30K/year as Percent (%) of Total
County of Kauaʻi	67,091	1,818	2.7%	382	0.6%	387	0.6%
City and County of Honolulu	953,207	4,685	0.5%	876	0.1%	795	0.1%
County of Maui	154,924	5,263	3.4%	890	0.6%	1,317	0.9%
County of Hawaiʻi	185,079	3,096	1.7%	341	0.2%	549	0.3%
Total	**1,360,301**	**14,862**	**1.1%**	**2,489**	**0.2%**	**3,048**	**0.2%**

Source: U.S. Census 2010; Pacific Disaster Center 2017
Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.
The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaiʻi. To convert households to residents, three people per household was used.

Land Use Districts

Table 4.4-11 shows the total area of each State Land Use District in the dam inundation hazard areas that were analyzed; refer to Appendix X for results by county. Of those dams chosen for analysis, Urban District Lands comprise the greatest area in the inundation areas. The high degree of exposure for these Urban District lands may have contributed to the counties' selection of these dams for analysis. Conservation District lands account for only a small amount of the dam inundation areas analyzed, likely due to the selection of particularly high impact dams. It is Conservation District Lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the subsection below. An assessment of the combined inundation areas and the relative exposure of the State Land Use Districts was not conducted for this 2018 HMP Update. As local hazard mitigation plans are updated, the full extent of this hazard in each county should be further analyzed.

Table 4.4-11. State Land Use Districts Located in the 12 Dam Failure Inundation Areas

Land Use District	Total (square miles)	Square Miles in Dam Inundation Area	Percent (%) of Total Area
Agricultural	2,942.8	5.3	0.2%
Conservation	3,156.3	0.6	0.0%
Rural	16.1	3.9	0.2%
Urban	319.7	8.5	1.7%
Total	**6,434.9**	**18.4**	**0.2%**

Source: Pacific Disaster Center, 2017; State Land Use Commission, 2016
Notes: Total area calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.

General Building Stock

The economic impact of dam failures varies depending upon the location and severity of the failure. Potential economic impacts include agriculture, business, tourism and the loss of buildings and tax-base. To further assess what is at risk, each county's general building stock's exposure was examined for the dams chose for further analysis. The general building stock in the inundation area is considered exposed to a dam failure. The structures closest to the dam failure inundation area are considered vulnerable because they would experience the largest, most destructive surge of water. Damages to buildings can displace people from their homes, threaten life safety and impact a community's economy and tax base. Table 4.4-12 summarizes the building replacement cost value located in the 12 dam failure inundation areas assessed.

Table 4.4-12. General Building Stock Exposure to the 12 Dam Failure Inundation Areas

County	Total Replacement Cost Value	Value Located in Dam Inundation Area	Percent (%) of Total Value
County of Kauaʻi	$13,287,882,000	$585,507,000	4.4%
City and County of Honolulu	$164,787,212,000	$731,088,000	0.4%
County of Maui	$31,320,693,000	$1,132,904,000	3.6%
County of Hawaiʻi	$33,326,392,000	$638,880,000	1.9%
Total	**$242,722,179,000**	**$3,088,379,000**	**1.3%**

Source: Hazus v4.2, State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal, 2017
Notes: Hazus Hazards-U.S.
RCV = replacement cost value structure and contents
Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.

Environmental Resources

The environment is vulnerable to a number of risks in the event of a dam failure. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks. The inundation may introduce foreign elements into local waterways, resulting in destruction of downstream habitat and impacting many animal and plant species, especially endangered species and coral ecosystems. Environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands, parks and reserves, and reefs located in dam inundation areas evaluated are summarized by county in Table 4.4-13.

Table 4.4-13. Environmental Resources Located in the 12 Dam Failure Inundation Areas

Environmental Asset	Total Area (square miles)	Area in the Dam Failure Inundation Area (square miles)	Percent (%) of Total Area
Critical Habitat[a]	915.2	0.3	0.03%
Wetlands	260.0	1.9	0.7%
Parks and Reserves	54.7	0.3	0.01%
Reefs[b]	3,837.6	0.0	0.0%
Total[c]	**915.2**	**2.6**	**0.1%**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; HWMO 2013
a. Critical area mileage includes the combined area of coverage of individual critical habitat areas
b. Reefs include artificial and coral reefs
c. Total square miles may be over reported as some environmental asset areas may overlap.
Sq. Mi. = Square miles.
Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.

Cultural Assets

Portions of the Hawaiian Home Lands are located in dam inundation hazards areas for the 12 dams assessed; land is vulnerable in the Counties of Hawaiʻi and Maui (see Table 4.4-14).

Table 4.4-14. Hawaiian Home Lands Located in Dam Failure Inundation Areas

County	Area		
	Total Area (square miles)	Dam Failure Inundation Area (square miles)	Percent (%) of Total Area
County of Kauaʻi	32.0	0.0	0.0%
City and County of Honolulu	10.9	0.0	0.0%
County of Maui	92.6	3.0	3.2%
County of Hawaiʻi	190.3	0.2	0.1%
Total	**325.8**	**3.2**	**1.0%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System
Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.

Future Changes that May Impact State Vulnerability

Understanding factors of change that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Potential or Projected Development

Dam failure inundation areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.4-15 below; refer to Section 3 for more information on projected development areas). None of the dam inundation areas selected for analysis intersect with the potential or projected development areas in the County of Kauaʻi or the City and County of Honolulu. Almost 4 square miles and more than 8 square miles are located in dam inundation areas in the County of Maui and the County of Hawaiʻi, respectively. It should be noted that this analysis does not include all dam failure risk within the State because only a subset of dam inundation areas was analyzed. It is likely that there are other dams whose failures would impact these areas. While existing floodplain development regulations in place at the county level may offer some protection for new development located in these areas, such protections would likely not be sufficient in many instances in the event of a catastrophic dam failure. This results from a number of factors such as, the extent of the dam inundation areas may be larger than the regulated floodplain and water depths and velocities may be stronger and higher than the 1% annual chance flood event.

Projected Changes in Population

As population in the State continues to increase there is the potential that more people will reside or work within dam inundation areas. Increased density and development is most likely to occur in Urban District lands, so careful attention should be paid to ensuring local zoning codes consider these risks. Additionally, as the population in the State ages (more than 23% of the population is projected to be 65 years of age of older by 2040) more residents may face challenges quickly evacuating an area in the event of an impending failure.

Other Factors of Change

The impacts of climate change in the state have the potential to increase the probability of future dam failure events as discussed in the Probability of Future Hazard Events section above; however, the direct impacts of a dam failure would not be likely to change.

Table 4.4-15. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in Dam Inundation Areas

County	Area (in square miles)								
	HCDA Community Development Districts	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kauaʻi	-	-	-	-	-	-	1,286.6	0.0	0.0%
City and County of Honolulu	7.4	0.0	0.0%	-	-	-	288.3	0.0	0.0%
County of Maui	-	-	-	27.6	0.3	1.2%	252.3	3.9	1.5%
County of Hawaiʻi	-	-	-	-	-	-	1,016.7	8.4	0.8%
Total	**7.47**	**0.0**	**0.0%**	**28**	**0.3**	**1.2%**	**2,844**	**3.9**	**1.5%**

Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (2) Maui Development Projects GIS layer from Maui County Planning Department (3) Enterprise Zones from Community Economic Development Program, DBEDT

Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal

Due to the limited number of dams evaluated, the tabular results do not fully represent the statewide exposure nor vulnerability.

SECTION 4. RISK ASSESSMENT

4.5 Drought

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Drought events that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP update.
- New and updated figures from federal and state agencies are incorporated.
- Provided a qualitative vulnerability assessment at the state level of damage to state assets and critical facilities from droughts.
- Provided a qualitative vulnerability assessment at the local (county) level of risk to the population, general building stock, and environmental resources and cultural assets from droughts.
- Included a qualitative vulnerability assessment of droughts in regard to future changes in development.

4.5.1 Hazard Profile

Hazard Description

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

Drought can be characterized from the perspectives of meteorology, agriculture, hydrology, and socio-economic impacts. For example, the meteorological perspective would describe drought as a rainfall deficit compared with some normal or expected rainfall amount. The agricultural perspective could describe drought by its impacts on the agricultural industry due to reduced rainfall and water supply (e.g., crop loss, herd culling, etc.). Hydrological descriptions of drought may compare stream flows, ground water, and reservoir levels to normal conditions. Drought can also be described from the socio-economic perspective by the direct and indirect impacts droughts have on society and the economy (e.g., increased unemployment due to failure of an industry because of drought).

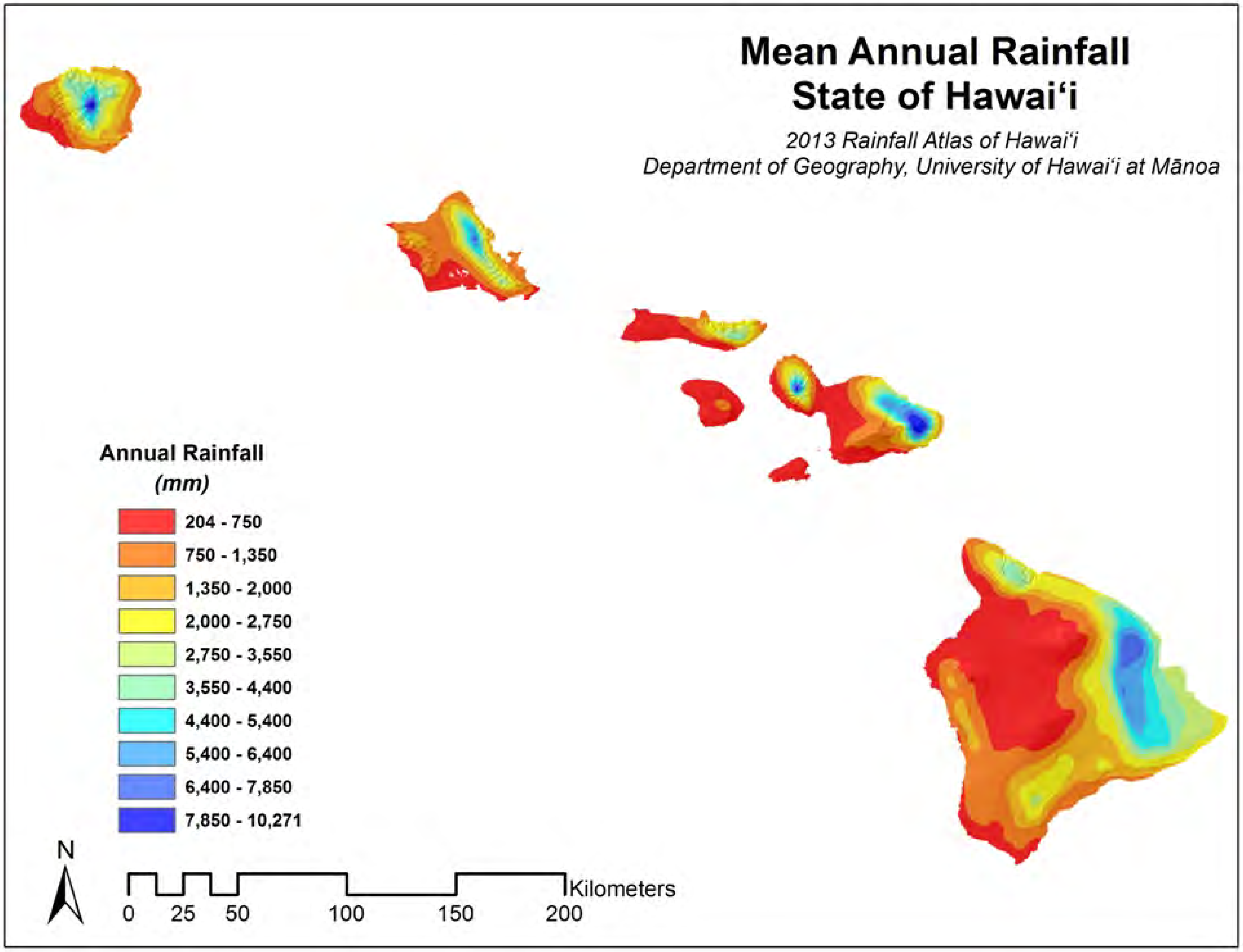
Lack of rainfall is not the only factor contributing to the impacts of drought. Both natural events and human activities; such as expanding populations, irrigation, and environmental needs; put pressure on water supplies. Lack of rainfall combined with the demands society place on water systems and supplies contribute to drought impacts.

Average Rainfall

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, however, rainfall varies considerably according to elevation. It should be noted that a recent study has shown fewer days with northeast trade winds than 40 years ago (Garza et al., 2012). Fewer days of northeast trade winds leads to more muggy weather and volcanic haze and results in longer-term effects for the state. The trade winds are responsible for much of the rainfall, especially in windward areas. As their occurrences decrease, so will the total rainfall, leading to more drought conditions. Over the last 30 years, the State of Hawaiʻi has experienced more frequent droughts and nearly half the state experienced some degree of drought in 2012 (University of Hawaiʻi at Mānoa Sea Grant College Program 2014; Gutierrez 2012).

Figure 4.4-1 shows a map of the main Hawaiian Islands indicating the average annual precipitation for the 30-year period between 1982 and 2011.

Figure 4.5-1. Mean Annual Precipitation Rainfall for the Main Hawaiian Islands



Source: Giambelluca et al. 2013

El Niño and La Niña

During El Niño, summers can have above average rainfall that extends the growing season and increases fuel loads, especially in drier areas where plant growth is limited by lack of rainfall. Extended drought through the winter months then causes vegetation to dry out, which can significantly increase wildfire risk, especially for windward parts of the state that are usually wet year-round (Trauernicht 2015).

La Niña is the opposite end of the oscillation. During these events, most of the tropical Pacific Ocean is cooler than average, and surface winds are stronger than normal. Rainfall decreases over the cooler central Pacific Ocean, including the State of Hawaiʻi. While La Niña is historically associated with wetter than normal rainfall in Hawaiʻi, drought conditions are still possible during these events.

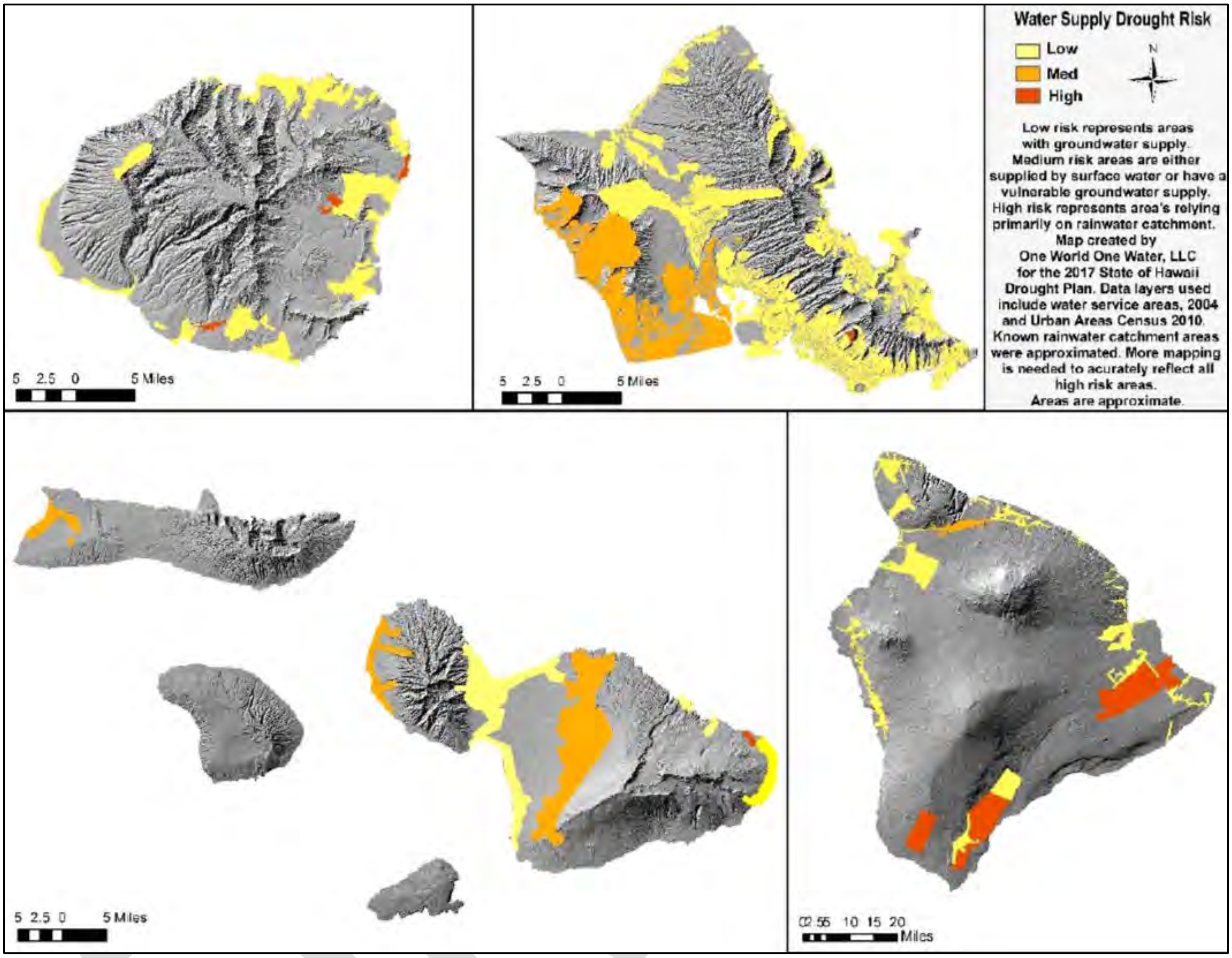
Location

All areas of the state are susceptible to drought, although the extent and severity of the drought will depend on the variance of rainfall throughout the state based on location. The identification of areas that are vulnerable to drought impacts is difficult due to the differences in microclimate and impact sectors. Figure 4.5-2 and Figure 4.5-3 show general risks to the water supply and agriculture and commerce sectors, respectively. For water supply, residents who rely primarily on rainwater catchment are at the highest risk (shown in red in Figure 4.5-2) to drought because they could run out of water from a week or two of reduced rainfall. The lowest risk to drought are those water supply areas that have adequate groundwater sources. Only a severe extended period of drought would affect these sources. It should be noted that water supply sources will only become more vulnerable with climate change. For further information, refer to the Hawaiʻi Drought Plan 2017 Update. The 'Impacts on Climate Change' subsection presented below details on how climate change will impact drought throughout the State of Hawaiʻi.

Figure 4.5-3 identifies agricultural areas that are more vulnerable to drought conditions. If the water supply source for the region is groundwater, it has a lower risk during periods of drought as it can most likely still withdraw water from groundwater to irrigate crops. Areas that rely on surface water have a medium drought risk as they typically have some ability to store water, although sources can run out in an extended drought period. Unirrigated areas, mostly pastures, are at highest risk because they rely directly on rainfall for productivity. Drought risk may change in the future due to changes in land use, water access, and climate change.

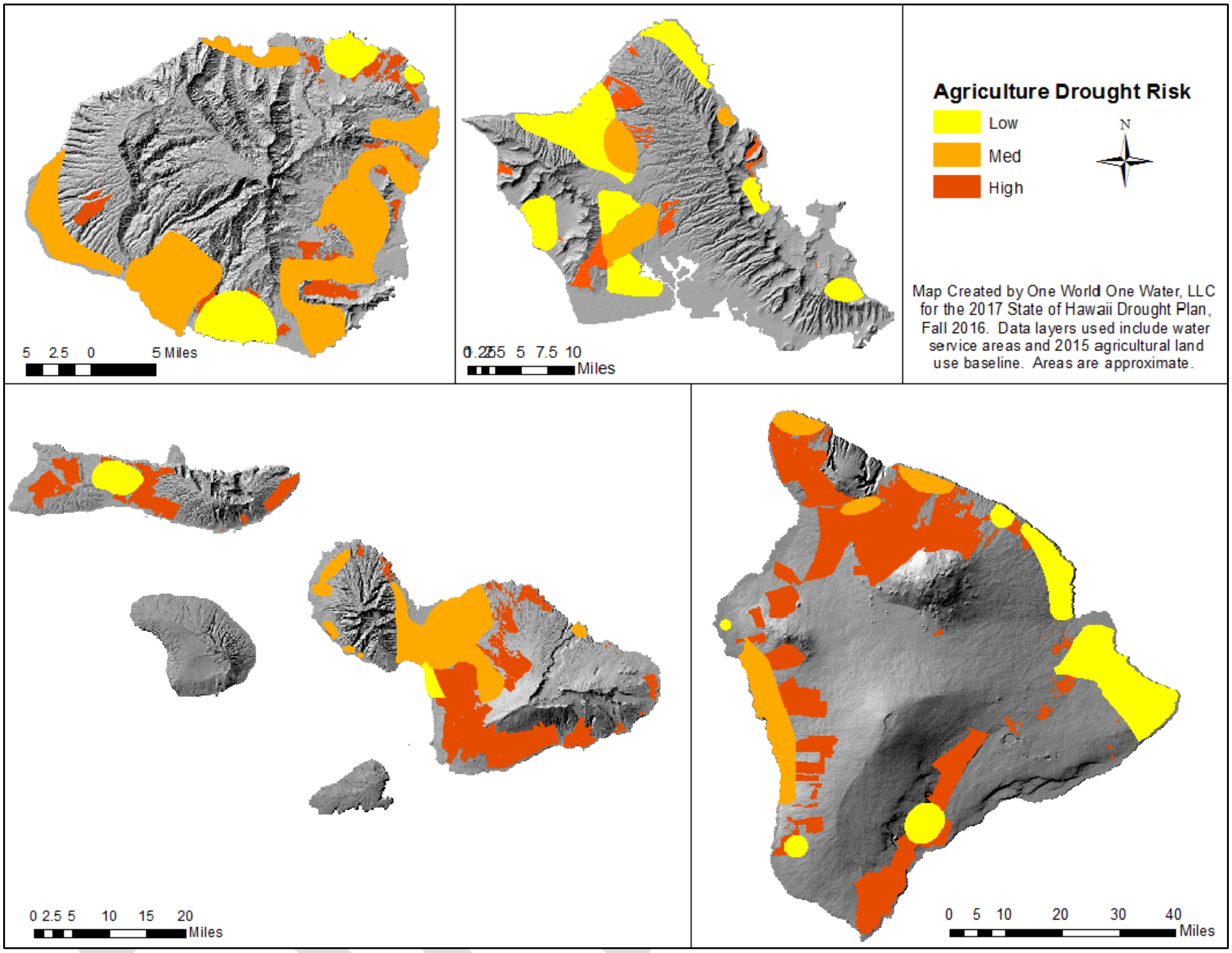
For the environment, public health, and safety sector in the state, refer to the Communities at Risk from Wildfires figure (Figure 4.15-X) found in Section 4.15 (Wildfire). This figure is beneficial for understanding areas at risk from environmental hazards of drought. During periods of drought, vegetation dries out and have an increase susceptibility to wildfire.

Figure 4.5-2. Water Supply Drought Risk in the State of Hawaiʻi



Source: Hawaiʻi Drought Plan 2017

Figure 4.5-3. Agricultural Drought Risk in the State of Hawai'i



Source: Hawai'i Drought Plan 2017

EXTENT

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. Droughts are not usually associated with direct impacts on people or property, but they can have significant impacts on agriculture, which can impact people indirectly. When measuring the severity of droughts, analysts typically look at economic impacts on an area.

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. The Drought Impact Reporter maps the effects of drought, based on reports from media, observers and other sources. Impacts are an observable loss or change at a specific place and time due to drought. The Drought Impact Reporter is not a comprehensive set of data, but is useful in tracking drought, if submissions are adequate, to aid in better understanding and response to drought impacts. The main emphasis is for drought planning.

The Drought Impact Reporter contains information on 59 drought impacts from droughts that affected Hawaiʻi between January 1, 2012, and December 31, 2017. Of those reported, 59% of them are from media reports. Most of the impacts (36) were classified as "agriculture." Other impacts include, "relief, response & restrictions" (24), "plants & wildlife" (21), "water supply & quality" (20), "fire" (11), "tourism & recreation" (4), "society & public health" (4), and "business & industry" (3). These categories are described on the National Drought Mitigation Center, Drought Impact Reporter website http://droughtreporter.unl.edu/.

Between January 1, 2012, and December 31, 2017, the County of Maui had 34 drought-related impacts; the County of Hawaiʻi had 31 drought-related impacts; the County of Kauaʻi had 8 drought-related impacts; and the City and County of Honolulu had 6 drought-related impacts.

Drought Monitoring and Forecasting

There are two popular drought indices used in Hawaiʻi to monitor and forecast droughts: the Standardized Precipitation Index and the Percent of Normal Rainfall Index. A third index, the Keetch-Byram Drought Index, is used by the National Weather Service to track wildland fire fuel conditions and to assess the potential for wildland fire in the State of Hawaiʻi.

Standardized Precipitation Index

The Standardized Precipitation Index (SPI) has been embraced by agencies such as the National Drought Mitigation Center (NDMC) and the Western Regional Climatic Center (WRCC). The SPI considers only precipitation, which makes the index ideal for use in Hawaiʻi, where there is a relatively dense network of rain gages. The SPI is computed for time scales ranging from 1 to 24 months. Because the SPI values are normalized, the wide range of rainfall conditions across the State of Hawaiʻi can be assessed on an equal basis. Furthermore, SPI values can be generated for multiple time scales. This feature is extremely useful for monitoring purposes because the effects of droughts occur over wide ranges of time scales. Finally, since the SPI uses standard statistical principles, it can also be used to monitor other data such as stream flow, reservoir levels, and ground water levels. Table 4.5-1 displays the different SPI categories and their associated values.

Table 4.5-1. SPI Categories

Value	Category
≥2.00	Extremely Wet
1.50 to 1.99	Severely Wet
1.00 to 1.49	Moderately Wet
0.99 to -0.99	Near Normal
-1.00 to -1.49	Moderate Drought
-1.50 to -2.00	Severe Drought
≤-2.00	Extreme Drought

Notes: ≥ *Greater than or equal to*
≤ *Less than or equal to*
SPI *Standardized Precipitation Index*

Percent of Normal Rainfall Index

The Percent of Normal Rainfall Index (PNRI) is based on the percentage of current rainfall value compared against the long-term mean. The PNRI is one of the simplest methods of comparing current precipitation amounts to recorded historical averages. The index is calculated by dividing the actual precipitation amount by a 30-year (typically) precipitation mean. Time scales are generally stated in months or a year. The PNRI is effective for comparing a single region or season in easily understood terms.

One of the disadvantages of using the PNRI is that the mean precipitation is often not the same as the median precipitation. The reason for this is that precipitation on monthly or seasonal scales does not have a normal distribution while the PNRI implies a normal distribution where the mean and median are considered being the same. Another disadvantage of the PNRI is that due to the variety in the precipitation records over time and location, there is no way to determine the frequency of the departures from normal or compare different locations inhibiting attempts to mitigate drought based on the departures from normal and form a plan of response.

Keetch-Bryam Drought Index

The Keetch-Byram Drought Index (KBDI) is calculated using weather station latitude, mean annual precipitation, maximum dry bulb temperature, previous 24-hour rainfall. The KBDI is used by the National Weather Service and foresters to assess fuel conditions and potential for wildfire. The KBDI describes soil moisture deficit with values ranging from 0 to 800. A value of 800 indicates extreme drought, and a value of 0 reflects saturated soil. KBDI at the Honolulu International Airport fluctuates through the year, while values in excess of 600 represent the highest 34% of values from 1975-2010. A KBDI of greater than 600 is typically encountered by late July and normally persists through late October (NOAA 2018a). The NWS issues Red Flag Warnings when all three of the following conditions are met for two hours or more during any part of a day at the Honolulu International Airport (NOAA 2018b):

1. KBDI ≥ 600
2. Minimum RH ≤ 45 % (2 hours or more)
3. Wind ≥ 20 mph (≥ 17 kt) (2 hours or more)

Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions. Though only generalized warnings can take place, the U.S. Drought Monitor provides current and recent history of areas and populations affected by drought (U.S. Drought Monitor 2018).

El Niño events are strongly correlated with drought in the State of Hawaiʻi. There is an approximately 70% chance of a drier than normal winter season following the onset of an El Niño event. This can give a lead time of up to 12 months or so for managers and decision makers to prepare for a potential drought. The intensity and duration of drought cannot be predicted, but an El Niño occurrence is one of the only indicators managers have to forecast drought in Hawaiʻi. It is very difficult to predict an El Niño or La Niña event but scientists monitor various ocean and atmospheric elements associated with these events and utilize complex computer models to make El Niño/La Niña forecasts. The NOAA Climate Prediction Center produces a monthly El Niño/Southern Oscillation (ENSO) Diagnostic Discussion, which provides analysis of current oceanic and atmospheric conditions as well as projection summaries of ENSO prediction models. It is important to note that a La Niña event can also affect rainfall – historically related to wetter than normal conditions, however this association is not as consistent as El Niño is to drought.

Drought is a very slow-developing hazard and depending on the impact sector, it may take anywhere from months to years for the impacts and effects of drought to be felt. Scientists at this time do not know how to predict drought more than one month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends 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 (NDMC 2018).

PREVIOUS OCCURRENCES AND LOSSES

Table 4.5-2 provides a summary of drought events that have impacted the State of Hawaiʻi between 2012 and 2017. Drought events that occurred prior to 2012 are included in the 2013 version of this HMP, which can be found in Appendix X.

Table 4.5-2. Drought Events in Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
January 1, 2012 to August 5, 2014	Drought	All	All portions of the state experienced abnormally dry to extreme drought conditions, particularly Hawaiʻi and Maui Counties. In 2012, the Counties of Maui, Kauaʻi, and Hawaiʻi were declared Primary Natural Disaster Area (USDA) due to drought. Between 2013 and 2014, Maui and Hawaiʻi Counties were designated Drought Disaster Areas (USDA).
September 16, 2014 to September 29, 2015	Drought	All	All portions of the State experienced abnormally dry to extreme drought conditions, particularly Hawaiʻi and Maui Counties. In 2015, the County

Date(s) of Event	Event Type	Counties Affected	Description
			of Hawaiʻi was in moderate drought. Less than one-fifth the normal average of rainfall fell at Hilo Airport in Hawaiʻi County.
November 10, 2015 to December 31, 2017	Drought	All	All portions of the state experienced abnormally dry to extreme drought conditions, particularly in the Counties of Hawaiʻi and Maui. In 2016, wildfires developed on Diamond Head on Oʻahu (City and County of Honolulu) and voluntary water reductions were encouraged in certain locations in the County of Maui.

Source: USDA 2018; National Drought Mitigation Center 2017; State of Hawaiʻi Department of Land & Natural Resources Commission on Water Resource Management 2017

As shown in Table 4.5-2, droughts have been and will continue to be a significant concern in the State of Hawaiʻi. Planning for and coping with recurring, if unpredictable, drought events is complicated by the inherent water resource limitations of the islands and the uneven range of drought-related concerns and relevant priorities across counties. The statewide variability in resources, vulnerability, and risk necessitates a sectoral approach to drought mitigation. Statewide, three sectors were identified as being vulnerable to drought as well as having the potential to be ameliorated through mitigation measures: public water supply; agriculture and commerce; and environment, public health and safety.

FEMA Disaster Declarations

Between 1954 and 2017, there have been no FEMA disaster declarations due to a drought in the State of Hawaiʻi.

USDA Disaster Declarations

In addition to FEMA disaster declarations, the State of Hawaiʻi has been included in agriculture-related drought disasters. According to the U.S. Department of Agriculture (USDA), these types of disasters are quite common; between one-half and two-thirds of the counties in the United States have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans (EM) to producers suffering losses in those counties and in counties that are contiguous to a designated county. In addition to EM eligibility, other emergency assistance programs, such as Farm Service Agency (FSA) disaster assistance programs, have historically used disaster designations as an eligibility requirement trigger. Table 4.5-3 and Table 4.5-4 provide the USDA Secretarial disaster declarations in all Hawaiian counties from January 1, 2012 through December 31, 2017. The Counties of Maui and Hawaiʻi received the most USDA declarations during this timeframe.

Table 4.5-3. Drought-Related USDA Declarations, 2012 to 2017

Year	Approval Date	Designation Number	Description of Disaster	Counties Affected
2012	May 7, 2012	S3247	Drought	Maui
2012	July 12, 2012	S3273	Drought	Hawaiʻi, Honolulu, Maui
2012	September 26, 2012	S3403	Drought	Kauaʻi
2013	January 9, 2013	S3458	Drought	Hawaiʻi, Maui
2014	January 15, 2014	S3628	Drought	Hawaiʻi, Maui
2015	August 19, 2015	S3867	Drought	Kauaʻi, Maui

Year	Approval Date	Designation Number	Description of Disaster	Counties Affected
2016	April 14, 2016	S3973	Drought	Hawaiʻi
2016	April 20, 2016	S3975	Drought	Maui
2016	May 11, 2016	S3978	Drought	Kauaʻi
2017	August 16, 2017	S4207	Drought	Hawaiʻi
2017	October 25, 2017	S4246	Drought	Maui
2017	November 21, 2017	S4258	Drought	Kauaʻi

Source: USDA 2018
Notes: USDA U.S. Department of Agriculture

Table 4.5-4. Summary of USDA Secretarial Disasters in Hawaiʻi, 2012 to 2017

County	2012	2013	2014	2015	2016	2017	6-Year Total
Hawaiʻi	1	1	2	0	1	1	6
Honolulu	1	0	0	0	0	0	1
Kauaʻi	1	0	0	1	1	1	4
Maui	2	1	1	1	1	1	7

Source: USDA 2018
Notes: USDA U.S. Department of Agriculture

Insured Crop Losses

According to the USDA Risk Management Agency (RMA), insured crop losses through the State of Hawaiʻi as a result of drought conditions for the six-year period of 2012 to 2017 totaled $2,829,361. In Table 4.5-5 the USDA RMA insured crop losses through the State of Hawaiʻi as a result of drought conditions are shown by year, from 2012 to 2017. It shows the highest year of crop losses as 2014 in this six-year period, followed by the years 2013 and 2012. Please note that this data only applies to insured crops.

Table 4.5-5. Total Insured Crop Insurance Paid by Year, 2012 to 2017

Year	Crop Insurance Paid
2012	$692,100
2013	$726,995
2014	$1,410,266
2015	$1,365
2016	$327,496
2017	$50,835
Total:	**$3,209,057**

Source: USDA Risk Management Agency
Notes: USDA U.S. Department of Agriculture

The USDA Farm Service Agency has two programs that cover agricultural losses: the Non-Insured Crop Disaster Assistance Program (NAP), and the Livestock Forage Disaster Program (LFP). For the period of 2012 to 2016, the total payments to the State of Hawaiʻi are $8,242,963 for NAP and $21,275,531 for LFP. For information on the full period of record, refer to Appendix X.

Table 4.5-6. USDA Farm Service Agency Disaster Benefits Paid by County and by Program, 2012 to 2016

County (and Year)	Non-Insured Crop Disaster Assistance Program	Ranchers	Livestock Forage Disaster Program	Ranchers
County of Kauaʻi				
2014	--	--	$918,705	61
2015	$25,000	5*	$159,435	49
2016	$15,000	5*	$382,268	52
Total for County of Kauaʻi	**$40,000**	--	**$1,460,408**	--
County of Maui				
2012	$561,729	20	--	--
2014	--	--	$2,642,304	310
2015	--	--	$134,770	80
2016	--	--	$310,977	60
Total for County of Maui	**$561,729**	--	**$3,088,051**	--
County of Hawaiʻi				
2012	$2,500,000	173	$4,560,087	253
2013	$2,544,485	192	$5,026,310	253
2014	$2,596,749	205	$4,560,413	253
2015	$0	0	0	0
2016	Ongoing**	--	$2,580,262	166
Total for County of Hawaiʻi	**$7,641,234**	--	**$16,727,072**	--
Total for Counties of Hawaiʻi, Kauaʻi and Maui	**$8,242,963**	**--**	**$21,275,531**	**--**

Source: State of Hawaiʻi Department of Land & Natural Resources Commission on Water Resource Management 2017
Notes: Only years that had disaster benefits paid in the time range are shown.
** Estimated*
*** Data from 2017 report noted above therefore, information for 2017 not available.*

Probability of Future Hazard Events

During the entire time period for the 2018 HMP Update, from January 1, 2012, to December 31, 2017, drought conditions existed somewhere in the State of Hawaiʻi. Based on the history of droughts in the state, the State of Hawaiʻi can expect drought conditions on an ongoing basis.

Impacts of Climate Change on Future Probability

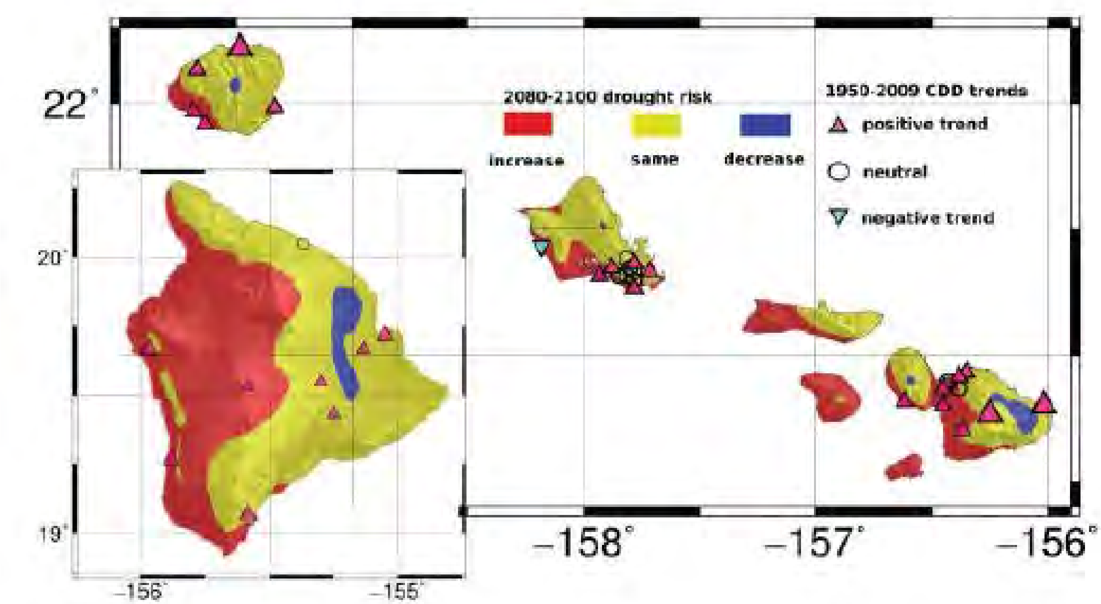
The effects of climate change on the drought hazard in the State of Hawaiʻi are described in detail in *Hawaiʻi Drought Plan 2017 Update* (State of Hawaiʻi Department of Land & Natural Resources Commission on Water Resource Management 2017). Climate change threatens the quality and quantity of fresh water available. Increasing temperatures, increased nutrient and sediment loads, and decreased dilution of pollutants during periods of drought threaten the availability of fresh water.

Over the past 93 years, the average annual rainfall has decreased, receiving almost one foot less rainfall today than a century ago. When trends are analyzed seasonally and spatially, much larger dry season declines are found, particularly on the leeward side of islands, up to a 10% decline per decade. Streamflow and base flow have also declined during this period of time, with impacts to groundwater storage–which supplies 99% of the State's drinking water. In addition, the State of Hawaiʻi is at risk to sea level rise (see Section 4.2 – Climate Change and Sea Level Rise). Rising sea levels may contaminate fresh water with salt water (Department of the Interior Pacific Islands Climate Science Center, 2017). Rising sea levels may also impact buried water and wastewater infrastructure near the shoreline.

Drought can also increase the likelihood of wildfire. An increase in wildfire events will destroy native plants and support the spread of fire-adapted (and often fire-promoting) invasive species (Department of the Interior Pacific Islands Climate Science Center, 2017).

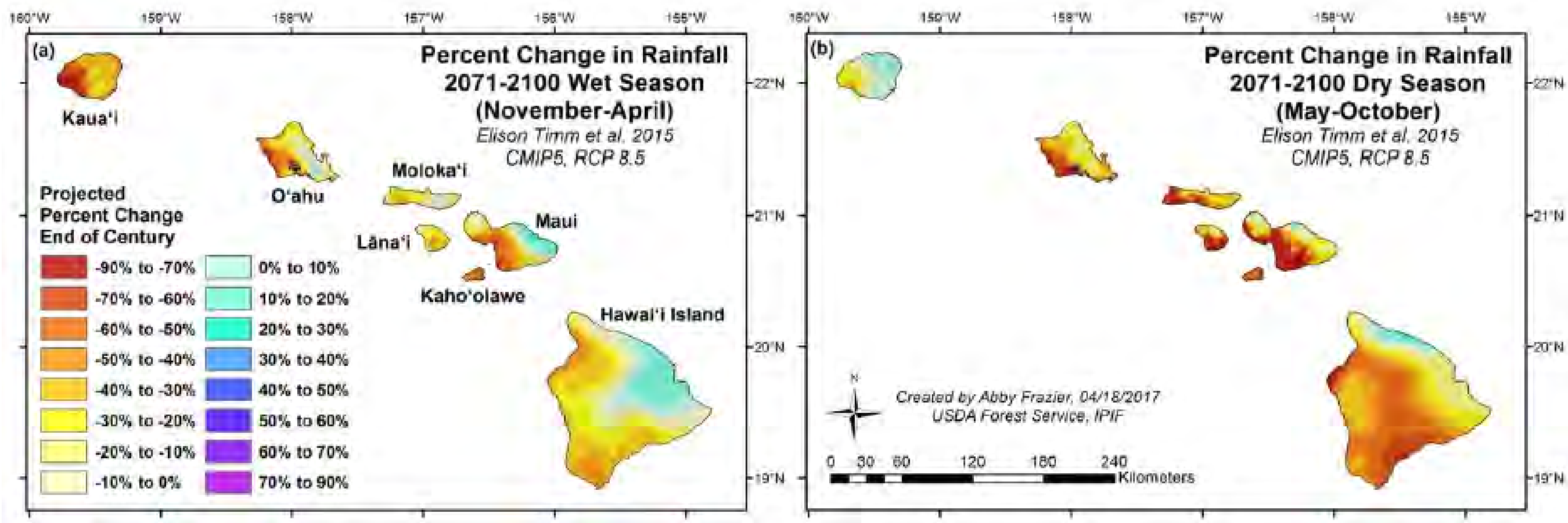
It is anticipated that climate change will increase the frequency of meteorological and agricultural droughts. This will increase the frequency of brief hydrological droughts, and the probability of a long hydrological drought. Figure 4.5-4 shows the potential for increased drought risk in the State of Hawaiʻi based on historical drought and future projections of climate change. Figure 4.5-5 shows precipitation projections for the 2071 to 2100 wet and dry seasons in Hawaiʻi based on statistical downscaling methods. It is important to note that there is inherent uncertainty in any global climate model that is downscaled to reflect the intricacies and microclimates of the Hawaiian Islands. These computer models continue to be refined and some downscaled Hawaii climate models have divergent results when compared with others.

Figure 4.5-4. Future Projections of Drought Based on Historical Data and Future Climate Projections



Source: State of Hawaiʻi Department of Land & Natural Resources Commission on Water Resource Management 2017

Figure 4.5-5. Percent Change in Rainfall



Source: State of Hawaiʻi Department of Land & Natural Resources Commission on Water Resource Management 2017

4.5.2 Vulnerability Assessment

The Hawaiʻi Drought Plan 2017 Update lists the different impacts of drought in the state, including: decimation of crops and livestock, the creating of dustbowls and erosion of landscapes, damage to terrestrial and aquatic wildlife habitats, enhanced wildfires, and economic damage. In addition to these impacts, the State of Hawaiʻi has other issues such as growing conflicts between agricultural uses of surface water and instream uses, surface and groundwater interrelationships, and the effects of growing water demands on traditional and cultural uses of water. Droughts have always been and will continue to be prevalent in the state. Droughts will continue to adversely affect the environment, economy, and the citizens of Hawaiʻi (State of Hawaiʻi Department of Land & Natural Resources Commission on Water Resource Management 2017).

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state-owned or state-leased buildings), state roads and critical facilities to droughts.

State Assets

Drought does not directly affect structures, so no state buildings are considered vulnerable to drought. However, there are secondary impacts that state buildings would be vulnerable to as a result of drought: wildfires and expansive soil effects on concrete and structure foundations.

Drought conditions may make structures more vulnerable to wildfires, which are more likely during a prolonged drought. Risk to life and property is greatest in areas where forested areas adjoin urbanized areas known as the wildland urban interface (WUI). Therefore, all state buildings and critical facilities (discussed below) in and adjacent to the WUI zone and located in high wildfire risk areas are considered vulnerable to wildfire. Section 4.15 describes the State's vulnerability to the wildfire hazard.

State buildings could be affected by the shrink-swell cycle that occurs as soils swell during wet periods and shrink during drought periods can cause damages to concrete components and structure foundations. Bridges and roads are especially vulnerable to damages as a result of the shrink-swell cycle. The Hawaiʻi Department of Transportation (HDOT) monitors this type of damage and is responsible for the repairs of those roads and bridges that are state-owned/maintained.

Critical Facility

As stated previously, drought does not directly impact structures. However, water-dependent critical facilities may be impacted. Under extreme drought conditions, where local water supplies are depleted and water utilities are unable to supply adequate water pressure, fire stations and healthcare facilities could be impacted. Healthcare facilities, including hospitals, clinics and nursing homes, rely on water for heating, cooling and ventilation systems, as well as for equipment sterilization, sanitation, water-based patient treatments, fire suppression and hazmat-decontamination.

Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the 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.

Secondary impacts from drought include an increased risk of wildfires which could threaten critical facilities and to the concrete components and structure foundations from the shrink-swell cycle of expansive soils, as discussed above.

ASSESSMENT OF LOCAL VULNERABILITY AND POTENTIAL LOSSES

Drought impacts cross jurisdictional boundaries and primarily impact the population's water supply and the agricultural/aquacultural industry. The state is vulnerable to drought, both statewide and county-specific because it has limited groundwater resources and is isolated. Buildings are not anticipated to be directly affected by a drought, and all are expected to be operational during a drought event. As discussed above, droughts can create conditions conducive to wildfires, and therefore local populations and buildings in and adjacent to the wildfire hazard areas are considered vulnerable to wildfire.

It is important to note that the unique terrain and orography of the Hawaiian Islands produce extremely variable microclimates and drought may impact limited geographical areas or affect large portions of an island. Where some areas on an island may be experiencing drought, other areas may be free of drought conditions. Drought conditions and impacts in Hawaii may vary greatly both temporally and spatially and this is an important factor to consider when planning for drought mitigation and preparedness.

Drought events impact the economy, including loss of business function and damage and loss of inventory. Industries that rely on water for business may be impacted the hardest (e.g., agriculture/aquaculture). Even though a majority of businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry which is an important part of each county's economy. In 2017, tourist expenditures in the State of Hawaii increased $980.7 million or 6.2 percent from the previous year.

Economic impacts may include:

- Losses from crop, livestock, timber, and aquaculture production and associated businesses.
- Losses from recreation providers and associated businesses.
- Losses related to the increased costs resulting from increased energy demand and from shortages caused by reduced hydroelectric generation capacity.
- Revenue losses for federal, state, and local governments from a reduced tax base and for financial institutions from defaults and postponed payments.
- Long-term loss of economic growth and development.

The size of the agriculture industry varies from county to county. A prolonged drought event could have significant impacts to the state's economy, particularly in counties that have large amounts of agricultural lands. Additionally, damaged and dead crops are also vulnerable to wildfires which can spread easily during periods of drought. Additional information about the potential exposure areas to drought in each county are discussed further below.

Based on past information, during a long-term drought (several months to years) drought first affects unirrigated agriculture and pasture operations. As the drought continues, surface water supplied water systems are impacted due to lowered stream flows, there is an increase in wildland fire occurrence, and residences that rely on rainwater catchment may need to purchase drinking water from water delivery companies (water haulers). If the drought continues, ground water supplies and drinking water utilities may be affected due to decreases in aquifer recharge, which is replenished by rainfall during normal conditions.

Population

Directly or indirectly, the entire population of the State of Hawaiʻi is vulnerable to drought events. Drought can affect people's health and safety, as well as other impacts. Health problems related to low water flows, poor water quality, or dust could arise. Additional possible impacts include recreational risks; air quality reduction; diminished living conditions related to compromised, local hydroelectric power sources; compromised food and nutrition; and increased incidence of illness and disease. How and to what degree drought affects the State's population does vary. However, there are primarily three sectors affected by drought which can affect the State as well as the individual counties populations to different degrees.

Overall, there are primarily three drought impact sectors that are critical to the health and welfare of the State's population in terms of social, economic, and environmental aspects. These impacts include: the Water Supply Sector, the Agriculture and Commerce Sector, and the Environment, Public Health, and Safety Sector. These sectors are not mutually exclusive and, as such, impacts in one sector may result in secondary or cumulative impacts in other sectors. The following describes these sectors:

Water Supply Sector

The water supply sector includes public and private urban and rural drinking water systems, agriculture water systems, and rainwater catchment systems. Since the availability of freshwater is crucial to human survival in both direct and indirect ways, minimizing the impact of drought to the State's freshwater is a significant priority. In the State of Hawaiʻi, most public water systems (PWS) are supplied by groundwater sources, but there are seven water systems and four catchment water systems that are considered PWS by the DOH (Hawaii Drought Plan 2017).

Agricultural and Commerce Sector

The Agriculture and Commerce Sector experiences severe negative drought impacts due to dependence upon both surface water and rainfall. Rainfall shortage-induced impacts are often exacerbated by the limits placed on ground water pumping during drought periods. A persistent shortage of rainfall and the resultant lack of soil moisture can result in reduced ground cover and lower agricultural yields. Reduced ground cover and pasture can result in the reduction of livestock herd sizes and is also associated with an increased rate of erosion. Drought impacts to the agriculture sector are highly dependent on whether or not the crops are irrigated since un-irrigated pasture, orchards, or other fields are most vulnerable to droughts. Irrigated agricultural areas become more vulnerable when water supplies become more threatened. Commerce sectors such as tourism will also experience negative drought impacts since tourism directly depends on healthy, thriving Hawaiian ecosystems (Hawaiʻi Drought Plan 2017).

Environment, Public Health, and Safety Sector

The Environment, Public Health, and Safety Sector mainly focuses on the increased incidence of wildfires due to drought conditions. Wildfires are described in Section 4.15 (Wildfire). However, there are environmental impacts of drought conditions that are also an important component of this sector. Stressed water supplies exacerbate already vulnerable island ecosystems and can result in impacts to wildlife habitats, water quality, land quality, biodiversity, and can contribute to erosion (Hawaiʻi Drought Plan 2017).

General Building Stock and Economy

As stated previously, drought does not directly impact structures, including the general building stock. The general building stock, as defined for this plan would continue to be functional during a drought. The only secondary impacts from drought would be an increased risk of wildfires which could threaten buildings located close to WUI areas, and to the concrete components and structure foundations from the shrink-swell cycle of expansive soils, as discussed previously.

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably in the State of Hawaiʻi, agriculture and aquaculture, as well as landscaping businesses. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses including reduced income for farmers and reduced business for retailers and others who provide goods and services to farmers.

According to the 2017 USDA Agriculture Overview for the State of Hawaiʻi, statewide there are 1,120,000 acres in agricultural use (USDA 2017). However, each county varies in the acreage of agricultural land and the overlapping risk from drought. Table 4.5-8 shows the USDA Census of the State of Hawai'i and the total value of agricultural products sold totaled $661 million that are exposed to drought conditions.

Table 4.5-7. State of Hawai'i State Agriculture Market Value

Agricultural Products Sold	Market Value
Value of crops, including nursery and greenhouse	$538,873,000
Value of livestock, poultry, and their products	$122,474,000
Total value of agricultural products sold	**$661,347,000**

Source: USDA Census 2012

According to the 2017 USDA Agriculture Overview for the State of Hawaiʻi, statewide there are 144,000 cattle (including calves) and 5,000 hogs (USDA 2017). The total value of livestock in 2012 was $122,474,000 (USDA 2018). Some of the best available current data to determine losses due to drought in the agricultural sector can be taken from records of the United States Drought Monitor which indicates severe impacts on livestock as well as crops. Lack of rainfall reduces the availability of forage plants for cattle grazing. During a severe drought, the herd may be culled to ensure that the remaining cattle stock survives during the drought. Once the drought is over, the plants take time to recover and this leads to a lag time in recovery to livestock herds. During a drought year, breeding cows decrease by 20% and calving decreases by 10%. Following the drought, it takes about 2.5 years to recover from the impacts to the herds (HMP 2013).

Estimates indicate a 50% reduction in production for cattle ranches, which approximate a decrease in revenue for ranches in the State of Hawaiʻi of about $4 million annually through the drought, and subsequently for 2.5 years following the drought while herds are reestablished. Not only are cattle affected by the lack of water, but by the lack of nutritional forage, which results in decreased weights of cattle and declines in reproduction. In October 2011, the FSA reported that various areas of the Island of Hawaiʻi have experienced a 30% to 100% loss of forage plants for livestock. Indirect costs from being unable to replace equipment, such as vehicles, during drought years compound the direct revenue losses and can extend recovery periods by three or four more years.

Environmental Resources and Cultural Assets

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.

Watersheds are critical to replenishing Hawaii's groundwater aquifers, which supply most of the state's drinking water. Healthy watersheds also reduce polluted runoff into our nearshore waters and support healthy stream ecosystems. Watersheds impacted by drought-induced ecosystem damage or wildfires result in decreased ground and surface water supplies and damage to nearshore waters and reef ecosystems.

Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary condition. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. The impacts to vegetation and wildlife can include death from dehydration and the spread of invasive species or disease because of stressed conditions. Invasive species pose problems for the ecosystems in which they are introduced. Like many hazards that affect the State of Hawaii's environment, invasive species have both direct and indirect impacts.

When groundwater is not replenished over a period of time, aquifer and well water levels diminish making irrigation and drinking water difficult to obtain. In addition, contamination of surface water sources can occur during drought conditions. Surface water reservoirs (although there are few in Hawaiʻi) may experience increased pollutant levels and lower levels of oxygen, contributing to higher concentrations of illness-causing bacteria and protozoa as well as toxic blue-green algae blooms.

Growing public awareness and concern for environmental quality has required that public officials focus greater attention and resources on these effects. Since the tourism industry accounts for a significant portion of the State's economy, adverse effects on the natural environment could have serious effects on this important sector (DLNR 2017).

The primary impacts on cultural assets from drought would be an increased risk of wildfires which could threaten these assets, and to structure foundations from the shrink-swell cycle of expansive soils.

Droughts may impact Native Hawaiian traditional and customary practices which rely on healthy terrestrial and marine ecosystems. These practices may include the collection of plants, animals and minerals and other practices. As discussed above, drought and its secondary impacts can damage watersheds and nearshore waters may impair, diminish, or impede the exercise of traditional and customary practices.

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population

- Other identified conditions as relevant and appropriate, including the impacts of climate change.

As the resident and visitor populations in the State of Hawaiʻi continue to increase, the stresses on the State's water sources will increase as more resources will be needed for human use and consumption and these resources are further taxed by changing climate conditions. Drought conditions and development are interrelated – as water is drawn down from increased rates of use, drought can occur more readily than from lack of precipitation alone. In addition, newly developed land or expansion into upland forested areas may reduce groundwater recharge as more land in the State becomes impermeable.

Native Hawaiian cultural practices are closely tied to the natural environment. Together, drought, wildfire, and invasive species threaten many of Hawaii's iconic plants and animals. When coupled with land use change and the spread of diseases facilitated by warming temperatures, impacts to native species and their habitat may incur (USGS 2018).

SECTION 4. RISK ASSESSMENT

4.6 Earthquake

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Earthquake events that occurred in Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update. Due to the severity of recent events, the May 2018 event is discussed; however, details regarding monetized impacts are not available at the time of this plan update.
- New and updated figures from federal and state agencies are incorporated.
- The probability of future occurrences was calculated based on the total number of earthquakes with epicenters in the State.
- Hazus was used to determine potential losses for the 100-year Probabilistic Event and four historic earthquake scenarios.

4.6.1 Hazard Profile

Thousands of earthquakes occur every year in the State of Hawaiʻi. Earthquakes in Hawaiʻi are caused by eruptive processes within the active volcanoes or by deep structural adjustments due to the weight of the islands on Earth's underlying crust (U.S. Geological Survey Hawaiian Volcano Observatory [USGS HVO] 2017). Most of these earthquakes are closely related to volcanic processes and are so small they can only be detected by seismometers. Some are strong enough to be felt on one or more of the islands. A few earthquakes are large enough to cause significant damage and impact residents across the State (USGS HVO 2017). Additionally, local or distant earthquakes can lead to tsunamis in the State of Hawaiʻi. For details regarding the volcano hazard in Hawaiʻi, refer to Section 4.13. For details regarding the tsunami hazard in the State of Hawaiʻi, refer to Section 4.12.

Hazard Description

Hawaiian earthquakes fall into three main categories: volcanic, tectonic, and mantle:

- Volcanic – magma movement within, and eruptions from, the presently active volcanoes in the state (Kīlauea, Mauna Loa, Hualālai, Haleakalā, and Lōʻihi) are usually accompanied by hundreds to thousands of small earthquakes that rarely cause significant damage. The small earthquakes are caused by the movement of magma and often occur in shallow swarms, especially after an eruption. These volcanic earthquakes are important for volcano monitoring (Wong et al. 2011; USGS HVO 2017).
- Tectonic – earthquakes occur when the large, thin plates of the earth's crust and upper mantle become stuck as they move past one another. They lock together, pressures build up, and when released, earthquakes occur (Gillespie 2018). Tectonic earthquakes are the most common type of less damaging earthquakes (up to magnitude 5) in the State of Hawaiʻi (USGS HVO 2017).

- Mantle – this type of earthquake reflects the flexing/bending of the earth's crust and upper mantle, known as the lithosphere, due to the weight of the islands above. This is the most common source of damaging earthquakes north of the Island of Hawaiʻi. This type of earthquake generally occurs more than 12 miles below sea level (USGS HVO 2017).

LOCATION

The majority of earthquakes in the State of Hawaiʻi occur on and around the County of Hawaiʻi, especially in the southern districts of the island where Kīlauea, Mauna Loa, and Lōʻihi volcanoes are located. These three volcanoes are the most active in the state (USGS HVO 2017). Most earthquakes are caused by ruptures along geological faults. The County of Hawaiʻi has 10 fault systems: Hilina fault system, Ka'oiki-Honu'apo fault system, Ka'oiki seismic zone, Kahuku fault system, Kealakekua fault system, Kilauea Volcano, Koa'e fault system, Kohala Volcano, Lo'ihi Seamount, and Mauna Loa Volcano (see Figure 4.6-2). Shaking from large scale events could potentially be felt anywhere in the State, but are most likely to be felt close to the earthquake's epicenter. Where shaking can be felt is discussed in more detail in the Extent Section below.

NEHRP Soil Classifications

Ground shaking is the primary cause of earthquake damage to buildings and infrastructure. Softer soils amplify ground shaking. One contributor to shaking amplification is the velocity at which the rock or soils transmits shear waves (S-waves). The National Earthquake Hazard Reduction Program (NEHRP) defined five soil types based on their shear-wave velocity (Vs.) that aid in identifying locations that will be significantly impacted by an earthquake. The NEHRP soil classification system ranges from A to E, as noted in Table 4.6-1, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses.

Table 4.6-1. NEHRP Soil Classifications

Soil Classification	Description
A	Hard Rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soils
E	Soft soils

Source: FEMA 2013

The NEHRP soil classifications have only been determined and spatially delineated for the Counties of Maui and Hawaiʻi (Table 4.5-2). Approximately 112 square miles (or 9.5%) of the County of Maui is underlain by NEHRP soil classes D and E, mainly class D; the County of Hawaiʻi has a similar size area underlain by D and E soil classes (130.1 square miles). Figure 4.6-1 and Figure 4.6-2 show the NEHRP soil classifications for these two counties.

Table 4.6-2. Area of NEHRP Class D and E Soils

County	Area (in square miles)		
	Total Area	Area of NEHRP Class D and E Soils	Area as % of Total Area
County of Kauaʻi	620.0	-	-
City and County of Honolulu	600.7	-	-
County of Maui	1,173.5	111.9	9.5%
County of Hawaiʻi	4,028.4	130.1	3.2%
Total	**6,422.6**	**242.1**	**3.8%**

Source: AECOM; Tetra Tech
Notes: NEHRP National Earthquake Hazard Reduction Program
The area of NEHRP soil classifications for the Counties of Kauaʻi and City and County of Honolulu are unknown at this time.
NEHRP soil classifications for the County of Maui are approximate and are appropriate for planning purposes only. Please see Section 4.0 Risk Assessment Overview for additional information.

Liquefaction Susceptibility

Liquefaction can be defined as a process by which sediments below the water table temporarily lose strength and behave as a liquid, usually in areas of loosely packed soil. Roads might buckle, bridges and overpasses might crash down, low-rise buildings might sink, but high-rise buildings which are anchored in the underlying rock should be able to survive without collapsing (Hawaiʻi State HMP 2013; Honolulu Magazine 2013). Areas underlain by NEHRP class D and E soils are more susceptible to liquefaction. Refer to the figures above for the location of these types of soils in the County of Maui and the County of Hawaiʻi.

In addition, NOAA Coastal Service Center sponsored a project in 2005 to identify areas with the potential for soil liquefaction in the Counties of Maui and Hawaiʻi. The results of the study showed small areas of high liquefaction susceptibility in Maui: the west Maui region (from Lahaina to Nāpili), the south Maui area (from Kīhei to Mākena), and the central Maui region (Kahului and Wailuku) (Hawaiʻi State HMP 2013).

Figure 4.6-1. NEHRP Soil Classification for the County of Maui

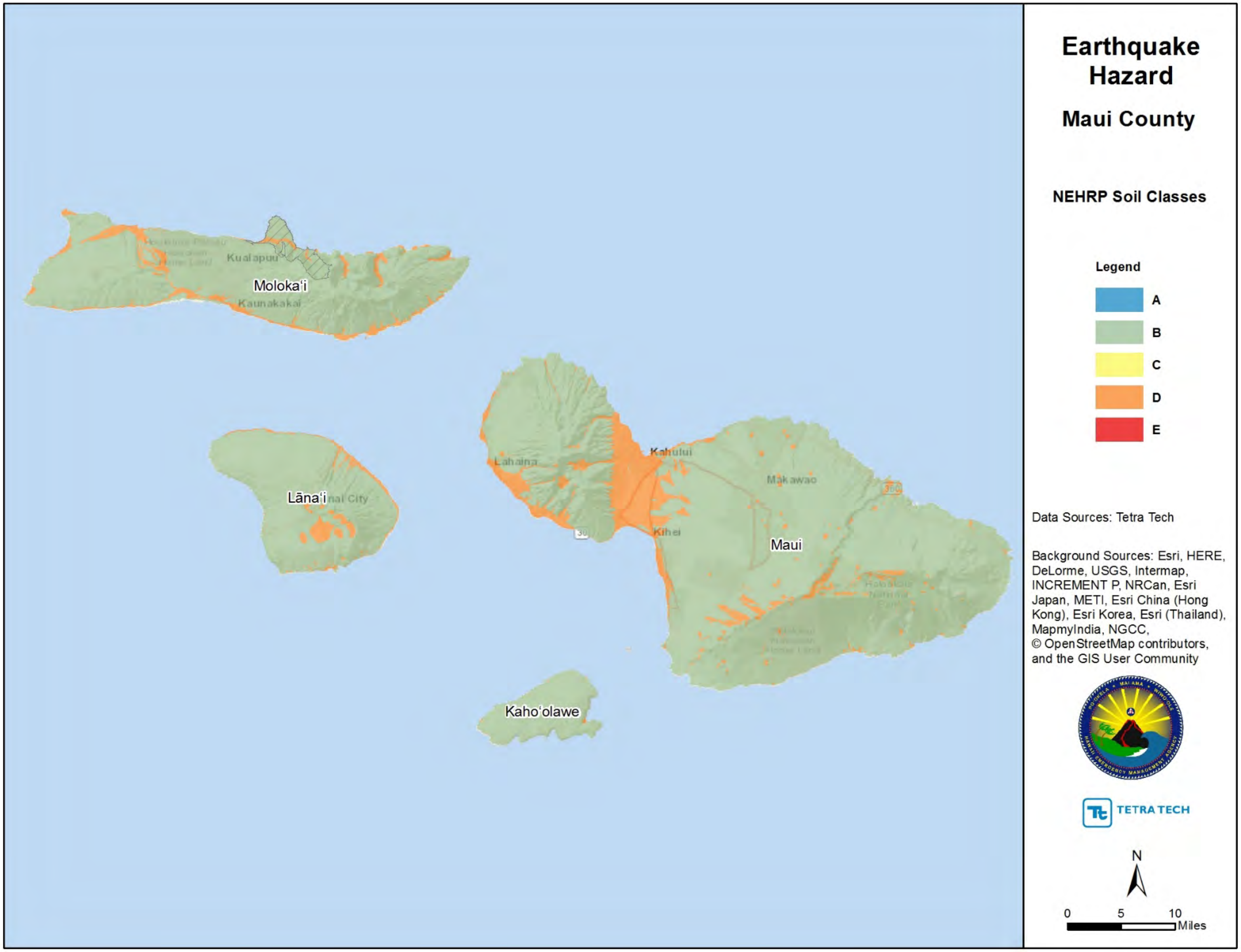
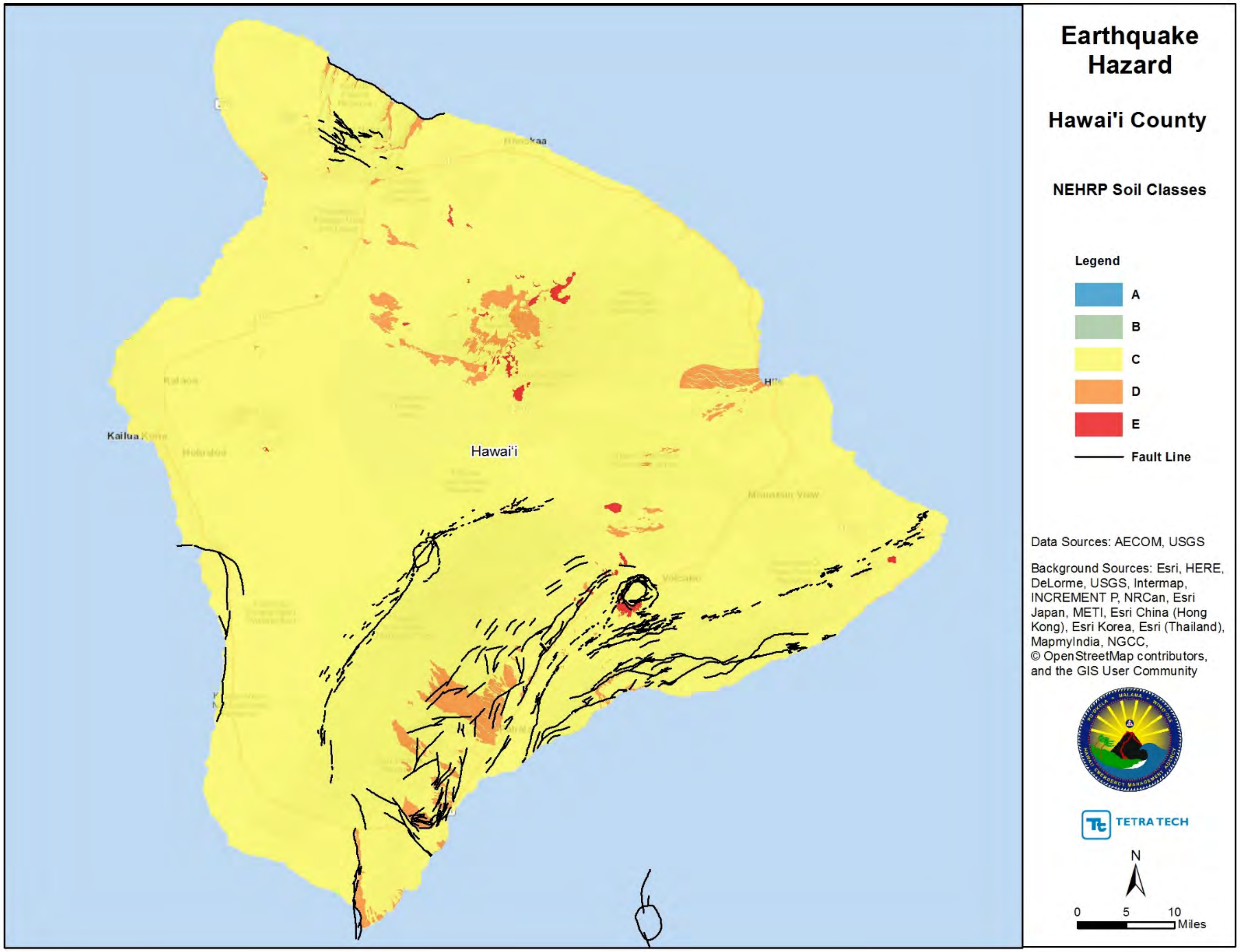


Figure 4.6-2. NEHRP Soil Classification for the County of Hawaiʻi



Extent

The severity of an earthquake is classified by magnitude and intensity. Magnitude is the amount of energy released at the epicenter of an earthquake. Intensity measures the effects of an earthquake on people and structures.

Ground Motion

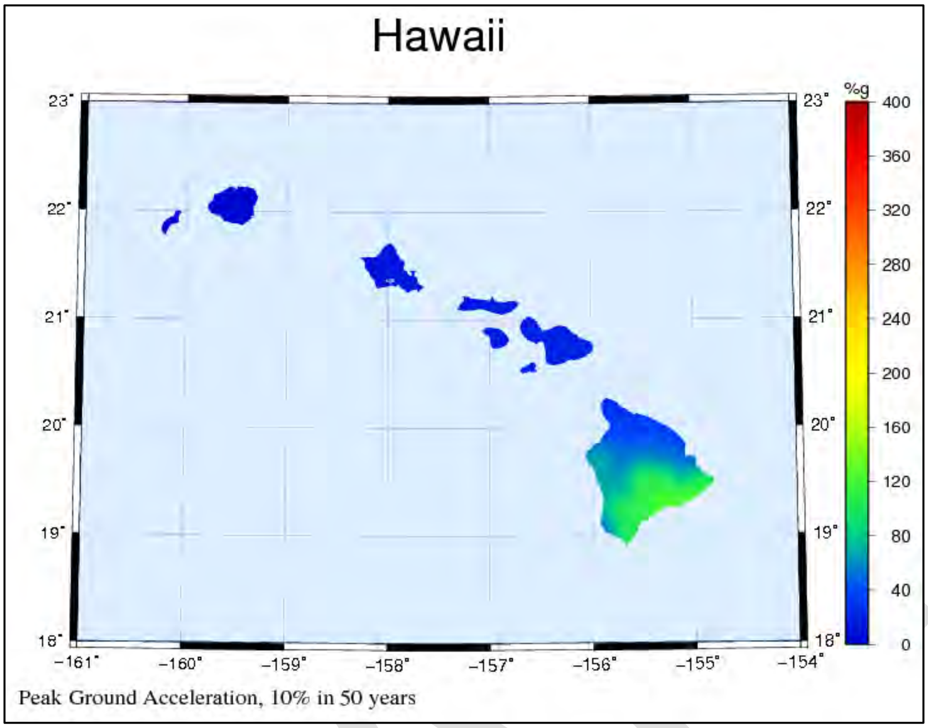
One way to express an earthquake's severity is to compare its acceleration to the normal acceleration due to gravity. Peak ground acceleration (PGA) measures the rate of change in motion to the earth's surface and expresses it as a percent of the established rate of acceleration due to gravity (9.8 meters per second squared [m/sec^2]). PGA is expressed as a percent acceleration force of gravity (%g). For example, 100%g PGA in an earthquake (an extremely strong ground motion) means that objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10%g PGA means that the ground acceleration is 10 percent that of gravity.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damages for earthquakes with various levels of ground shaking (PGA) at a given site:

- Ground motions of 1 to 2%g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
- Ground motions below 10%g usually cause only slight damage, except in unusually vulnerable facilities.
- Ground motions of 20 to 50%g may cause significant damage in some modern buildings and very high levels of damage (including collapse) in poorly designed buildings.
- Ground motions greater than 50%g may cause higher levels of damage in many buildings, even those designed to resist seismic forces.

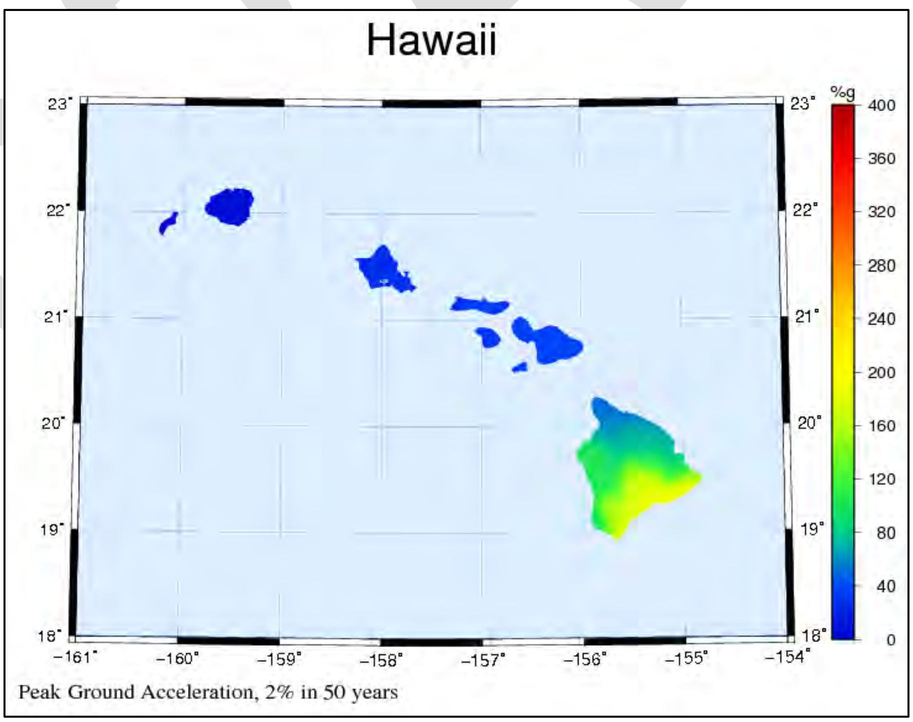
According to USGS Earthquake Hazards Program, PGA maps (also known as earthquake hazard maps) are used as planning tools when designing buildings, bridges, highways, and utilities so that they can withstand shaking associated with earthquake events. These maps are also used as planning tools for the development of building codes that establish construction requirements appropriate to preserve public safety. Figure 4.6-3 and Figure 4.6-4 show contours of PGA with 10% and 2% chances of occurring over the next 50 years. These maps are created with data from the USGS to produce uniform probabilistic seismic hazard maps for the United States. The 10% of a 50-year PGA value means that over the next 50 years, there is a 10% probability of this level of ground shaking or higher. This also represents a likely earthquake while the 2% of a 50-year PGA represents a level of ground shaking close to but not the absolute worst-case scenario. Both figures show a majority of the State have low levels of seismic hazard with the Island of Hawaiʻi having intermediate levels of seismic hazard.

Figure 4.6-3. 1998 Seismic Hazard Map, PGA with 10% Probability of Exceedance in 50 Years



Source: USGS 1998

Figure 4.6-4. 1998 Seismic Hazard Map, PGA with 2% Probability of Exceedance in 50 Years



Source: USGS 1998

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 (Mw), 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 intensity of an earthquake is based on the observed effects of ground shaking on people, buildings, and natural features, and varies with location. The Modified Mercalli scale expresses intensity of an earthquake; the scale is a subjective measure that describes how strong a shock was felt at a particular location. The Modified Mercalli scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. Table 4.6-3 summarizes earthquake intensity as expressed by the Modified Mercalli scale and lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Table 4.6-3. Modified Mercalli Intensity and Peak Ground Acceleration Equivalents

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA (%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%

Sources: USGS, 2008; USGS, 2010
Notes: Peak ground acceleration (PGA) measured in percent of g, where g is the acceleration of gravity
< = Less than
> = More than
USGS U.S. Geological Society

ShakeMap

The ShakeMap was developed by the U.S. Geological Survey (USGS) and facilitates communication of earthquake information beyond just the magnitude and location. A ShakeMap shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Three types of ShakeMaps are typically generated:

- Probabilistic—A probabilistic seismic hazard map shows the hazard from earthquakes that geologists and seismologists agree could occur. The maps are expressed in terms of probability of exceeding a certain ground motion, such as the 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas.
- Figure 4.6-5 shows the estimated ground motion for the 100-year probabilistic seismic hazard in the State of Hawaiʻi generated by Hazus v4.2.
- Scenario Maps—Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. Maps of these scenarios can be used to support all phases of emergency management.
- Historic/Current Scenario Events—ShakeMaps are generated for historic earthquake events or earthquake events that have recently occurred. Recent events help emergency managers and the public understand where damages are likely and also provide insight to what types of damages would be likely if the event were to occur with today's level of development. Four historic scenarios were chosen for analysis in the 2018 HMP Update (see Figure 4.6-6 through Figure 4.6-9):
    - Kalapana M7.2 earthquake on November 29, 1975 (Kalapana M7.7 ShakeMap data represents this event)
    - Kaʻū District M7.9 earthquake on April 3, 1868 (Kaʻū M8.0 ShakeMap data represents this event)
    - Lānaʻi M6.8 earthquake on February 20, 1871 (Lānaʻi M7.0 ShakeMap data represents this event)
    - Northeast (NE) Maui M6.5 earthquake on January 23, 1938 (NE Maui 7.0 ShakeMap data represents this event).

Warning Time

Under the Disaster Relief Act of 1974, the USGS has the federal responsibility to issue alerts for earthquakes, enhance public safety, and reduce losses through effective forecasts and warnings. USGS currently issues rapid, automatic earthquake information via the Internet, e-mail messages, text messages, and social media (USGS 2012). However, this is no current 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.

Figure 4.6-5. PGA for the 100-Year Probabilistic Statewide Scenario

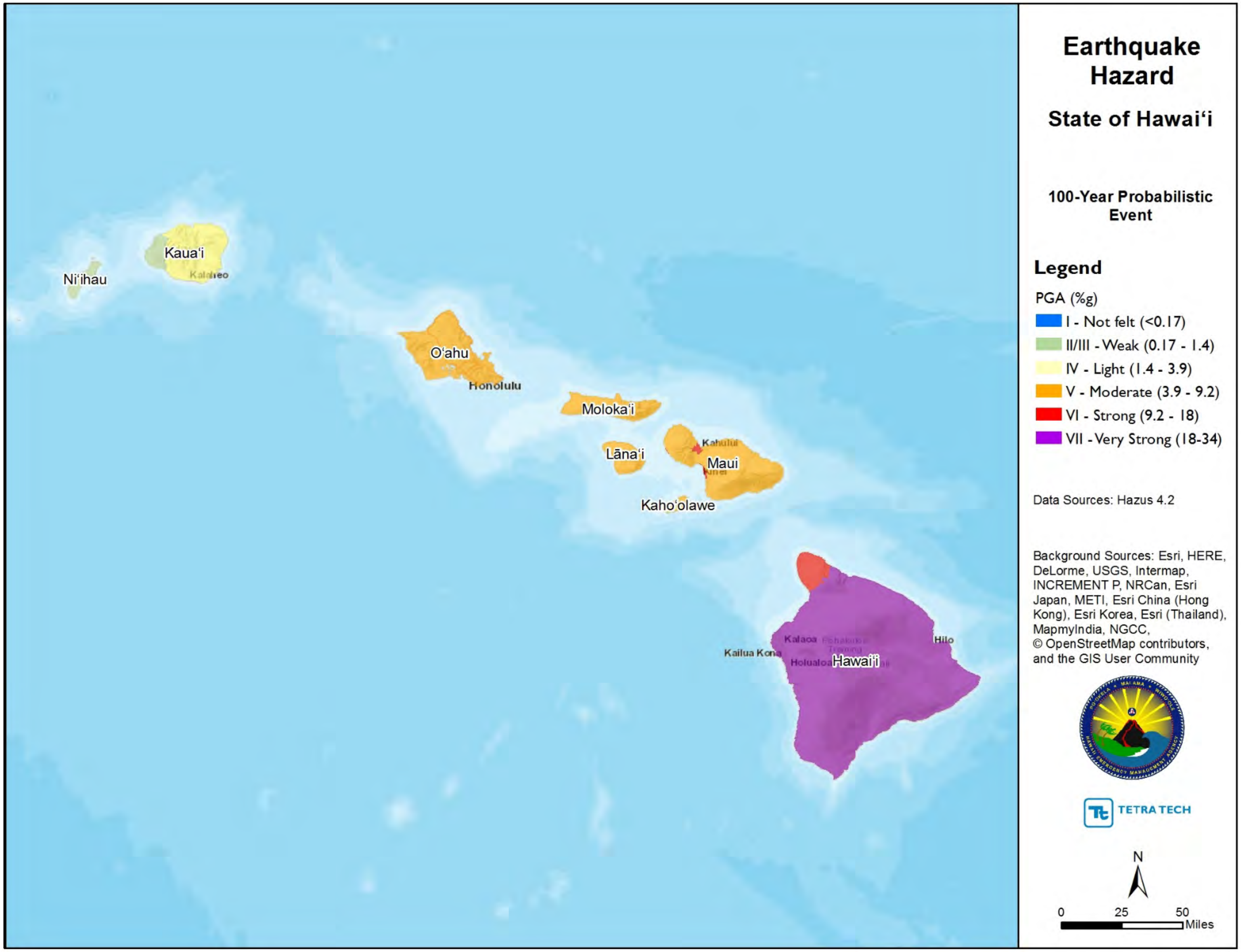
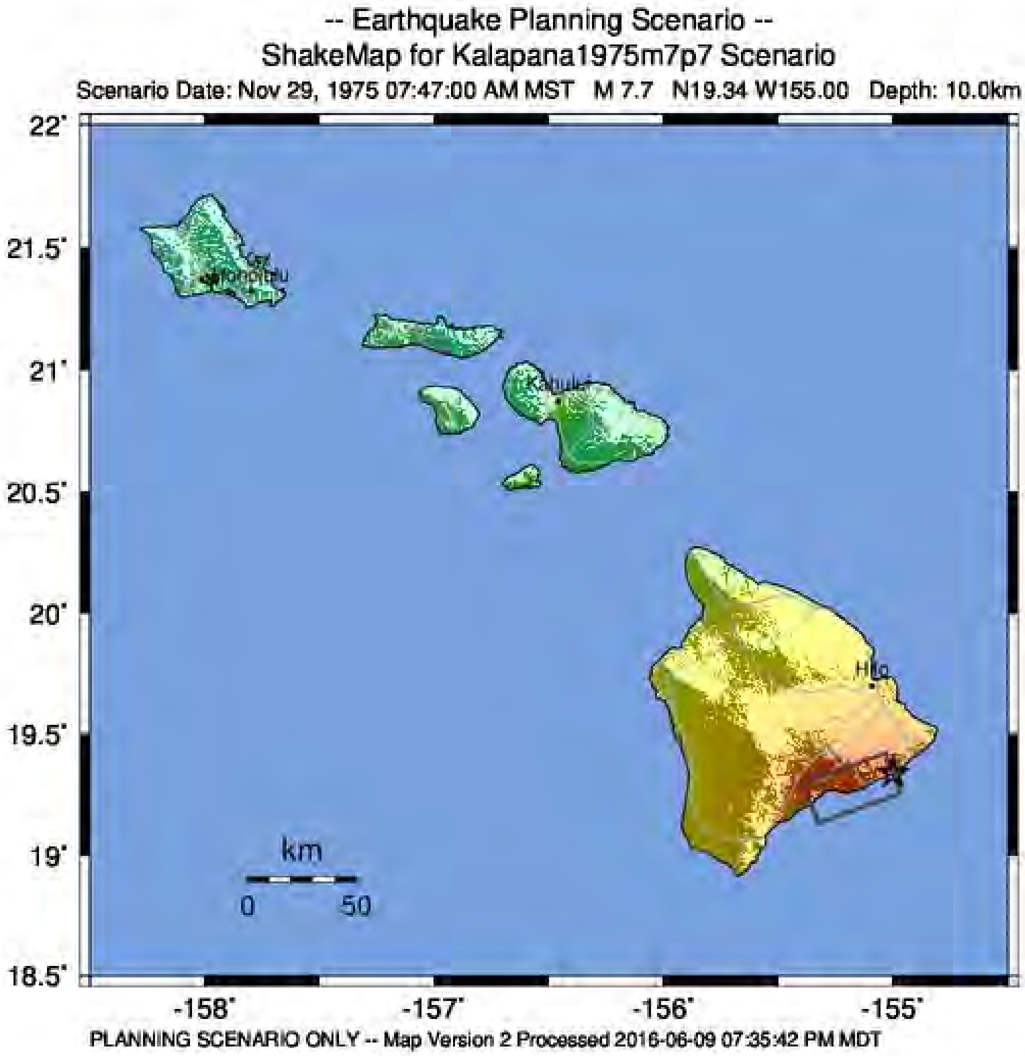


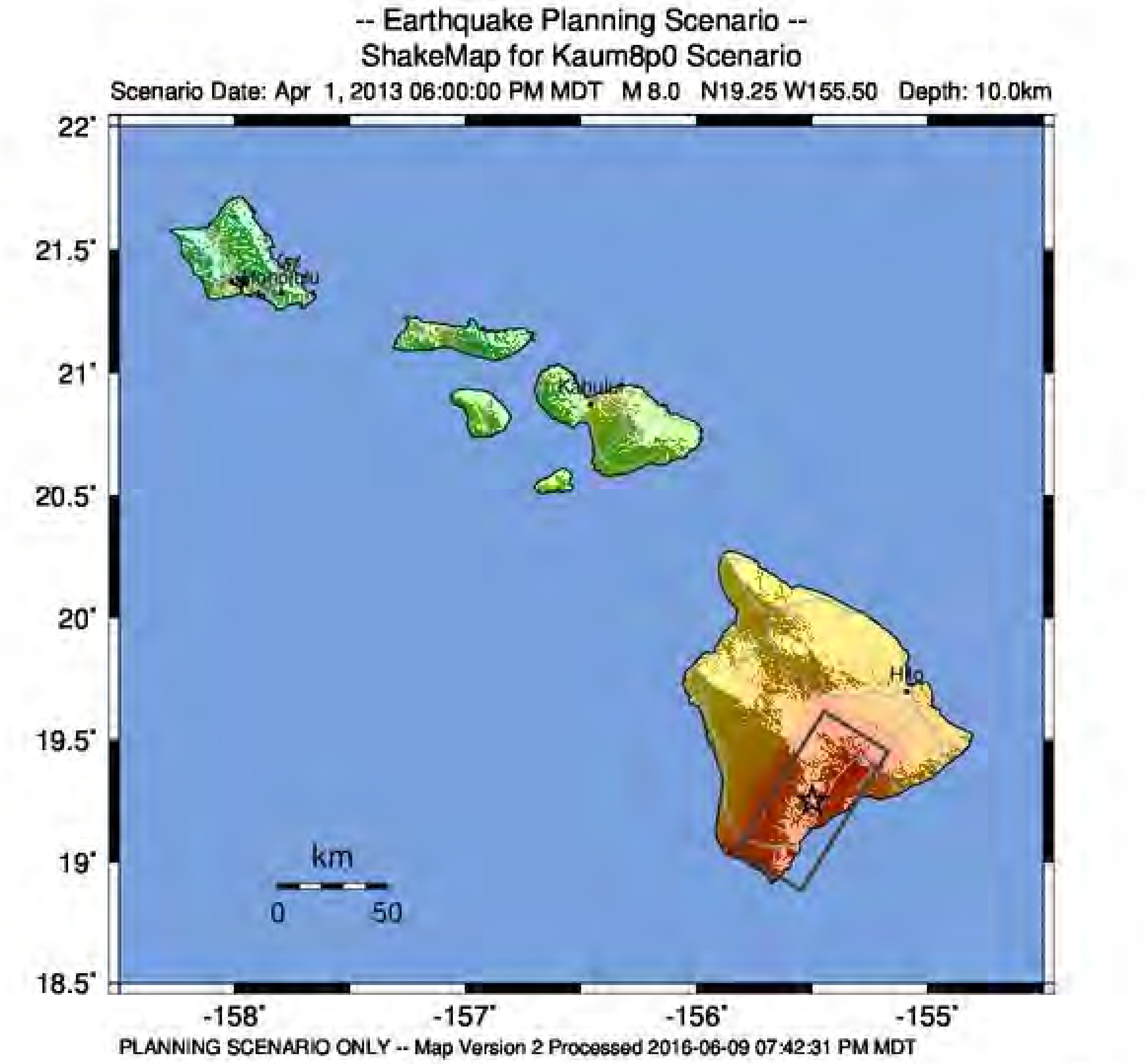
Figure 4.6-6. Kalapana M7.2 Earthquake Scenario



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	<0.02	0.1	1.4	4.7	9.6	20	41	86	>178
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

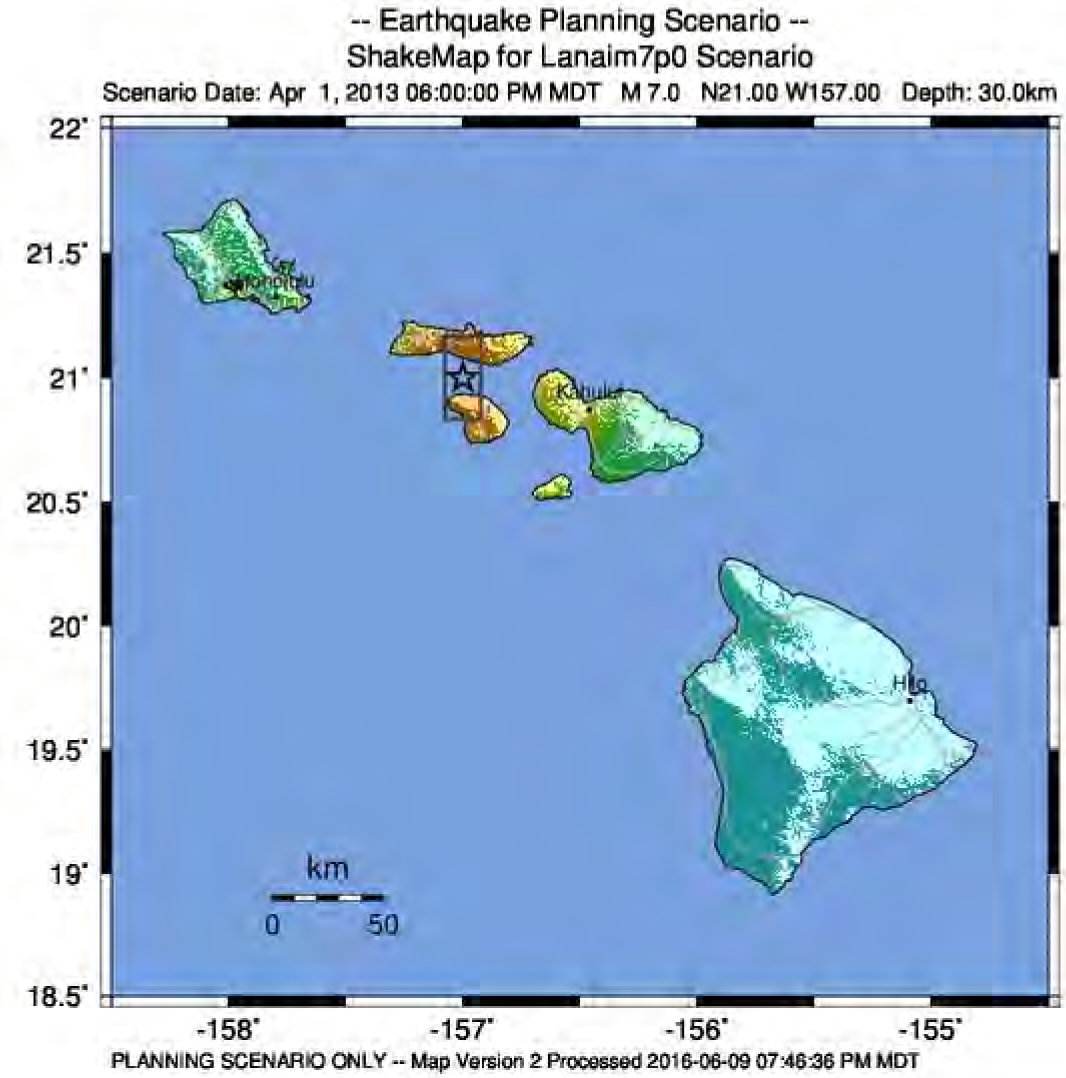
Figure 4.6-7. Kaʻū District M7.9 Earthquake Scenario



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

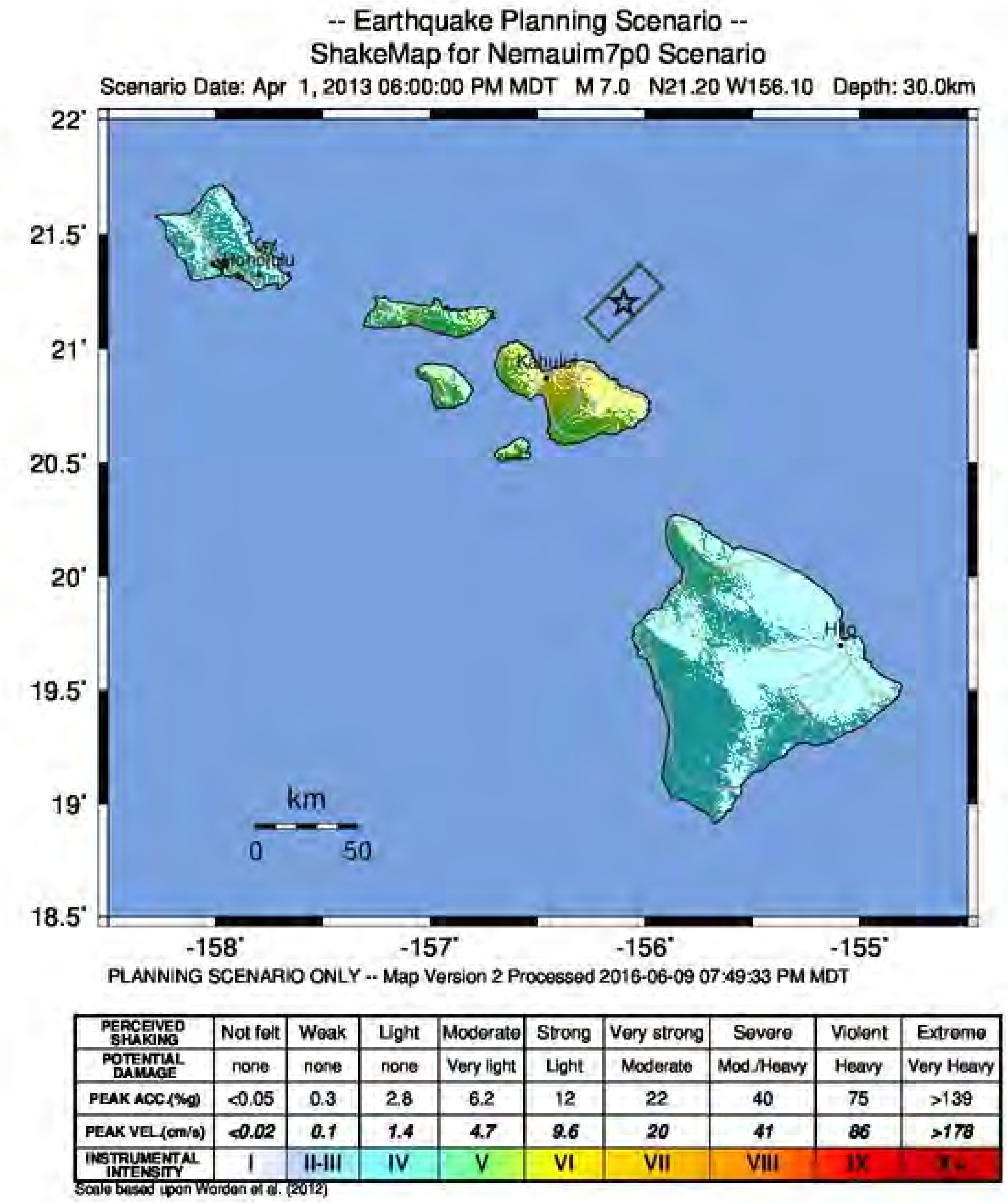
Figure 4.6-8. Lānaʻi M6.8 Earthquake Scenario



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

Figure 4.6-9. Northeast (NE) Maui M6.5 Earthquake Scenario



Previous Occurrences and Losses

During the planning process for this plan update, many sources were researched that provided earthquake information regarding previous occurrences and losses associated with earthquake events throughout the State of Hawaiʻi. The 2013 Plan discussed specific earthquake events that occurred in the State of Hawaiʻi through 2012. For this 2018 HMP Update, earthquake events were summarized between January 1, 2012, and December 31,

2017. According to the USGS, over 11,000 earthquakes have been recorded in the state between 2012 and 2018. The magnitudes of these events range from 1.0 to 6.9 (USGS 2018).

Table 4.6-5 includes details regarding earthquake events that occurred in the State between 2012 and 2017 that had a magnitude 4 or higher. For events prior to 2012, please refer to Appendix X.

FEMA Disaster Declarations

Between 1954 and 2017, FEMA included the State of Hawaiʻi in five earthquake-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: earthquake, volcanic disruptions, or seismic waves. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2017).

Tale 4.6-4 lists the earthquake events that have affected the State of Hawaiʻi and were declared a FEMA disaster, between 2012 and 2018. This table provides information on the disaster declarations for earthquake events, including date of declaration, federal disaster declaration and disaster number, and counties affected. For details regarding all declared disasters to date, refer to Section 4 (Risk Assessment Overview). Refer to Appendix X which illustrates the number of earthquake-related FEMA-declared disasters by county since 1954.

Table 4.6-4. Earthquake-Related Federal Declarations (2012 to 2018)

Year	Event Type	Date Declared	Federal	Counties Affected
2012	Severe Storms, Flooding and Landslides	April 18, 2012	DR-4062	Kauaʻi, Maui

Source: FEMA 2018

Table 4.6-5. Earthquake Events in Hawaiʻi with a Magnitude of 4 or Greater, 2012 to 2017

Date(s) of Event	Magnitude*	Location (recorded epicenter)	Counties Affected	Description
January 23, 2012	4.8	Hawaiʻi region, Hawaiʻi	Maui and Hawaiʻi	USGS reported that over 600 people on the islands of Hawaiʻi and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
February 24, 2012	4.1	Hawaiʻi region, Hawaiʻi	Maui and Hawaiʻi	USGS reported that over 70 people on the Islands of Hawaiʻi and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
February 24, 2012	4.5	Hawaiʻi region, Hawaiʻi	Hawaiʻi	USGS reported that over 90 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating moderate shaking.
March 24, 2012	4.6	Hawaiʻi region, Hawaiʻi	Maui and Hawaiʻi	USGS reported that 800 people on the Islands of Hawaiʻi and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking. However, according to the ShakeMap for this event, the maximum intensity of shaking was VI, indicating strong shaking.
November 25, 2012	4.3	Hawaiʻi region, Hawaiʻi	Hawaiʻi	USGS reported that over 90 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
January 5, 2013	4.3	Hawaiʻi region, Hawaiʻi	Hawaiʻi	USGS reported that over 300 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
April 13, 2013	4.3	50 km northeast of Honokaʻa, Hawaiʻi	Maui and Hawaiʻi	USGS reported that over 90 people on the Islands of Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
June 5, 2013	5.3	54 km southeast of Pāhala, Hawaiʻi	Oʻahu, Kalawao, Maui and Hawaiʻi	USGS reported that over 400 people on the Islands of Oʻahu, Molokaʻi, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
June 21, 2013	4.5	48 km north of Kualapuʻu, Hawaiʻi	Honolulu, Kalawao, and Maui	USGS reported that over 60 people on the Islands of Oʻahu, Molokaʻi, and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.

Date(s) of Event	Magnitude*	Location (recorded epicenter)	Counties Affected	Description
August 11, 2013	4.9	10 km south-southwest of Volcano, Hawaiʻi	Maui and Hawaiʻi	USGS reported over 600 people on the Islands of Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
June 7, 2014	4.1	34 km southwest of Kaunakakai, Hawaiʻi	Honolulu, Maui and Kalawao	USGS reported that over 100 people on the Islands of Oʻahu, Molokaʻi and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
August 7, 2014	4.5	14 km west-northwest of Waimea, Hawaiʻi	Maui and Hawaiʻi	USGS reported over 600 people on the Islands of Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
August 12, 2014	4	30 km east-northeast of Honokaʻa, Hawaiʻi	Hawaiʻi	USGS reported that 70 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
August 22, 2014	4.2	74 km west-northwest of Lānaʻi City, Hawaiʻi	Honolulu and Maui	USGS reported that over 100 people on the Islands of Oʻahu and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was III on the Modified Mercalli Intensity Scale, indicating weak shaking.
August 22, 2014	4.2	61 km south of Waimānalo Beach, Hawaiʻi	Hawaiʻi	USGS reported that 70 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
October 13, 2014	4	13 km west-southwest of Pāhala, Hawaiʻi	Honolulu and Maui	USGS reported that over 100 people on the Islands of Oʻahu and Maui said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was III on the Modified Mercalli Intensity Scale, indicating weak shaking.
October 13, 2014	4	13 km west-southwest of Pāhala, Hawaiʻi	Hawaiʻi	No reference and/or no damage reported.
December 13, 2014	4.2	53 km west-northwest of Kalaoa, Hawaiʻi	Hawaiʻi	USGS reported that over 100 people on the Islands of Oʻahu, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
February 9, 2015	4.25	12 km west-southwest of Volcano, Hawaiʻi	Hawaiʻi	USGS reported that over 100 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
April 5, 2015	4.5	12 km west of Kalaoa, Hawaiʻi	Hawaiʻi	USGS reported that over 250 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking. However,

Date(s) of Event	Magnitude*	Location (recorded epicenter)	Counties Affected	Description
				according to the ShakeMap for this event, the maximum intensity of shaking was V, indicating moderate shaking.
May 9, 2015	4.46	13 km west-southwest of Pāhala, Hawaiʻi	Hawaiʻi	USGS reported that over 140 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
June 28, 2015	5.2	11 km south-southeast of Volcano, Hawaiʻi	Honolulu, Maui and Hawaiʻi	USGS reported that over 950 people on the Islands of Oʻahu, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking. However, according to the ShakeMap for this event, the maximum intensity of shaking was VI, indicating strong shaking.
February 12, 2016	4.1	18 km south of Fern Acres, Hawaiʻi	Hawaiʻi	USGS reported that over 200 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
March 20, 2016	4.59	14 km southeast of Waikoloa, Hawaiʻi	Honolulu, Kalawao, Maui and Hawaiʻi	USGS reported that over 800 people on the Islands of Oʻahu, Molokaʻi, Lānaʻi, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking. However, according to the ShakeMap for this event, the maximum intensity of shaking was VI, indicating strong shaking.
April 1, 2016	4.2	72 km north-northeast of Honokaʻa, Hawaiʻi	Honolulu, Kalawao, Maui and Hawaiʻi	USGS reported that 76 people on the Islands of Oʻahu, Molokaʻi, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
July 23, 2016	4.32	3 km west-southwest of Honalo, Hawaiʻi	Kalawao, Maui, and Hawaiʻi	USGS reported that over 400 people on the Islands of Molokaʻi, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
September 6, 2016	4.05	28 km east of Hōnaunau-Nāpoʻopoʻo, Hawaiʻi	Hawaiʻi	USGS reported that 3 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported was III on the Modified Mercalli Intensity Scale, indicating weak shaking. However, according to the ShakeMap for this event, the maximum intensity of shaking was VI, indicating strong shaking.
December 18, 2016	4.5	77 km south-southeast of Hawaiian Ocean View, Hawaiʻi	Hawaiʻi	USGS reported that 75 people on the Island of Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was III on the Modified Mercalli Intensity Scale, indicating weak shaking.

Date(s) of Event	Magnitude*	Location (recorded epicenter)	Counties Affected	Description
February 17, 2017	4.66	28 km west-northwest of Waikoloa Village, Hawaiʻi	Honolulu, Kalawao, Maui and Hawaiʻi	USGS reported that over 1,500 people on the Islands of Oʻahu, Molokaʻi, Lānaʻi, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
March 9, 2017	4.71	75 km north-northeast of Kualapuʻu, Hawaiʻi	Honolulu, Kalawao, Maui and Hawaiʻi	USGS reported that over 500 people on the Islands of Oʻahu, Molokaʻi, Lānaʻi, Maui and Hawaiʻi said they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
March 23, 2017	4.49	17 km south-southeast of Volcano, Hawaiʻi	Hawaiʻi	USGS reported that over 200 people on the Island of Hawaiʻi reported having the felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was V on the Modified Mercalli Intensity Scale, indicating moderate shaking.
June 8, 2017	5.28	16 km southeast of Volcano, Hawaiʻi	Honolulu, Maui, and Hawaiʻi	USGS reported that nearly 1,000 people on the Islands of Oʻahu, Maui and Hawaiʻi reported having felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was between V and VI on the Modified Mercalli Intensity Scale, indicating moderate to strong shaking. This was the largest earthquake to strike Hawaiʻi in over 10 years.
June 21, 2017	4.51	28 km east-southeast of Hawaiian Ocean View, Hawaiʻi	Maui and Hawaiʻi	USGS reported that over 200 people on the Islands of Maui and Hawaiʻi reported they felt the earthquake. The maximum intensity of shaking reported and computed by the USGS was IV on the Modified Mercalli Intensity Scale, indicating light shaking.
July 30, 2017	4.21	33 km west-northwest of Hawi, Hawaiʻi	Hawaiʻi, Maui, Molokaʻi, and Oʻahu	The maximum intensity of shaking reported by residents on the Islands of Hawaiʻi, Maui, Molokaʻi, and Oʻahu and computed by the USGS ShakeMap was III on the Modified Mercalli Intensity Scale, indicating light shaking. According to HVO Seismic Network Manager Brian Shiro, the earthquake was likely due to bending of the oceanic plate from the weight of the island and poses no significant hazard.
August 19, 2017	4.1	107 km east-northeast of Hawaiian Beaches, Hawaiʻi	Hawaiʻi, Maui, Molokaʻi, and Oʻahu	USGS reported that approximately 100 people on the Islands of Hawaiʻi, Maui, Molokaʻi, and Oʻahu said they felt the earthquake. USGS stated that the earthquake was likely caused by the bending of the oceanic plate from the weight of the island.
May – June 2018	0.5 to 6.9	Kīlauea Volcanic Eruption and Earthquakes (DR-4366)	Hawaiʻi	Between May 1 and June 7, there have been over 6,000 recorded earthquakes, ranging in magnitude 0.5 to magnitude 6.9. On May 1, the USGS HVO issued a report that a migration of seismicity and deformation downrift (east) of Puʻu ʻŌʻō indicated that a large area along the East Rift Zone was potentially at risk of new outbreak, possibly in the Lower Puna area. On May 3, Kīlauea began erupting and has been erupting since then with numerous earthquakes occurring each day. On May 11,

Date(s) of Event	Magnitude*	Location (recorded epicenter)	Counties Affected	Description
				FEMA issued a major disaster declaration for the State of Hawaiʻi due to the eruption of Kīlauea. The County of Hawaiʻi was included in this declaration. As of the date of this plan update, this is an ongoing event and not all information regarding this event has been captured. For details regarding the volcanic eruption, please refer to Section 4.13 (Volcanic Hazards).

Sources: FEMA 2018; USGS 2018; Okubo 2017
** Magnitudes with decimals are approximate*
Note (1): For events that occurred between 2012 and 2017, only those with magnitude 4 are shown in the above table
Note (2): With earthquake documentation for Hawaiʻi being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.5 4 may not include all events that have occurred in the State (in that time period and magnitude level) and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP Update.
FEMA Federal Emergency Management Agency
Km Kilometers
USGS U.S. Geological Survey

Probability of Future Hazard Events

For the purpose of this 2018 HMP Update, the probability of future occurrences is defined by the number of events over a specified period of time. Between 1950 and 2017, there have been 1,247 earthquakes, magnitude 3 (often felt but causes minor damage) and greater (refer to Table 4.5-3 earlier in this section for a description of magnitude and intensity), with epicenters in or near the State of Hawaiʻi. Based on this historic data, the state may experience an average of 18 earthquakes, magnitude 3 or greater, each year. As for earthquakes categorized as strong to severe, between 1950 and 2017, there have been 8 earthquakes, magnitude 6 and greater, with epicenters in or near the State of Hawaiʻi. Based on this historic data, the state has an estimated 11% annual chance of a strong or greater strength earthquake occurring.

Impacts of Climate Change on Future Probability

The potential impacts of global climate change on earthquake probability are unknown. Some scientists feel 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. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes. A University College London scientist reported that over the past 40 years, El Niño cycles in the Pacific Ocean have triggered a regular seismic response as the pressure of water has changed with short-term sea level fluctuations. There are more earthquakes in the eastern Pacific in the months after the cycle lowers sea levels in the area by a few centimeters, which flexes the plates beneath (Pearce 2012).

Secondary impacts of earthquakes could be magnified by climate change. Earthquakes can cause large and sometimes disastrous landslides. Any steep slope is vulnerable to slope failure. Rising air temperatures can facilitate soil breakdown, allowing more water to penetrate soils and affect the rates of erosion, sediment control, and the likelihood of landslides. Climate change may also increase the probability of more frequent, intense rain storms. This can result in greater erosion, higher sediment transport in rivers and streams, and a higher probability of landslides, primarily as a result of higher soil content (University of Washington 2014). Refer to Section 4.11 (Landslides and Rock Falls) for details regarding climate change impacts on landslides.

Another secondary impact of an earthquake is dam failure. Earthen dams are highly susceptible to seismic events. The most common type of earthquake-induced dam failure is slumping or settlement of earth-fill dams where the fill has not been properly compacted. If the slumping occurs when the dam is full, then overtopping of the dam, with rapid erosion leading to dam failure is possible. Changes in weather patterns and increase in rainfall can lead to dams being full more often, increasing the risk of a failure during an earthquake. Refer to Section 4.3 (Dam Failure) for details regarding climate change impacts on dam failure.

4.6.2 Vulnerability Assessment

ShakeMap data prepared by the U.S. Geological Survey (USGS) and probabilistic earthquake data in Hazus version 4.2 were used to assess the earthquake hazard. The evaluation of the historic events utilizing the current environment provides an understanding of potential loss if the events were to happen today.

- The Kalapana 1975 M7.7 scenario with an epicenter approximately 26 miles south southeast of Hilo. This scenario represents the Kalapana M7.2 earthquake on November 29, 1975.
- The Kau M8.0 scenario with an epicenter approximately 4 miles northwest of Pahala. This scenario represents the Kau District M7.9 earthquake on April 3, 1868.
- The Lanai M7.0 scenario with an epicenter approximately 13 miles north northwest of Lanai City. This scenario represents the Lanai M6.8 earthquake on February 20, 1871.
- The NE Maui M7.0 scenario with an epicenter approximately 31 miles northeast of Kahului. This scenario represents the Maui M6.5 earthquake on January 23, 1938.
- The standard Hazus 100-year probabilistic event.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the earthquake hazard.

State Assets

The total replacement cost value of state buildings is an estimated $24 billion; all of which are exposed to an earthquake event. Table 4.6-6 summarizes these values by county. The potential damage estimated to state buildings associated within the 100-year probabilistic earthquake event is approximately $754 million which represents approximately 3% of the inventory's total replacement cost value. The County of Hawaiʻi has the greatest estimated potential loss (12.2%) to state buildings.

Table 4.6-6. State Buildings Exposure and Potential Losses to the 100-year Probabilistic Earthquake Event

County	Total Value	Estimated Potential Loss	
		Value	Percent of Total
County of Kauaʻi	$957,679,537	$408,327	<1%
City and County of Honolulu	$16,750,785,426	$200,226,950	1.2%
County of Maui	$2,862,316,819	$38,663,498	1.4%
County of Hawaiʻi	$4,209,774,236	$515,166,625	12.2%
Total	**$24,780,556,017**	**$754,465,400**	**3.0%**

Source: *Hawaiʻi State Risk Management Office 2017; Hazus v4.2*

The estimated potential state building loss to the Kaʻū M8.0 and the Lānaʻi M7.0 scenarios are summarized in Table 4.6-7; and results for the Kalapana M7.7 and the NE Maui M7.0 scenarios are summarized in Table 4.6-8 by county. The results by state agency for the 100-year Probabilistic Earthquake Event and the four historic scenario events are included in Appendix X.

Of the four historic scenarios evaluated, the Kaʻū M8.0 scenario has the greatest potential state building loss at approximately $191 million (see Table 4.6-7). The County of Hawaiʻi has the greatest estimated potential state building loss equating to $189.8 million (3.7%) of the four counties.

Table 4.6-7. State Buildings Exposure and Potential Losses to the Kaʻū M8.0 and Lānaʻi M7.0 Earthquake Events

County	Total Value	Estimated Potential Loss			
		Kaʻū M8.0		Lānaʻi M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$1,067,278,062	$7,990	<1%	$7,990	<1%
City and County of Honolulu	$18,548,040,469	$979,185	<1%	$1,330,246	<1%
County of Maui	$2,983,348,758	$138,204	<1%	$74,132,065	2.5%
County of Hawaiʻi	$5,095,297,885	$189,822,827	3.7%	$4,425	<1%
Total	**$27,693,965,174**	**$190,948,206**	**0.7%**	**$75,474,725**	**0.3%**

Source: Hazus v4.2
Notes: M Magnitude

Table 4.6-8. State Buildings Exposure and Potential Losses to the Kalapana M7.7 and NE Maui M7.0 Earthquake Events

County	Total Value	Estimated Potential Loss			
		Kalapana M7.7		NE Maui M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$1,067,278,062	$7,990	<1%	$7,990	<1%
City and County of Honolulu	$18,548,040,469	$467,367	<1%	$270,490	<1%
County of Maui	$2,983,348,758	$52,197	<1%	$2,651,332	<1%
County of Hawaiʻi	$5,095,297,885	$136,781,301	2.7%	$7,217	<1%
Total	**$27,693,965,174**	**$137,308,854**	**0.5%**	**$2,937,029**	**0.01%**

Source: Hazus v4.2.
Notes: M Magnitude

State roads can be damaged by moderate to significant earthquake shaking. Roads that are on soft ground or on embankments can experience extensive cracking, ripped apart, settlement and sloughing. This can result in a disruption of transportation systems, which limits post-disaster emergency response.

Table 4.6-9 shows the length of State roads located on the vulnerable NEHRP Class D and E soils for the Counties of Hawaiʻi and Maui. The County of Maui has the greatest number of miles (80.4 miles) located on NEHRP Class D and E soils. The County of Hawaiʻi has a total of 12.8 miles on Class D and E soils. A complete list of state roads exposed is included in Appendix X.

Table 4.6-9. State Road Exposure to NEHRP Class D and E Soils by County

County	Length (in miles)						
	Total Length of State Roads	NEHRP Class D Area	Exposed Length as % of Total	NEHRP Class E Area	Exposed Length as % of Total	NEHRP Class D and E Area	Exposed Length as % of Total
County of Kauaʻi	104.0	-	-	-	-	-	-
City and County of Honolulu	375.3	-	-	-	-	-	-
County of Maui	238.6	80.4	33.7%	0.0	0.0%	80.4	33.7%

County	Length (in miles)						
	Total Length of State Roads	NEHRP Class D Area	Exposed Length as % of Total	NEHRP Class E Area	Exposed Length as % of Total	NEHRP Class D and E Area	Exposed Length as % of Total
County of Hawaiʻi	378.7	12.6	3.3%	0.2	0.0%	12.8	3.4%
Total	**1,096.5**	**93.0**	**8.5%**	**0.2**	**0.0%**	**93.2**	**8.5%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017
Notes: GIS Geographic Information System
NEHRP National Earthquake Hazard Reduction Program
SDOT State Department of Transportation
The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.

Critical Facilities

All critical facilities in the State of Hawaiʻi are exposed to the earthquake hazard. Critical facilities need to remain in operation during and after a disaster event to provide essential services. To remain in operation, these facilities may depend on electrical power. Maintaining electrical power generation and distribution is essential; however, substations and switchyards are vulnerable to strong ground shaking. As part of the *Makani Pahili 2017 Temporary Emergency Power County Workshop Report*, the HI-EMA and county emergency managers developed a list of county and state critical facilities and essential services that require emergency power during response operations; and a methodology to prioritize temporary emergency power in each county. These critical facilities are included in the Hazus analysis for the 2018 HMP Update.

Table 4.6-10 summarizes the estimated potential losses to critical facilities as a result of the 100-year probabilistic earthquake event by county. The County of Hawaiʻi has the greatest estimated loss ($404 million or 8.1% of the total value of critical facilities in the county). The greatest loss is to the Mass Care Support Services core category ($217 million), followed by water, waste and wastewater systems ($144 million).

Refer to Appendix X which lists the estimate potential loss to critical facilities for the four historic earthquake scenarios evaluated.

Table 4.6-10. Estimated Potential Losses to Critical Facilities to the 100-year Probabilistic Earthquake Event

County	Total Replacement Cost Value	Estimated Potential Loss	
		Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$2,859,152,410	$216,373	0.0%
City and County of Honolulu	$19,235,387,455	$78,367,504	0.4%
County of Maui	$6,286,051,833	$33,919,568	0.5%
County of Hawaiʻi	$4,966,896,651	$404,613,545	8.1%
Total	**$33,347,488,348**	**$517,116,990**	**1.6%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2

Table 4.6-11. Critical Facilities Potential Losses by Core Category to the 100-year Probabilistic Earthquake Event

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Estimated Potential Loss	
			Replacement Cost Value	Percent (%) of Total
Commercial Facilities	60	$206,894,206	$2,668,319	1.3%
Communications	130	$523,848,060	$7,134,239	1.3%
Emergency Services	149	$1,017,628,710	$15,566,716	1.5%
Energy	90	$2,591,975,628	$20,242,145	0.8%
Food & Agriculture	39	$829,869,410	$47,906,425	5.8%
Government Facilities	100	$399,781,575	$5,641,081	1.4%
Healthcare & Public Health	193	$3,399,521,375	$36,091,347	1.1%
Mass Care Support Services	353	$11,497,547,155	$217,342,622	1.9%
Transportation Services	56	$1,739,256,960	$20,052,619	1.1%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	$144,471,477	1.3%
Total	**1,475**	**$31,687,768,838**	**$517,116,990**	**1.6%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2

Fires may also follow earthquakes, often occurring in developed areas. They may be caused by broken power lines or leaking combustibles that find a source of ignition. Response may be affected due to losses incurred to critical facilities and services including communication service, isolated or damaged equipment, water supply access and other competing emergency demands on available facilities and resources.

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets by county.

Population

The entire population is potentially exposed to the direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors including the age and type of construction people live in, the soil types their homes are located on, the intensity of the earthquake etc. Whether directly or indirectly impacted, residents may be faced with business closures, road closures that could isolate population and loss of function of critical facilities and utilities.

Overall, the County of Kauaʻi lies in an area of reduced seismic risk. However, if a severe earthquake affects the City and County of Honolulu) the County of Kauaʻi, as well as the Counties of Hawaiʻi and Maui would be impacted severely in the receipt of goods, services, and finances since many systems rely on the ports and harbors or institutions on the island of Oʻahu.

Table 4.6-12 displays the estimated population located on the NEHRP Class D and E soils. Greater than 50% of the population in the County of Maui are located on Class D and E soils. As noted earlier, NEHRP soils are only delineated for the Counties of Maui and Hawaiʻi. This analysis does not include the number of tourists and visitors in the State whose lodgings may be located on NEHRP Class D and E soils. Therefore, this estimate may be underestimating exposure and vulnerability.

While all people located in the NEHRP Class D and E Soils areas are considered exposed and potentially vulnerable, populations considered most vulnerable include the elderly (persons over the age of 65) and individuals living below the U.S. Census poverty threshold. These socially vulnerable populations are most susceptible based on many factors including their physical and financial ability to react or respond during a hazard, the location and construction quality of their housing, and the ability to be self-sustaining for prolonged periods of time after an incident because of limited ability to stockpile supplies. In the County of Maui, 7% of the population on Class D and E soils is over the age of 65 years and greater than 12% have an annual income less than $30,000 per year.

Table 4.6-12. 2010 U.S. Census Population Located on the NEHRP Class D and E Soils by County

County	Population						
	Total Population	Population on Class D and E Soils	Population Exposed as Percent (%) of Total	Population Over 65 in Hazard Area	Population Over 65 Exposed as Percent (%) of Total	Income <$30K/yr in Hazard Area	Income <$30K/yr Exposed as Percent (%) of Total
County of Kauaʻi	67,091	-	-	-	-	-	-
City and County of Honolulu	953,207	-	-	-	-	-	-
County of Maui	154,924	82,293	53.1%	11,052	7.1%	18,936	12.2%
County of Hawaiʻi	185,079	7,069	3.8%	1,085	0.6%	3,783	2.0%
Total	**1,360,301**	**89,362**	**6.6%**	**12,137**	**0.9%**	**22,719**	**1.7%**

Source: U.S. Census 2010
Notes: NEHRP National Earthquake Hazard Reduction Program
The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.
The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaiʻi. To convert households to residents, three people per household was used.

Residents may be displaced or require temporary to long-term sheltering because of an earthquake event. The number of people requiring shelter is generally less than the number displaced, as some displaced persons use hotels or stay with family or friends following a disaster event. Estimated shelter requirements as a result of the 100-year probabilistic event and the four historic scenario events were calculated using Hazus; results of these analyses are summarized in Table 4.6-13 and Table 4.6-14.

Table 4.6-13. Estimated Shelter Requirements for the 100-year Probabilistic Event

County	100-year Probabilistic Event	
	Displaced Households	Short-Term Sheltering Needs
County of Kauaʻi	0	0
City and County of Honolulu	104	65
County of Maui	84	49
County of Hawaiʻi	1,549	1,044
Total	**1,737**	**1,158**

Table 4.6-14. Estimated Shelter Requirements for the for Kaʻū, Lānaʻi Kalapana and NE Maui Scenarios

County	Kaʻū M8.0		Lānaʻi M7.0		Kalapana 1975 M7.7		NE Maui M7.0	
	Displaced Households	Short-Term Sheltering Needs	Displaced Households	Short-Term Sheltering Needs	Displaced Households	Short-Term Sheltering Needs	Displaced Households	Short-Term Sheltering Needs
County of Kauaʻi	0	0	0	0	0	0	0	0
City and County of Honolulu	0	0	0	0	0	0	0	0
County of Maui	0	0	6	5	0	0	0	0
County of Hawaiʻi	76	53	0	0	45	31	0	0
Total	**76**	**53**	**6**	**5**	**45**	**31**	**0**	**0**

Source: Hazus v4.2
Notes: M Magnitude
NE Northeast

Hazus 4.2 estimates the number of people that may be potentially be injured and/or killed by an earthquake depending on the time of day the event occurs. These estimates are provided for three times of day (2:00 a.m., 2:00 p.m. and 5:00 p.m.), representing the periods of the day that different sectors of the community are at their peak. The 2:00 am estimate considers the residential occupancy at its maximum; the 2:00 p.m. estimate considers the educational, commercial, and industrial sector at their maximum; and the 5:00 p.m. estimate represents peak commuter time. Table 4.6-15 and Table 4.6-16 summarize the injuries and casualties estimated for the 100-year probabilistic event and the four earthquake scenarios.

Table 4.6-15. Estimated Injuries and Casualties for 100-year Probabilistic Event

Level of Severity	100-year Probabilistic Event		
	2AM	2PM	5PM
Injuries	377	708	501
Hospitalization	71	178	118
Casualties	10	38	23

Source: Hazus v4.2

Table 4.6-16. Estimated Injuries and Casualties for Kaʻū, Lānaʻi Kalapana and NE Maui Scenarios

Level of Severity	Kaʻū M8.0			Lānaʻi M7.0			Kalapana 1975 M7.7			NE Maui M7.0		
	2AM	2PM	5PM	2AM	2PM	5PM	2AM	2PM	5PM	2AM	2PM	5PM
Injuries	37	93	65	7	13	9	25	62	40	2	4	3
Hospitalization	4	19	12	1	2	1	3	10	6	0	0	0
Casualties	1	3	2	0	0	0	0	1	1	0	0	0

Source: Hazus v4.2

Notes: M Magnitude
NE Northeast

Land Use Districts

Table 4.6-17 shows the square miles of NEHRP Class D and E soils in the combined State Land Use District in the County of Maui and the County of Hawaiʻi; refer to Appendix X for results by County. Agricultural District lands have the most square miles of Class D and E soils, as these soil types frequently overlap with floodplain areas, which are commonly highly productive agricultural lands. Approximately 16.2% of the Urban District Land in these two counties have Class D or E soils. Urban Districts are those areas that are most likely to be developed. The majority of this area of intersect is in Maui County with 44% of Urban District land on these soil types. NEHRP soils are used in the International Building Code (IBC) to classify sites, with Class A and E corresponding to the best and poorest soil conditions, respectively) (Hawaiʻi State HMP 2013). The State of Hawaiʻi adopted the 2010 IBC on April 16, 2010 and include seismic designs required for buildings in the state based on NEHRP soil classifications (Hawaiʻi State Building Code 2010). Counties in the State have adopted or are in the process of adopting the 2012 IBC (see Section 5 for more information).

Table 4.6-17. State Land Use Districts with on NEHRP Class D and E Soils

Land Use District	Total (square miles)	Square Miles NEHRP Class D and E Soils	Percent (%) of Total Area
Agricultural	2,454.5	118.1	4.8%
Conservation	2,602.1	98.7	3.8%
Rural	14.0	3.1	22.5%
Urban	133.1	21.6	16.2%
Total	**5,203.7**	**241.5**	**4.6%**

Source: AECOM; Tetra Tech; State Land Use Commission, 2016
Notes:
Total area calculated from the State of Hawaiʻi State Land Use District GIS layer
The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.

General Building Stock and Economy

Similar to the analyses presented earlier, the general building stock data was overlaid with the earthquake hazard area to assess vulnerability. The total replacement cost value of general building stock is an estimated $242 billion; all of which are exposed to an earthquake event. Table 4.6-18 summarizes these values by county. The potential damage estimated to general building stock as a result of a 100-year probabilistic earthquake event is approximately $2.1 billion statewide. The County of Hawaiʻi may experience the greatest damages ($1.7 billion or 5.4% of their total general building stock inventory replacement cost).

Table 4.6-18. General Building Stock Exposure and Potential Losses to the 100-year Probabilistic Earthquake Event

County	Total Replacement Cost Value	Estimated Potential Loss	
		Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$13,287,882,000	$156,787	0.0%
City and County of Honolulu	$164,787,212,000	$216,109,266	0.1%
County of Maui	$31,320,693,000	$137,500,628	0.4%

County	Total Replacement Cost Value	Estimated Potential Loss	
		Replacement Cost Value	Percent (%) of Total
County of Hawaiʻi	$33,326,392,000	$1,783,530,908	5.4%
Total	**$242,722,179,000**	**$2,137,297,589**	**0.9%**

Source: Hazus v4.2

Of the four historic scenarios evaluated, the Kaʻū M8.0 scenario would result in the greatest estimated potential building loss; approximately $372 million in damages statewide (see Table 4.6-19). The County of Hawaiʻi is estimated to experience the greatest loss at more than $347 million in building damages, followed by the City and County of Honolulu and County of Maui, respectively. The estimated potential building losses resulting from all four historic scenarios are summarized in Table 4.6-19 and Table 4.6-20 by county.

Table 4.6-19. General Building Stock Exposure and Potential Losses to the Kaʻū M8.0 and Lānaʻi M7.0 Earthquake Events

County	Total Replacement Cost Value	Estimated Potential Loss			
		Kaʻū M8.0		Lānaʻi M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$13,287,882,000	$503,490	<1%	$0	<1%
City and County of Honolulu	$164,787,212,000	$13,354,539	<1%	$8,806,737	<1%
County of Maui	$31,320,693,000	$10,525,454	<1%	$87,185,308	0.3%
County of Hawaiʻi	$33,326,392,000	$347,847,705	1.0%	$90,888	<1%
Total	**$242,722,179,000**	**$372,231,186**	**0.2%**	**$96,082,933**	**<1%**

Source: Hazus v4.2
Notes: M Magnitude

Table 4.6-20. General Building Stock Exposure and Potential Losses to the Kalapana M7.7 and NE Maui M7.0 Earthquake Events

County	Total Replacement Cost Value	Estimated Potential Loss			
		Kalapana M7.7		NE Maui M7.0	
		Value	Percent of Total	Value	Percent of Total
County of Kauaʻi	$13,287,882,000	$503,490	<1%	$0	<1%
City and County of Honolulu	$164,787,212,000	$9,131,224	<1%	$2,370,220	<1%
County of Maui	$31,320,693,000	$4,363,416	<1%	$53,376,422	0.2%
County of Hawaiʻi	$33,326,392,000	$218,870,428	0.7%	$318,104	<1%
Total	**$242,722,179,000**	**$232,868,558**	**0.1%**	**$56,064,746**	**<1%**

Source: Hazus v4.2.
Notes: M Magnitude
NE Northeast

Earthquakes have the potential to impact economies at both the local and regional scale. Losses can include structural and non-structural damage to buildings, loss of business function, damage to inventory, relocation costs, wage loss, and rental loss caused by the repair and replacement of buildings. Table 4.5-21 summarizes the estimated potential economic loss as calculated by Hazus for the four historic earthquake scenarios evaluated.

Roads that cross earthquake-prone soils have the potential to be significantly damaged during an earthquake event, potentially impacting commodity flows. Access to major roads is crucial to life and safety after a disaster event, as well as to response and recovery operations. Further, water and sewer infrastructure would likely suffer considerable damage in the event of an earthquake.

Table 4.6-21. Estimated Potential Economic Losses for the State of Hawaiʻi (Millions of Dollars) for the Kaʻū, Lānaʻi Kalapana and NE Maui Scenarios

	Kalapana 1975 M7.7	Kaʻū M8.0	Lānaʻi M7.0	NE Maui M7.0
Income Losses				
Wage	$5.4	$9.9	$2.9	$0.4
Capital-Related	$3.6	$6.4	$2.1	$0.3
Rental	$6.5	$11.0	$2.9	$0.7
Relocation	$14.4	$23.3	$4.9	$0.9
Subtotal	**$29.8**	**$50.6**	**$12.8**	**$2.3**
Capital Stock Losses				
Structural	$28.1	$50.1	$9.2	$3.0
Non-Structural	$146.9	$232.1	$59.3	$33.8
Content	$57.9	$90.1	$27.6	$19.2
Inventory	$0.9	$1.7	$0.2	$0.2
Subtotal	**$233.8**	**$374.0**	**$96.3**	**$56.3**
Total	**$263.6**	**$424.5**	**$109.1**	**$58.6**

Source: Hazus v4.2

Due to its geographic location and isolation, the state faces unique challenges in addressing disaster debris. With limited landfill capacity, advanced planning for large amounts of debris is critical. The Hazus earthquake model also estimates volume of debris that may be generated as a result of an earthquake event to enable the State to prepare and rapidly and efficiently manage debris removal and disposal. Debris estimates are divided into two categories: (1) reinforced concrete and steel that require special equipment to break up before transport, and (2) brick, wood, and other debris that can be loaded directly onto trucks with bulldozers (FEMA 2015). Table 4.6-22 summarizes the estimated debris generated by the 100-year probabilistic event and the four earthquake scenarios in Hazus 4.2.

Table 4.6-22. Estimated Debris Generated for each Earthquake Scenario

Scenario	Debris Type: Brick/Wood (tons)	Debris Type: Concrete/ Steel (tons)
100-year Probabilistic Event	224,819	282,275
Kalapana 1975 M7.7	20,217	18,110
Kaʻū M8.0	32,596	38,248
Lānaʻi M7.0	7,094	4,829
NE Maui M7.0	3,533	707

Source: Hazus 4.2
Notes: M Magnitude
NE Northeast

Environmental Resources

Earthquakes can lead to numerous, widespread, and devastating environmental impacts. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. 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. Facilities holding hazardous materials are of concern because of possible isolation of neighborhoods surrounding them. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment.

Additional environmental impacts may include but are not limited to:

- Induced flooding or landslides
- Poor water quality
- Damage to vegetation
- Breakage in sewage or toxic material containments

Cultural Assets

Consistent with Native Hawaiian culture, Hawaiian Home Lands include areas from mauka to makai (from the mountain to the sea). The population and structures located on Hawaiian Home Lands are more vulnerable to earthquake events if located on NEHRP Class D and E soils (see Table 4.6-23). The County of Maui has 7.5% of its Hawaiian Home Lands on this type of soil.

Table 4.6-23. Hawaiian Home Lands on NEHRP Class D and E Soils

County	Area (in square miles)						
	Total Area of Hawaiian Home Lands	NEHRP Class D Area	Percent (%) of Total	NEHRP Class E Area	Percent (%) of Total	Total NEHRP Class D and E Area	Percent (%) of Total
County of Kauaʻi	32.0	-	-	-	-	-	-
City and County of Honolulu	10.9	-	-	-	-	-	-
County of Maui	92.6	7.0	5.2%	0.0	0%	7.0	7.5%
County of Hawaiʻi	190.3	5.2	2.7%	2.5	1.3%	7.7	4.1%
Total	**325.8**	**12.2**	**4.3%**	**2.5**	**0.9**	**14.7**	**5.2%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System
NEHRP National Earthquake Hazard Reduction Program
The County of Kauaʻi and the City and County of Honolulu do not have spatially-delineated NEHRP soils available for this analysis.

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

NEHRP Class D and E soil areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.6-24 below; refer to Section 3 for more information on projected development areas). Because only the County of Hawaiʻi and the County of Maui have this data available, the analysis was only conducted using Maui Development Project Areas and Enterprise Zones in these counties. About 22% of the area in the Maui Development Projects are and 6% of Enterprise Zone areas have Cass D or E soils. Generally, new development will be more resistant to damage from earthquake events than older construction as building code seismic design standards have improved over time and modern codes, such as the International Building Code, include provisions for classifying soils.

Table 4.6-24. Maui Development Projects and Enterprise Zones Located in NEHRP Class D or E Soils

County	Area (square miles)					
	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Maui	27.6	6.0	21.9%	1,016.7	93.8	9.2%
County of Hawaiʻi	-	-		1,286.6	45.6	3.5%
Total	**27.6**	**6.0**	**21.9%**	**2,303.4**	**139.4**	**6.1%**

Notes: NEHRP soil classification has not been conducted in the County of Kaua'i or in the City and County of Honolulu
Total area calculated from: (1) Maui Development Projects GIS layer from Maui County Planning Department (2) Enterprise Zones from Community Economic Development Program, DBEDT
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
NEHRP National Earthquake Hazard Reduction Program

SECTION 4. RISK ASSESSMENT

4.7 Event-Based Flood

2018 HMP Update Changes

- The flood hazard profile is divided into several separate hazards. This profile explains the event-based flooding hazard in the State of Hawaiʻi and includes event-based coastal and inland flooding.
- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Flood events that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update. Due to the severity of recent events, the April 2018 event is discussed; however, details regarding monetized impacts are not available at the time of this plan update.
- New and updated figures from federal and state agencies are incorporated.
- The 1% annual chance flood or special flood hazard area (SFHA) served as the basis for the exposure analysis for State assets, critical facilities, population, general building stock, environmental resources and cultural assets.
- Hazus was used to generate estimated potential losses for State buildings, critical facilities and general building stock located in the special flood hazard area.

4.7.1 Hazard Profile

The State of Hawaiʻi is a mountainous tropical archipelago, making floods a frequent occurrence (National Science Foundation 2018). Flooding in the state is caused by numerous sources, including: rainfall from storms, storm surge, tsunamis, dam failures, and tidal flooding. Event-based flooding as defined in the 2018 HMP Update includes coastal flooding and rainfall flooding in the special flood hazard area, which is the 1% annual chance flood depicted on counties' Flood Insurance Rate Maps (FIRM). Flooding caused by dam failure is discussed in Section 4.3 (Dam Failure); passive inundation, annual high waves, coastal erosion, and tidal flooding/King tides are discussed in Section 4.2 (Chronic Coastal Flood); storm surge is discussed in Section 4.10 (Hurricane); and chronic coastal flooding from sea level rise is discussed in Section 4.1 (Climate Change and Sea Level Rise).

Summary of Key Terms

Event-Based Flood *– The 1% annual chance flood as depicted on the FEMA Flood Insurance Rate Maps, also known as the Special Flood Hazard Area (inclusive of V- and A-zones).*

A-Zones *– Special flood hazard areas that are not subject to wave heights of 3 feet or greater; includes A-, AE-, AO-, and AH-zones.*

LiMWA *– The inland limit of the area expected to receive 1.5-foot or greater breaking waves during the 1% annual chance flood event.*

V-Zones *– Areas subject to coastal flooding with velocity hazard (wave action of 3 feet or greater); includes V- and VE-zones.*

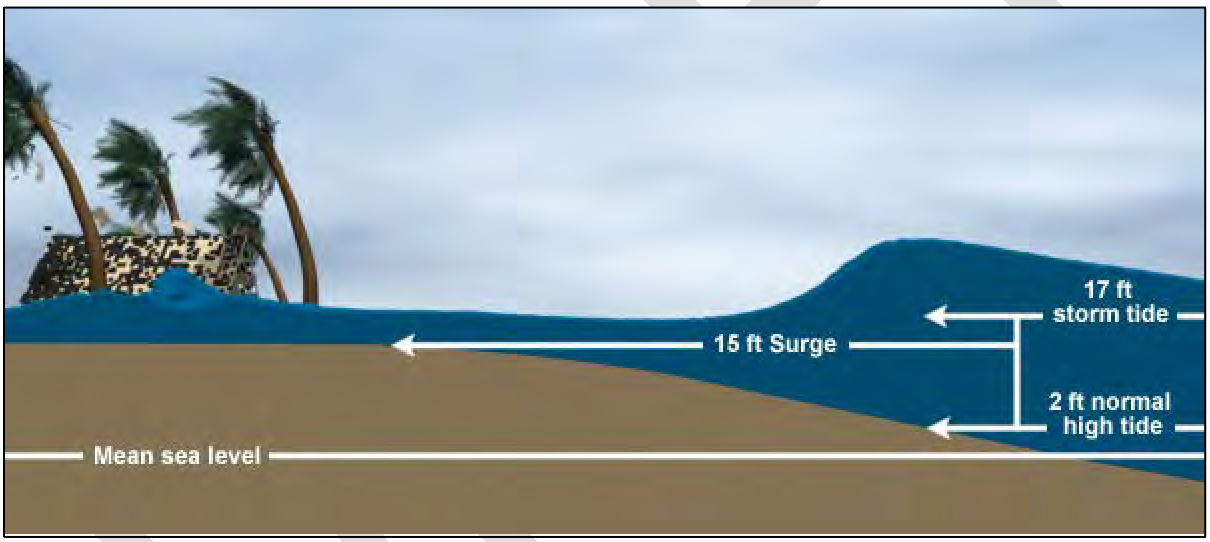
Hazard Description

Event-based floods are the result of storms that cause temporary inundation of land from excessive rainfall or wave action. Flooding also occurs as a result of other event-types such as storm events which are discussed in other sections of the risk assessment. For the purposes of the 2018 HMP Update, event-based flood include both coastal and inland flooding as depicted on Flood Insurance Rate Maps (FIRMs).

Event-Based Coastal Flooding

Coastal flooding in the State of Hawaiʻi generally occurs along the coasts of oceans, bays, and estuaries and is caused by seawater over and above normal tide action as a result of the storm surge (see Figure 4.7-1.) Hurricanes and severe storms cause most coastal flooding (National Hurricane Center [NHC] 2018a; NHC 2018b). During these events, high winds and surf can push water several feet and even hundreds of yards inland. Conditions can be exacerbated by large waves that form on top of rising water (Hawaiʻi State HMP 2013). Event-based coastal flooding is limited to discussion of such flooding from a 1% annual chance storm. Refer to Section 4.10 (Hurricanes) for additional discussion on hurricanes and storm surge from less frequent and more severe events.

Figure 4.7-1. Storm Surge



Source: National Hurricane Center 2018

Inland Flooding

Inland flooding is a general term used to describe non-coastal flooding. In the State Hawaiʻi, inland flooding is caused by rainfall events, which cause three types of inland flooding:

- Channel overflow— 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. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches (FEMA 2008). Flooding from channel overflow is sometimes referred to as riverine flooding.

- Overland sheet flow—Overland sheet flow occurs primarily in areas with undefined drainage ways and flood waters simply flow over land.
- Ponding of standing water in poorly drained low-lying areas—Poorly drained low-lying areas are a problem when flooding occurs even when rainfall is not heavy (Hawaiʻi State HMP 2013). Such drainage issues can be naturally occurring or human-caused. When human-caused such flooding is sometimes referred to as urban flooding.

LOCATION

The Federal Emergency Management Agency (FEMA) conducts flood studies that use historical records to determine the probability of occurrence for different flood levels in a community. Flood Insurance Rate Maps (FIRMs) show the location of these flood hazard areas. This mapping reflects risk from both coastal and major inland flooding, but does not generally reflect risk from urban flooding as it has been defined in the 2018 HMP Update. There is no statewide system for mapping risk from urban flooding. As a result, the location, extent, and vulnerability of the event-based flood hazard is analyzed using the special flood hazard areas (SFHA) depicted on each county's FIRM, which shows flood zones for rainfall flooding, coastal flooding, shallow flooding, and distinguishes areas where detailed studies have been conducted to determine flood elevations.

The special flood hazard area serves as the regulatory boundary in which each county's flood damage prevention ordinance is enforced. The flood damage prevention ordinance requires that development in the community's special flood hazard areas meet certain standards to reduce damage from flooding, such as being elevated above the base flood elevation. The SFHA shows the horizontal extent of a flood that has a 1% chance of being equaled or exceeded in any given year (e.g. a 1% annual chance flood), while the base flood elevation shows the vertical height of flooding from a 1% annual chance flood at any given location within the SFHA.

It should be noted that the source of flooding used to determine base flood elevations within the SFHA for each county may include a combination of tsunami inundation, freshwater flooding from rain events, and storm surge as FIRMs differentiate flood zones based on flooding characteristics with a 1% annual chance of occurrence and do not differentiate based on flood source (e.g. tsunami, hurricane). Refer to the individual county's Flood Insurance Study for details on the hydrologic analyses performed.

Table 4.7-1 displays the total area of each county that is located in the SFHA. Approximately 1.4% of the entire state is located within the mapped SFHA. The City and County of Honolulu has the largest SFHA area, with 4.6% of its land located in the SFHA. Figure 4.7-2 through Figure 4.7-5 illustrate the SFHAs throughout the State of Hawaiʻi.

Table 4.7-1. Area Located in the Special Flood Hazard Area by County

County	Area (square miles)		
	Total Area	SFHA	SFHA as Percent (%) of Total Area
County of Kauaʻi	620.0	20.4	3.3%
City and County of Honolulu	600.7	27.8	4.6%
County of Maui	1,173.5	22.8	1.9%
County of Hawaiʻi	4,028.4	20.8	0.5%
Total	**6,422.6**	**91.8**	**1.4%**

Source: FEMA National Flood Hazard Layer 2017; State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal 2017
Notes: GIS Geographic Information System SFHA Special Flood Hazard Area

Figure 4.7-2. Special Flood Hazard Areas in the County of Kauaʻi

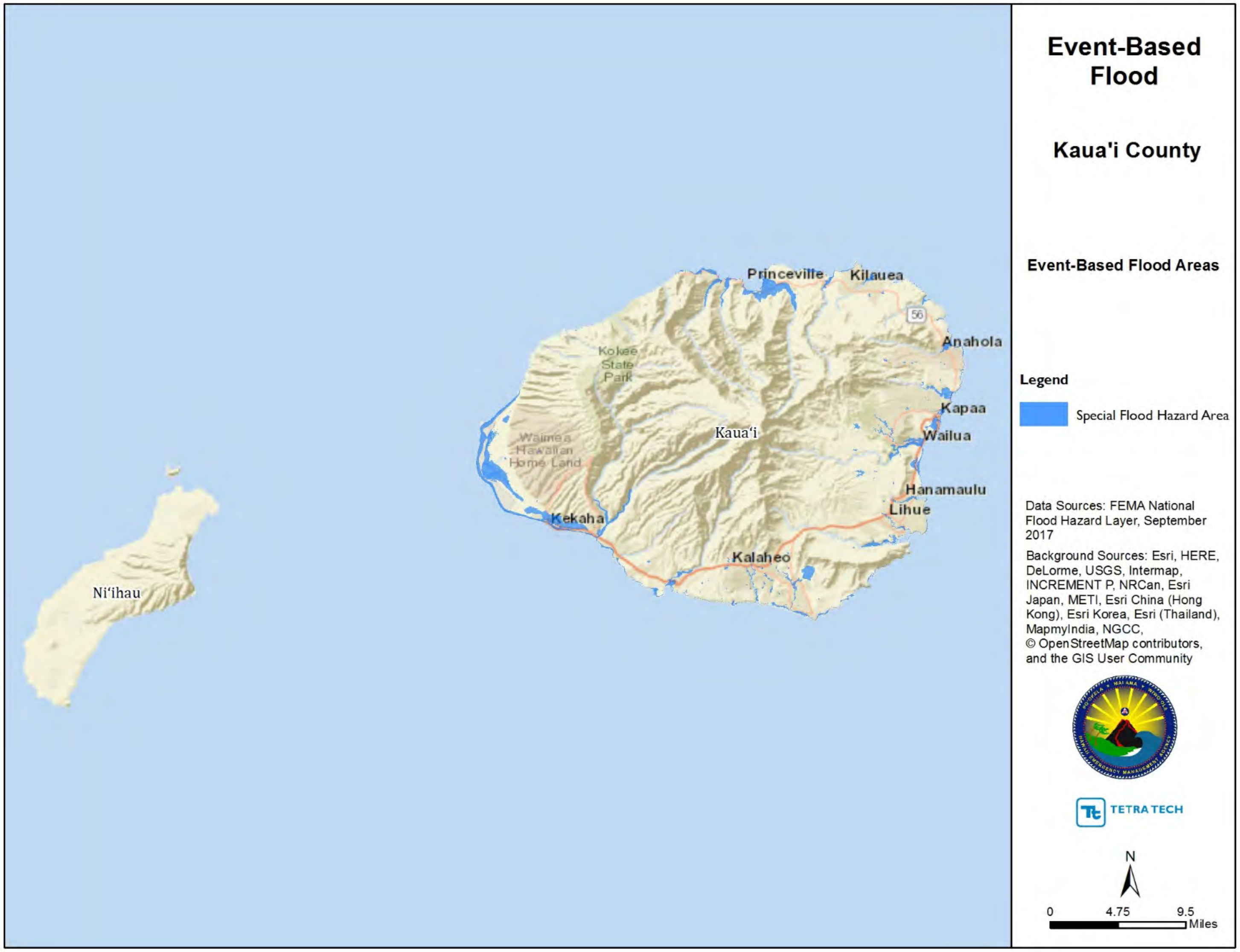


Figure 4.7-3. Special Flood Hazard Areas in the City and County of Honolulu

Figure 4.7-4. Special Flood Hazard Areas in the County of Maui

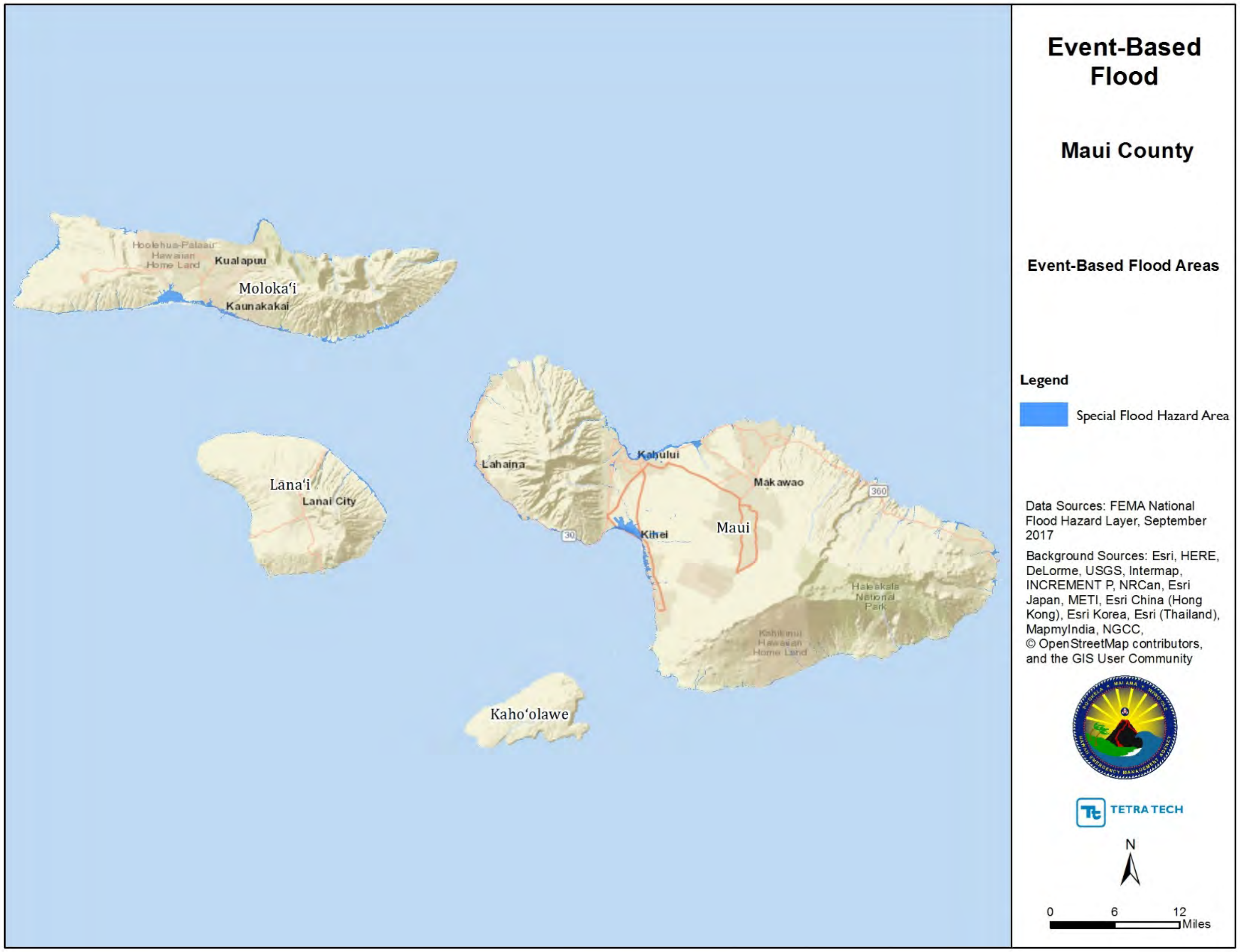
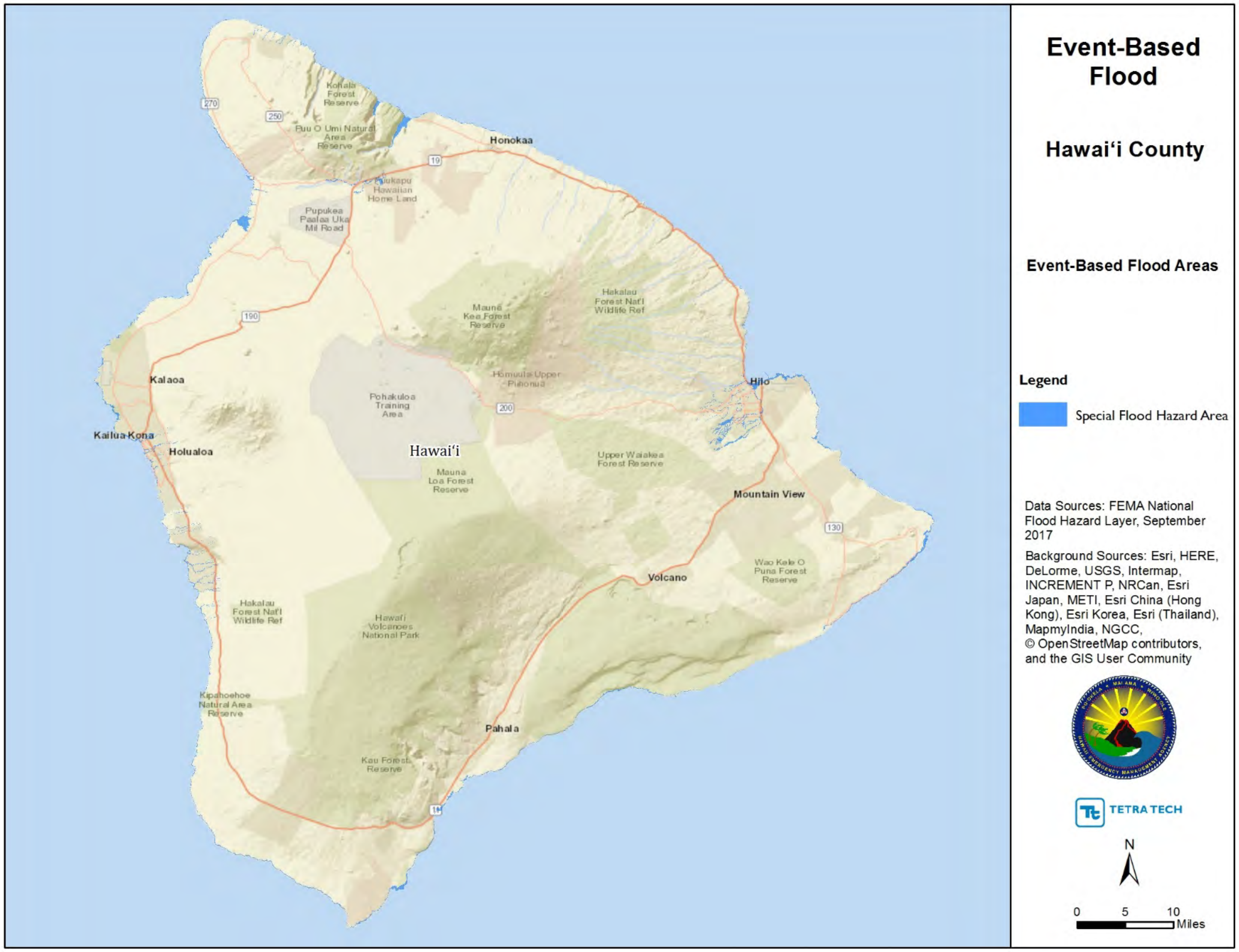


Figure 4.7-5. Special Flood Hazard Areas in the County of Hawaiʻi



EXTENT

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. The special flood hazard area on a community's FIRM is divided into different zones generally referred to as A-zones and V-zones. These zones represent characteristics of flooding pertaining largely to depth and velocity.

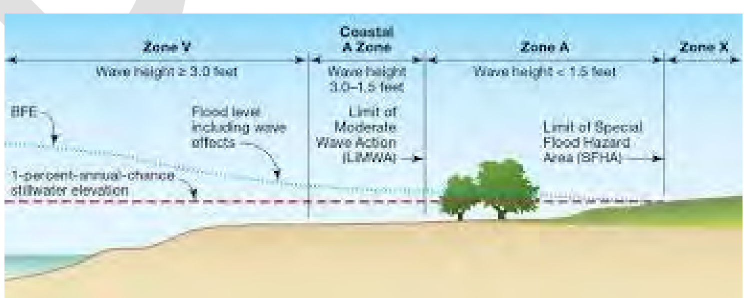
Event-Based Coastal Flooding

Flood severity from coastal flooding is generally determined by wave runup and setup. The degree of damage caused depends on the tidal cycle occurring at the time of the event. During high tides, water levels can be significantly higher than low tide and can inundate further inland causing more extensive damage. The area of impact of storm surge floods is confined to regions along the immediate coastlines and typically extends to a few hundred feet inland (Hawaiʻi State HMP 2013).

On each county's FIRM, areas that have a 1% annual chance of experiencing wave heights of 3 feet or greater are shown as V-zones. These areas have been traditionally known as coastal high hazard areas and there are stringent requirements in place to ensure that buildings constructed in these areas can withstand the velocities associated with this degree of wave action. Recent studies conducted after large scale flood events, such as following Hurricane Katrina, have shown that wave heights as small as 1.5 feet can cause considerable damage to structures and other development. This means that V-zones depicted on FIRMs do not include all areas with a 1% annual chance of experiencing wave action velocities significant enough to cause serious structural damage. Some A-zones, commonly referred to as Coastal A-zones, may also be subject to these velocities. Requirements to withstand these wave impacts are not part of required building codes in the Coastal A-zones.

Because of this new information on structure vulnerability, FEMA now delineates an area known as the Limit of Moderate Wave Action (LiMWA) that can be shown on a FIRM when the Flood Insurance Study that provides the basis for the FIRM is updated. The LiMWA generally bisects an A-zone, which shows areas that have a 1% annual chance of flooding and less than 3 feet of expected wave heights. Areas seaward of the LiMWA may experience wave heights of 1.5 feet or greater. Areas landward of the LiMWA may still be flooded by ocean waves or other sources; however, the height of waves will be less than 1.5 feet in a 1% annual chance storm (see Figure 4.7-6). At the time of the 2018 HMP Update, none of the county's FIRMs show the LiMWA.

Figure 4.7-6. Coastal Flooding on Flood Insurance Rate Maps



Source: FEMA, 2015

Inland Flooding

Factors influencing inland flooding conditions include rainfall intensity and duration; rain shed area, topography and steepness, soil type, soil moisture before an event, and ground cover (State of Hawai'i HMP 2013). The frequency and severity of inland flooding that occurs along a stream or river is measured using a discharge probability, which is the probability that a certain discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels, which are then used to determine the extent of flooding. Inland flooding that has a 1% annual chance of exceedance is shown on FIRMs as A-zones. Because the county FIRMs do not show LiMWAs as described above, there is no simple way to differentiate between coastal and riverine A-zones besides making an educated guess based on location.

In the case of flooding along a river or stream, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- **Minor Flooding**—minimal or no property damage, but possibly some public threat or inconvenience.
- **Moderate Flooding**—some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- **Major Flooding**—extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS 2011).

Prolonged rainfall may result in an accumulation of water creating flooding conditions that last several days, or even weeks. Alternatively, flooding can occur very quickly in instances of high rainfall intensity. When flooding emerges quickly over a matter of hours, it is known as flash flooding. Flash floods are characterized by rapid rise in water level, high velocity, large amounts of debris, and concentration in stream beds that are often normally small or even dry (Hawai'i State HMP 2013).

Warning Time

It is unusual for a flood to occur without warning. Warning time for floods are typically between 24 and 48 hours. Flood warnings and watches are issued by the local NWS office. The NWS will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for flooding in the State of Hawai'i are as follows (NWS 2016).

The NWS issues coastal flood advisories, warnings, and watches:

- **Coastal Flood Advisory** is issued when minor or nuisance coastal flooding is occurring or imminent.

Figure 4.7-7. Flooding in Kona Area in the County of Hawai'i

Source: West Hawai'i Today 2015

- **Coastal Flood Watch** is issued when moderate to major coastal flooding is possible. Such flooding could potentially pose a serious risk to life and property.
- **Coastal Flood Warning** is issued when moderate to major coastal flooding is occurring or imminent. This flooding will pose a serious risk to life and property.

The NWS issues inland flood advisories, watches, and warnings:

- **Flood Advisory**—A Flood Advisory means 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**—A Flash Flood Watch means 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**—A Flash Flood Warning means that 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. Never drive or walk across a flooded roadway.

Duration of a flood event means the time between the start and end of the flood or the event that caused the flood. 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 (M&E Studies 2018). Additionally, the duration of a flood depends on the type of flood. Flash flooding occurs within six hours of a rain event, while other types of flooding are a longer-term event and may last a week or more (NWS 2018).

Flood Control Structures

Flood control structures can significantly alter the extent of flooding in an area. Major flood control structures in the State include dams and levees. For details regarding dams, refer to Section 4.3 (Dam Failure). The following provides information regarding levees located in the State.

Levees are usually earthen embankments or concrete floodwalls, which have been designed and constructed to contain, control, or divert the flow of water to reduce the risk of temporary flooding. Vertical concrete floodwalls may be erected in urban areas where there is insufficient land for an earthen levee. They are designed to provide a specific level of protection and can be overtopped in larger flood events. Levees require regular maintenance to retain their level of protection. Over time, levees decay and require maintenance. When levees fail or overtop, they can cause catastrophic impacts and lead to major flooding and impacts. Areas protected from flooding by levees certified to the 1% annual chance event are not located in special flood hazard areas.

According to the U.S. Army Corps of Engineers (USACE), there are 25 levees (12 federal flood control projects and 13 non-federal flood control projects) in the State that are approximately 13 miles in total length. These 13 miles are located across the State with: 2.3 miles in the County of Hawaiʻi, 3.8 miles in the City and County of Honolulu, 2.7 miles in the County of Kauaʻi, and 4.1 miles in the County of Maui. Of the 25 levees, 12 have an inspection rating of minimally acceptable, 9 are unacceptable, and 4 are unknown. For more detailed information on these levees, please refer to the Flood Insurance Studies for each county.

Table 4.7-2. Levees in the State of Hawaiʻi

County	System Name (and Acronym)	Length (in miles)	Construction Date	Date of Last Inspection	Inspection Rating
Kauaʻi	Waimea River—RB, All Levees (WRR1)	1.44	January 1, 1950	July 17, 2012	Minimally Acceptable
Kauaʻi	Hanapēpē Stream—RB Levee (HRRB)	0.85	January 11, 1966	May 24, 2011	Unacceptable
Kauaʻi	Hanapēpē Stream—LB Levee (HRLB)	0.41	January 11, 1966	May 24, 2011	Unacceptable
Honolulu	Waimalu Stream—NF Debris Basin and Channel (WSNB)	0.54	Unknown	Unknown	Unknown
Honolulu	Kalauao Stream—RB (NOKA)	0.2	April 12, 1966	Unknown	Unknown
Honolulu	Kuliʻouʻou Stream—RB & Channel (KIBR)	0.83	January 2, 1970	November 1, 2011	Minimally Acceptable
Honolulu	Kuliʻouʻou Stream—LB & Channel (KIBL)	0.26	January 2, 1970	November 1, 2011	Minimally Acceptable
Honolulu	Kawainui Marsh—6850 lf Levee, Floodwall and Oneawa Channel (KMFL)	1.5	January 8, 1966	February 21, 2012	Unacceptable
Honolulu	Kahawainui Stream—RB Levee (KSLR)	0.5	January 1, 1990	August 10, 2010	Unacceptable
Maui	ʻĪao Stream—Channel at Bottom and LB (ISAL)	0.28	January 10, 1981	Unknown	Unknown
Maui	Kaunakakai Stream—RB Levee (KSRB)	0.21	January 1, 1950	April 11, 2012	Minimally Acceptable
Maui	Kaunakakai Stream—LB Levee (KSUL)	0.72	January 1, 1950	April 11, 2012	Minimally Acceptable
Maui	Kahoma Stream—RB, Channel and Levee (KORB)	0.09	January 4, 1990	June 11, 2011	Minimally Acceptable
Maui	Kahoma Stream—LB, Channel and Levee (KOLB)	0.3	January 4, 1990	June 11, 2011	Minimally Acceptable
Maui	ʻĪao Stream—Levee I, H, Channel at Bottom—LB (ISIL)	0.76	January 10, 1981	September 22, 2011	Unacceptable
Maui	ʻĪao Stream—Levee G, LB (ISLG)	0.27	January 10, 1981	September 22, 2011	Unacceptable
Maui	ʻĪao Stream—Levee F, LB (ISLF)	0.2	January 10, 1981	September 22, 2011	Unacceptable
Maui	ʻĪao Stream—Levee A, B, C, D, E, H, I, Channel and Revt X, RB (ISLE)	1.31	January 10, 1981	September 22, 2011	Unacceptable
Hawaiʻi	Keōpū Drainageway*	0.11	Unknown	Unknown	Unknown
Hawaiʻi	Wailoa Stream RB—Diversion Levee 1, 2, 3, 4 & Channel (WSRB)	0.99	January 8, 1965	October 30, 2012	Minimally Acceptable
Hawaiʻi	Wailoa Stream LB (WALB)	0.23	January 8, 1965	October 30, 2012	Minimally Acceptable
Hawaiʻi	Wailoa Stream—Diversion Levee LB 5 (WSL5)	0.07	January 8, 1965	October 30, 2014	Minimally Acceptable
Hawaiʻi	Pāʻauʻau Stream—All (PALV)	0.4	January 10, 1984	August 28, 2013	Minimally Acceptable
Hawaiʻi	Alenaio Stream LB—Levee, Floodwall C & Lined Channel (ASFC)	0.32	January 11, 1997	August 26, 2013	Minimally Acceptable
Hawaiʻi	Alenaio Stream—Floodwall A, B—RB & Lined Channel (ASFA)	0.20	January 11, 1997	August 26, 2013	Unacceptable

Source: USACE 2018
Note: The length, construction date, date of last inspection, and inspection rating is for levee structure.
N/A Not Applicable
** Inactive levee*
LB Left Bank
LF Linear feet
RB Right Bank

Previous Occurrences and Losses

Many sources provided flooding information regarding previous occurrences and losses associated with flooding events throughout the State of Hawaiʻi. The 2013 HMP discussed specific flooding events that occurred in the State of Hawaiʻi through 2012. For this 2018 HMP Update, event-based flood events were summarized between January 1, 2012, and December 31, 2017. However, due to the heavy rains and flooding that caused damages and losses to areas in the City and County of Honolulu and the County of Kauaʻi during the time of the 2018 HMP Update, this event was included.

Table 4.7-3 includes details of major flooding events that occurred in the State between 2012 and 2017, with the addition of the April 2018 flood event. These events do not include tropical storms or hurricanes that may also cause flooding; refer to Section 4.11 (Hurricane) for a listing of these events. Major events include those that resulted in losses or fatalities, as reported by the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), events that resulted in the activation of the State and/or County Emergency Operations Center (EOC), and/or events that led to a FEMA disaster declaration. For events prior to 2012, please refer to Appendix X.

According to the NOAA NCEI storm events database, the State of Hawaiʻi experienced 170 flooding events between 2012 and 2017. Total property or crop damage was not estimated. However, it was reported these events led to five fatalities. These events included flash floods and floods.

Table 4.7-3. Event-Based Flood Events in the State of Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
January 17, 2012	Heavy Rain and Flash Flooding	Kauaʻi and Hawaiʻi	Heavy showers fell over the Counties of Hawaiʻi and Kauaʻi. The rain was intense enough in the County of Kauaʻi to cause flash flooding. In Princeville (Kauaʻi), the Kūhiō Highway was closed at the Hanalei Bridge due to flooding in the area of the Hanalei River. In Kapaʻa, there were road closures due to flooding of Keālia Stream. A flash flood warning was issued for the County of Kauaʻi, which led to the activation of County's EOC.
February 26, 2012	Flash Flood Warning	Kauaʻi and Honolulu	Surface and upper troughs generated heavy rain across the City and County of Honolulu, as well as the County of Kauaʻi, with flash flooding occurring over northern parts of Kauaʻi. In the County of Kauaʻi, Kūhiō Highway was closed at the Hanalei Bridge due to flooding. In Kōloa, Weliweli Road, Hapa Road and Ala Kinoki were closed due to flooding. A flash flood warning was issued for the County of Kauaʻi which led the partial activation of the County's EOC.
March 3 to 11, 2012	Severe Weather, Flooding and Tornado (FEMA-DR-4062)	Kauaʻi, Honolulu, and Maui	On March 3 and 4, an upper trough in the vicinity of the Hawaiian Islands brought heavy rain and flash flooding to the County of Kauaʻi and the City and County of Honolulu. Numerous roads and bridges were closed throughout the impacted counties due to flooding. The City and County of Honolulu EOC was activated. This event resulted in a FEMA declaration for the counties of Kauaʻi and Maui. A total of $3.6 million in public assistance was approved for the impacted counties.
December 19, 2012	Heavy Rain and Flash Flooding	Hawaiʻi	Heavy showers fell over the windward side of the County of Hawaiʻi near Pāpaʻaloa. A motorist tried to cross the swollen Pāhale Stream but was swept away by the current; the motorist died.
January 26 to 27, 2013	Severe Weather and Flooding	Kauaʻi, Honolulu, and Maui	A winter storm triggered heavy rain and flash flooding over the Hawaiian Islands from the County of Kauaʻi and the City and County of Honolulu, to the County of Maui. Roadway and property flooding was reported in the impacted counties. The EOCs for these the counties of Kauaʻi, Honolulu, and Maui were activated as a result of this event.
February 21, 2013	Severe Weather and Flooding	Kauaʻi, Honolulu, Maui, and Hawaiʻi	Heavy rain brought flash flooding, mainly to the County of Maui. In the County of Kauaʻi, approximately 50 hikers were stranded on the Nā Pali Coast on Kauaʻi. One hiker died when swept away into the swollen Hanakāpiʻai Stream. Numerous roads were closed due to flooding throughout the area. The County of Kauaʻi activated its EOC. In the County of Honolulu, heavy rain was observed. In the County of Maui, flash flooding was reported which resulted in road closures. In the County of Hawaiʻi, heavy rain was observed.
March 26 to 27, 2013	Severe Weather and Flooding	Kauaʻi	A strong upper trough brought heavy rain to the County of Kauaʻi, causing flash floods. Many roads were closed throughout due to flooding. Emergency managers reported that 12 hikers were airlifted out of Hanakāpiʻai because they could not pass Hanakāpiʻai Stream due to rising waters. The County of Kauaʻi activated its EOC.
April 4, 2013	Severe Weather and Flooding	Kauaʻi, Honolulu	The County of Kauaʻi and the City and County of Honolulu EOCs were activated.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
May 4 to 5, 2013	Flood	Hawaiʻi	Heavy rain produced small stream and drainage ditch flooding, and ponding on roadways near Hawi, Waikoloa Village, Māhukona, and Kawahae in the County of Hawaiʻi. The County of Hawaiʻi EOC was activated as a result of this event.
May 18, 2013	Flood	Hawaiʻi	Heavy rain fell over the County of Hawaiʻi. The precipitation led to small stream and drainage ditch flooding and ponding on roadways. Heavy rain led to the activation of the County of Hawaiʻi EOC.
May 28 to 29, 2013	Flood	Kauaʻi, Honolulu, Maui, and Hawaiʻi	A surface trough and upper low brought heavy rain to the State of Hawaiʻi. The showers caused ponding on roadways and small stream and drainage ditch flooding. On May 28, in the City and County of Honolulu, the rainfall was intense enough to overflow the banks of the Kalihi Stream due to clogged culverts. Four people were caught in the swollen stream but were able to make it to safety. The City and County of Honolulu EOC was activated as a result of this event.
September 30 to October 1, 2013	Severe Weather and Flooding	Kauaʻi	An upper low just north of the State of Hawaiʻi induced heavy rain and thunderstorms over the County of Kauaʻi. The rain caused ponding on roadways and small stream and drainage ditch flooding. The County of Kauaʻi EOC was activated as a result of this event.
October 11, 2013	Severe Weather and Flooding	Kauaʻi, Honolulu, and Maui	Heavy rain fell over the Counties of Kauaʻi, Maui and the City and County of Honolulu. The City and County of Honolulu EOC was activated as a result of this event.
October 14, 2013	Severe Weather and Flooding	Kauaʻi, Honolulu, Maui, and Hawaiʻi	An upper low moving over the State of Hawaiʻi produced heavy showers and thunderstorms, and the occasional funnel cloud and waterspout. There was small hail reported in central Oʻahu. The rainfall led to small stream and drainage ditch flooding, minor debris flows, and ponding on roadways. The City and County of Honolulu EOC was activated as a result of this event.
October 27, 2013	Severe Weather and Flooding	Hawaiʻi and Maui	An upper trough produced heavy rain and thunderstorms over much of the State of Hawaiʻi. The rain caused ponding on roadways, small stream and drainage ditch flooding, and minor debris flows. The County of Maui EOC was activated as a result of this event.
November 9 to 10, 2013	Severe Weather and Flooding	Kauaʻi, Honolulu, and Maui	An upper level low, north of the Hawaiian Islands, combined with a surface trough and shear line produced heavy rain and flash flooding over parts of the State of Hawaiʻi. In the County of Kauaʻi, heavy rain caused the Hanalei River to overflow its banks along Kūhiō Highway. Homes flooded and roadways were inundated with water as a result of the heavy rains. The County of Kauaʻi activated its EOC as a result of this event.
December 1, 2013	Severe Weather and Flooding	Kauaʻi	An advancing cold front and upper trough brought heavy rain, thunderstorms, and flash flooding to portions of the County of Kauaʻi, the Island of Molokaʻi (located in the County of Maui), and the City and County of Honolulu. Multiple roadways were closed due to flooding. The County of Kauaʻi activated its EOC as a result of this event.
December 30, 2013	Severe Weather and Flooding	Hawaiʻi	Heavy rain and thunderstorms impacted a large portion of the County of Hawaiʻi. There were reports of flash flooding, hail and microbursts. Roads were closed throughout the county due to flooding. Several roadways washed out. The County of Hawaiʻi activated its EOC as a result of this event.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
January 11 to 12, 2014	Severe Weather and Flooding	Honolulu, Maui, and Hawaiʻi	Heavy downpours and isolated thunderstorms impacted parts of the State of Hawaiʻi (counties of Honolulu, Maui, and Hawaiʻi). Ponding on roadways, and small stream and drainage ditch flooding occurred in several areas. The County of Maui EOC activated.
February 16, 2014	Severe Weather and Flooding	Kauaʻi	A surface low and upper trough west of the Hawaiian Islands caused instability over the western parts of the State of Hawaiʻi. Heavy rain and flash flooding occurred over the County of Kauaʻi. Roadways were closed due to flooding. The County of Kauaʻi activated its EOC as a result of this event.
May 24 to 26, 2014	Heavy Rain and Flash Flooding	Kauaʻi and Honolulu	The combination of abundant low-level moisture and an upper trough northwest of the State of Hawaiʻi generated heavy showers and isolated thunderstorms across the County of Kauaʻi and the City and County of Honolulu. The heavy rain caused ponding on roadways, and small stream and drainage ditch flooding. The City and County of Honolulu EOC was activated as a result of this event.
July 19 to 20, 2014	Severe Weather and Flooding (remnants of Tropical Storm Wali)	Honolulu and Maui	An upper trough near the Hawaiian Islands acted on remnant moisture from former Tropical Storm Wali to generate heavy showers and thunderstorms. The rain was intense enough to produce flash flooding in windward parts of the Island Oʻahu and in windward West Maui. Strong winds accompanied the precipitation, and blew down trees and damaged homes. Also, a man, snorkeling with a group, died when he succumbed to high waves that battered the area off the County of Maui on July 20. Flooding inundated roads in the impacted areas. The City and County of Honolulu activated its EOC as a result of this event.
July 22, 2015	Heavy Rain and Flash Flooding	Kauaʻi	Heavy showers and isolated thunderstorms impacted the western portion of the State. The heavy rain led to flash flooding in the County of Kauaʻi near Hanalei as the Hanalei River overflowed its banks and inundated Kūhiō Highway near Hanalei Bridge. The County of Kauaʻi EOC was activated as a result of this event.
August 17, 2015	Flooding	Honolulu, Maui, and Hawaiʻi	Heavy showers and isolated thunderstorms developed over parts of the State of Hawaiʻi, causing small stream and drainage ditch flooding, ponding on roadways, and flash flooding. In the County of Hawaiʻi, 14 hikers were rescued by the fire department after the trail they were on was blocked by high water after flash flooding. Many roads were closed throughout the County of Hawaiʻi as a result of flooding. In the City and County of Honolulu, officials reported between 8 and 12 inches of water on the Kamehameha Highway near Waikane Valley Road in windward Oʻahu. In the County of Maui, water over the road forced the closure of Piʻilani Highway at Mile Marker 29 in the Nuʻu area. As a result of this event, the County of Maui and County of Hawaiʻi EOCs were activated.
August 25, 2015	Flash Flood and Severe Weather	Kauaʻi and Maui	Heavy rain, thunderstorms and flash flooding impacts parts of the State. In the County of Maui, lower Honoapiʻilani Highway was flooded by excessive rainfall near Kahana and Honokōwai. The County of Kauaʻi EOC was partially activated as a result of this event.
September 3, 2015	Flash Flood and Severe Weather	Honolulu	With a moist air mass over the islands, warm ocean temperatures, and low-level instability; heavy showers and thunderstorms brought flooding to parts of the State of Hawaiʻi (City and County of Honolulu). In the City and

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
			County of Honolulu, one foot of water flooded Liliha Street, Dillingham Boulevard, and North King Street in Honolulu. More flash flooding was reported at the intersection of Dillingham Boulevard and Alakawa Street. Liliha Street was closed in both directions from North King Street to Vineyard Boulevard because of excessive ponding on the roadway. In the Iwilei section of Honolulu, Dole Cannery and surrounding offices had to be evacuated due to flooding on the first floor, including rooms with electrical equipment. The City and County of Honolulu EOCs were activated as a result of this event.
September 11, 2015	Flash Flood and Severe Weather (remnants of Hurricane Jimena)	Honolulu	Another round of heavy rain and flooding developed over parts of the State of Hawaiʻi (City and County of Honolulu) as the remnants of former Hurricane Jimena passed north of the islands. Warm ocean temperatures and the added instability from the tropical disturbance helped generate deep convection over the area. In the City and County of Honolulu, Waikane Bridge along Kamehameha Highway was closed due to flooding from Waikane Stream in windward Oʻahu. The City and County of Honolulu activated its EOC as a result of this event.
September 14, 2015	Heavy Rain and Flash Flooding	Hawaiʻi	High running water at Wailuku River's Boiling Pots in the County of Hawaiʻi resulted in one drowning fatality after the swimmer was pulled downstream.
November 20, 2015	Flash Flooding	Honolulu	An area of deep tropical moisture moving from the southeast brought heavy showers to most of the Hawaiian Islands, with a majority of impacts in the City and County of Honolulu. The rainfall was intense enough to cause flash flooding over a portion of windward Oʻahu. Most of the showers, however, produced mainly small stream and drainage ditch flooding, and ponding on roadways. The City and County of Honolulu EOC was activated as a result of this event.
May 26, 2016	Flash Flooding and Landslide	Kauaʻi and Honolulu	Heavy rain fell in the County of Kauaʻi and the City and County of Honolulu. The City and County of Honolulu EOC was activated as a result of this event.
September 11 to 14, 2016	Severe Storms, Flooding, Landslides and Mudslides (FEMA-DR-4282)	Maui and Hawaiʻi	As a weak tropical disturbance with abundant low-level moisture moved through the Hawaiian Islands, an upper low moved in from the northwest. This combination generated heavy showers and thunderstorms, which then resulted in flash flooding over the County of Maui. In the County of Hawaiʻi, flash flooding was reported closing roadways in the Mountain View area of the county. Other parts of the State received heavy rainfall as well. Overall damages were estimated at $15 million. On September 27, 2016, Governor Ige requested a major disaster declaration due to this event. On October 6, 2016, President Obama declared that a major disaster existed in the State of Hawaiʻi. The County of Maui was included in the declaration.
December 3, 2016	Heavy Rain and Flash Flooding	Statewide	An upper low and a separate upper trough produced heavy rain and showers, isolated thunderstorms, and flash flooding over much of the State. The system also produced snow in the upper elevations of the County of Hawaiʻi. A woman was swept away and killed during flash flooding on the County of Kauaʻi during a kayak and hiking tour near the Wailua River.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
January 21, 2017	Heavy Rain and Flash Flooding	Hawaiʻi	Strong wind and heavy rains impacted the County of Hawaiʻi, downing trees and power lines, causing power outages, and bringing flash flooding. A woman attempted to cross fast-moving water in Ahumoa but was swept away and died.
February 28 to March 1, 2017	Heavy Rain and Flash Flooding	Kauaʻi, Honolulu, and Maui	Heavy showers and thunderstorms impacted parts of the State of Hawaiʻi, mainly the Counties of Kauaʻi and Maui, and the City and County of Honolulu. Some of the rainfall led to flash flooding. In the City and County of Honolulu, an elementary school and church were damaged. Police closed Kamehameha Highway in the area because of deep water on the roadway. Waimea Valley Park and a home were also damaged due to flooding. The Counties of Maui and Kauaʻi, and the City and County of Honolulu EOCs were partially activated as a result of this event.
March 7, 2017	Heavy Rain and Flooding	Maui	An upper trough near the Hawaiian Islands induced heavy downpours and thunderstorms over the County of Maui, particularly the leeward Haleakalā area. Intense rainfall inundated Kūlanihāko'i Gulch, which then led to South Kihei Road being flooded. Seven individuals trapped by the deluge had to be rescued by fire crews. The flood waters damaged several vehicles and condominiums. The storm system also produced heavy rain and thunderstorms over the County of Hawai'i and the City and County of Honolulu. In the County of Maui, several roads were closed due to flash flooding and individuals were evacuated from their homes. The County of Maui EOC was activated as a result of this event.
August 21, 2017	Flash Flood	Kauaʻi and Maui	An upper trough brought heavy showers and thunderstorms over the Counties of Kauaʻi and Hawaiʻi. Most of the rain caused ponding on roadways and small stream and drainage ditch flooding. In the County of Kauaʻi, the rain caused flash flooding. The Kūhiō Highway in Hanalei (Kauaʻi) became impassable, and county officials were forced to close the Hanalei Bridge. The County of Kauaʻi and the County of Maui activated their EOCs as a result of this event.
October 23 to 24, 2017	Severe Weather and Flooding	Maui and Hawaiʻi	Periods of strong winds, heavy rain, thunderstorms, and flash flooding impacted the counties of Maui and Hawaiʻi. Lightning strikes led to power outages, and gusty winds downed trees and power lines. In the County of Maui, the strong winds led to island-wide power outages after lightning hit the electrical system. The storm downed trees and power lines in multiple areas; and flash flooding occurred as well. The County of Maui EOC was partially activated. In the County of Hawaiʻi, the storms brought strong winds, lightning strikes, and heavy rain. The County of Hawaiʻi EOC was fully activated.
October 31 to November 1, 2017	Severe Weather and Flooding	Kauaʻi	Flooding conditions in the County of Kauaʻi resulted in several road closures, including Kūhiō Highway in the vicinity of the Hanalei Bridge. County officials were warning motorists of ponding, low visibility, and other hazardous driving conditions. The County of Kauaʻi EOC was partially activated as a result of this event.
November 11 to 12, 2017	Severe Weather and Flooding	Honolulu	Rainfall totals ranged from 3.74 inches to 4.37 inches. Multiple car accidents were reported due to water on the roadways. Water rescues were performed near the intersection of Waialae Avenue and Koali Road, where two

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
			people were in need of assistance amid rain-swollen stream conditions. The City and County of Honolulu EOC was partially activated.
December 20, 2017	Flash Flood	Honolulu and Maui	Heavy rain, flash flooding, and isolated thunderstorms impacted the counties of Honolulu and Maui. In the City and County of Honolulu, the intersection at Puʻunēnē and Wakea Avenues near Christ the King Church were closed in all directions due to flooding. In the County of Maui, on Kahekili Highway in the area of Mile Marker 7, the road was impassable due to flooding.
December 26, 2017	Flash Flood	Honolulu	An area of showers formed over the County of Honolulu, becoming intense and isolated thunderstorms developed. The storm led to flash flooding conditions in the county; however, no significant injuries were reported. Water was flowing into stores at Market City between Kapiolani Boulevard and Kapahulu Avenue.
April 2018	Heavy Rains, Flooding, and Mud and Rock Slides	Kauaʻi and Honolulu	Heavy rains and flooding caused damages and losses to areas in the City and County of Honolulu and the County of Kauaʻi. According to the NWS, 27.52 inches of rain fell in two days in the Town of Hanalei. In the County of Kauaʻi, heavy rain caused extensive damage to the slopes adjacent to Kūhiō Highway and impacted the communities of Wainiha and Hāʻena. Multiple landslides led to the closure of the road. Numerous road closures reported in the impacted areas. Many homes were damaged or destroyed. American Red Cross conducted damage assessments and distributed clean up kits to residents in Aina Haina, Niu Valley, Kuliʻouʻou, Waimānalo, and Kailua. In the County of Kauaʻi, the American Red Cross opened five shelters. Ten residents from Wainiha were airlifted to be taken to a shelter. Between April 13 and 19, the American Red Cross provided shelter to 110 individuals on the County of Kauaʻi. Governor Ige declared the District of Hanalei in the County of Kauaʻi a disaster area. This declaration provided relief for damage caused by the event. Details regarding monetized impacts are not available at the time of this 2018 HMP Update.

Sources: FEMA 2017, NOAA-NCEI 2017, Storm Prediction Center 2017, State of Hawaiʻi 2017; State of Hawaiʻi Emergency Management Agency 2018

Notes: With flood documentation for the State of Hawaiʻi being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, this table may not include all events that have occurred in the State and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP Update.

The State did experience flooding as a result of Tropical Storm Iselle (DR-4194); this is discussed further in Section 4.11 (Hurricane).

EOC Emergency Operations Center
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

FEMA Disaster Declarations

Between 1954 and 2018, FEMA included the State of Hawaiʻi in 17 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: flooding, heavy rains, high surf, mudslides, landslides, or severe storms. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2017).

Table 4.7-4 summarizes the flood-related FEMA disaster declarations between 2012 and 2018. This list does not include tropical storm or hurricane disaster declarations that may have resulted in flooding; refer to Section 4.11 (Hurricane) for a listing of these events. For details regarding all declared disasters, refer to Section 4.0 (Risk Assessment Overview). Refer to Appendix X which includes a figure that illustrates the number of flood-related FEMA-declared disasters by county.

Table 4.7-4. Flood-Related Federal Declarations (2012 to 2018)

Year	Event Type	Date Declared	Federal Designation	Counties Affected
2012	Severe Storms, Flooding and Landslides	April 18, 2012	DR-4062	Kauaʻi, Maui
2016	Severe Storms, Flooding, Landslides and Mudslides	October 6, 2016	DR-4282	Maui
2018	Severe Storms, Flooding, Landslides, and Mudslides	May 8, 2018	DR-4364	Honolulu and Kauaʻi

Source: FEMA 2018
Notes: FEMA Federal Emergency Management Agency
Tropical Storm Iselle (DR-4194) is in Section 4.11 (Hurricane).

Repetitive Loss Properties

Properties that are located within the SFHA and have federally backed mortgages or were constructed using federal or federally-related financial assistance are required to purchase flood insurance. When an insured property is damaged by flooding, they typically file a claim. If the insured property has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978, they are referred to as a Repetitive Loss (RL) property. An insured property is known as a Severe Repetitive Loss (SRL) property if: (1) the insured property has had four or more paid flood losses of $5,000 (amount of each claim) and a total amount of claims payments of $20,000; or (2) the insured property field at least two separate claims that have been paid with the cumulative amount of claim payments exceeding the fair market value of the insured building on the day before each loss (FEMA 2017).

PROBABILITY OF FUTURE HAZARD EVENTS

Flooding is common in the State of Hawaiʻi and can take place any time of the year; however, flooding is more frequent during the rainy season which runs from October through April. Based on the history of flood events and the evidence of climate change and sea level rise, flood events may become more frequent throughout the State of Hawaiʻi.

The recurrence interval of a flood, or flood frequency, is the average number of years between floods of a certain size. The actual number of years between floods of any given size varies because of the natural variations in climate and weather events (USGS 2016). As discussed previously, FIRM maps identify a flood hazard area as the area that would be inundated by a flood with a 1% chance of occurring annually (State of Hawaiʻi HMP 2013). These measurements reflect statistical averages only; it is possible for two or more floods with a 1% annual or greater chance to occur in a short time period. Table 4.7-5 describes the recurrence intervals and probabilities of occurrence for flood events.

Table 4.7-5. Recurrence Intervals and Probabilities of Occurrence

Recurrence Interval (in years)	Probability of Occurrence in Any Given Year	Percent Chance of Occurrence in Any Given Year
100	1 in 100	1
50	1 in 50	2%
25	1 in 25	4%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%

Source: USGS 2016
Note: USGS U.S. Geological Survey

For the 2018 HMP Update, the most up-to-date information was collected to calculate the probability of future occurrence of event-based flood events, of all magnitudes, in the State of Hawaiʻi. Information from the 2013 State HMP, FEMA, and NOAA-NCEI were used to identify the number of event-based flood events that occurred between 1879 and 2017. Using these resources ensures the most accurate probability estimates possible. Based on these historic statistics, the State of Hawaiʻi has a 100% chance of an event-based flood, of any magnitude, occurring any given year and can experience approximately five to six event-based flood events each year. The State has a 26% chance (or one declaration every four years) of receiving a FEMA declaration for event-based floods in any given year. However, some areas in the State are more flood prone than others and the frequency and size of flood events varies.

Potential Impacts of Climate Change on Probability of Future Events

Climate projections for the State of Hawaiʻi indicate an overall decline in rainfall; however, the State will experience an increase in heavy rain events causing more frequent or intense flash flooding, infrastructure damage, runoff, and sedimentation. Sea level is also projected to rise, increasing the risk of coastal flooding from hurricanes and tropical storms. Event-based coastal flooding with sea level rise would alter the extent of the area subject to flooding from storm events. Beach and wetland systems may not be able to adapt to rising sea levels and could be lost if not able to migrate inland. Their loss reduces the coast's ability to buffer impacts from storms and flooding (University of Hawaiʻi 2014). Overall, it is highly likely that changing future conditions will exacerbate current conditions and increase future event-based flood risk.

For additional climate change and sea level rise details, refer to Section 4.1 (Climate Change); Section 4.2 (Chronic Coastal Flooding); and Section 4.10 (Hurricane).

4.7.2 Vulnerability Assessment

To assess the State's risk to the flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. In summary, to determine exposure, the hazard areas were overlaid with the assets to determine the total number and replacement cost value located in the hazard areas. If the asset is in the hazard area, it is deemed exposed to the hazard and potentially vulnerable to loss. FEMA's Hazus flood model was used to estimate potential losses to structures from event-based flooding by looking at the depth of flooding at each structure location.

> **Event-Based Flood Hazard Area Definition**
>
> ***Special Flood Hazard Area (SFHA) –*** *The 1% annual chance flood as depicted on the FEMA Flood Insurance Rate Maps (inclusive of V- and A-zones). The hazard area is called the SFHA.*
>
> *Exposure represents assets located in the SFHA.*
>
> *Estimated potential losses are calculated for the 1% annual chance flood event for assets located in the SFHA.*

To evaluate vulnerability to event-based flooding, the SFHA was used. Estimated 1% annual chance flood depth grids were generated utilizing 3D Analyst tools in ArcGIS for A-zones and V-zones. The depth grids were integrated into Hazus version 4.2 and the flood model was run to estimate potential losses to state buildings and critical facilities as user-defined facilities and the default dasymetric general building stock in Hazus.

According to DLNR, the flood maps need to be updated due to new development. In addition, there are large sections in the City and County of Honolulu and the County of Hawaiʻi that have not been studied. Therefore, the estimated results below may be underestimating vulnerability.

As discussed previously, structures located in coastal high hazard areas (V-zones) are at considerable risk of structural damage due to wave action velocities. In order to highlight this added degree of risk, as well as the additional construction requirements in these areas, exposure and vulnerability estimates presented in the following sections show both V-zone risks and the combined risk (A-zone and V-zone) for the special flood hazard area.

When interpreting the information presented, it is important to remember that the entire state is unlikely to experience impacts from a 1% annual chance flood event in all SFHAs at the same time.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of areas susceptible to event-based flooding and potential losses to state assets (state buildings and state roads) and critical facilities.

The exposure analysis for the event-based flooding hazard determined there are 486 state buildings (7.3%) located in the SFHA; of which 98 are located in the V-zone. As noted earlier, buildings located in the V-zone are at considerable risk of structural damage due to wave velocity. The City and County of Honolulu has the greatest total replacement cost value exposed to the SFHA ($598.2 million). The Department of Education has the greatest total replacement cost value exposed ($440 million). Table 4.7-6 summarizes the state buildings located in the SFHA by county. Table 4.7-7 summarizes state buildings exposure and potential loss to event-based flooding by agency.

Table 4.7-6. State Buildings Located in the SFHA by County

County	State Buildings in the SFHA (A- and V-Zones)		State Buildings in the V-Zone	
	Number	Total Replacement Cost Value	Number	Total Replacement Cost Value
County of Kauaʻi	79	$113,527,762	9	$5,004,551
City and County of Honolulu	320	$598,229,038	69	$32,866,631
County of Maui	50	$141,073,152	2	$112,450
County of Hawaiʻi	37	$42,609,275	18	$31,608,663
Total	**486**	**$895,439,226**	**98**	**$69,592,294**

Source: Hawaiʻi State Risk Management Office 2017; Hazus v4.2
Note: SFHA Special Flood Hazard Area

Table 4.7-7. State Buildings Exposure and Potential Loss to the 1% Annual Chance Flood Event by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	State Buildings Located in the SFHA				Potential Loss to the 1% Annual Chance Flood Event	
			Number	Percent (%) of Total Buildings	Replacement Cost Value	Percent (%) of Total Value	Estimated Potential Loss	Percent (%) of Total
Dept of Accounting & General Services	66	$946,504,656	6	9.1%	$50,613,018	5.3%	$1,284,901	2.5%
Dept of Agriculture	70	$133,065,375	5	7.1%	$4,998,715	3.8%	$0	0.0%
Dept of Attorney General	15	$95,151,863	1	6.7%	$1,953,251	2.1%	$0	0.0%
Dept of Budget & Finance	16	$26,624,294	1	6.3%	$121,540	0.5%	$0	0.0%
Dept of Business, Economic Development and Tourism	25	$612,574,032	2	8.0%	$26,786,125	4.4%	$9,104,816	34.0%
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.0%	$0	0.0%	$0	0%
Dept of Defense	69	$246,099,477	17	24.6%	$62,162,658	25.3%	$20,579,115	33.1%
Dept of Education	4,090	$9,604,111,443	266	6.5%	$439,963,050	4.6%	$21,835,704	5.0%
Dept of Hawaiian Home Lands	12	$100,471,477	1	8.3%	$4,748,597	4.7%	$2,172,881	45.8%
Dept of Health	44	$387,068,440	1	2.3%	$429,251	0.1%	$0	0.0%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%	$0	0%
Dept of Human Services	130	$420,004,555	8	6.2%	$9,995,739	2.4%	$1,868,356	18.7%

Agency	Total Number of State Buildings	Total Replacement Cost Value	State Buildings Located in the SFHA				Potential Loss to the 1% Annual Chance Flood Event	
			Number	Percent (%) of Total Buildings	Replacement Cost Value	Percent (%) of Total Value	Estimated Potential Loss	Percent (%) of Total
Dept of Labor and Industrial Relations	22	$79,322,626	2	9.1%	$2,251,107	2.8%	$0	0.0%
Dept of Land and Natural Resources	90	$98,666,185	28	31.1%	$12,682,661	12.9%	$1,349,360	10.6%
Dept of Public Safety	154	$427,884,909	14	9.1%	$30,496,180	7.1%	$2,827,053	9.3%
Dept of Taxation	1	$6,864,408	0	0.0%	$0	0.0%	$0	0%
Dept of Transportation	68	$2,912,510,888	25	36.8%	$84,824,357	2.9%	$1,140,185	1.3%
Hawai'i State Ethics Commission	1	$891,212	0	0.0%	$0	0.0%	$0	0%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	1	0.9%	$829,553	0.1%	$0	0.0%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	1	1.2%	$39,460,800	11.8%	$6,092,283	15.4%
Hawaiʻi Public Housing Authority	273	$933,255,767	40	14.7%	$47,266,236	5.1%	$166,090	0.4%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%	$0	0%
Hawaiʻi State Public Library System	53	$525,584,082	7	13.2%	$14,566,099	2.8%	$95,348	0.7%
Judiciary	41	$511,093,204	1	2.4%	$1,983,075	0.4%	$0	0.0%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%	$0	0%
Office of Hawaiian Affairs	11	$53,991,251	5	45.5%	$17,078,644	31.6%	$3,114,166	18.2%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%	$0	0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%	$0	0%
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%	$0	0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%	$0	0%
Research Corporation of the	3	$3,713,497	1	33.3%	$412,021	11.1%	$164,585	39.9%

Agency	Total Number of State Buildings	Total Replacement Cost Value	State Buildings Located in the SFHA				Potential Loss to the 1% Annual Chance Flood Event	
			Number	Percent (%) of Total Buildings	Replacement Cost Value	Percent (%) of Total Value	Estimated Potential Loss	Percent (%) of Total
University of Hawai'i								
University of Hawai'i	637	$5,000,692,783	53	8.3%	$41,816,547	0.8%	$7,061,523	16.9%
Total	**6,095**	**$24,780,556,017**	**486**	**8.0%**	**$895,439,226**	**3.6%**	**$78,856,366**	**8.8%**

Source: Hawaiʻi State Risk Management Office 2017;

The Hazus flood model estimates $78.8 million in damages to state buildings as a result of the 1% annual chance flood event. This figure does not include the cost of damage to roads or utilities which could be considerable. The City and County of Honolulu is estimated to experience the greatest loss ($72 million, or 12% of the county's total building replacement cost value), with more than $8 million of the total loss located in the V-zone. Table 4.7-8 summarizes the state building loss by county; estimated potential loss by state agency is summarized in Table 4.6-6. The Department of Education and the Department of Defense occupy buildings with the greatest potential loss; $21.8 billion and $20.5 billion in damages, respectively which nearly equate to half of the state building estimated loss.

Table 4.7-8. State Building Estimated Potential Loss to the 1% Annual Chance Flood Event by County

County	Estimated Potential Loss to the 1% Annual Chance Flood Event (A- and V-Zones)		Estimated Potential Loss in the V-Zone Only	
	Replacement Cost Value	Percent (%) of Total	Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$5,635,238	5.0%	$0	0.0%
City and County of Honolulu	$72,423,675	12.1%	$8,230,618	25.0%
County of Maui	$0	0.0%	$16,990	15.1%
County of Hawaiʻi	$797,453	1.9%	$0	0.0%
Total	**$78,856,366**	**8.8%**	**$8,247,644**	**11.9%**

Source: Hawaiʻi State Risk Management Office 2017; Hazus v4.2
Note: SFHA Special Flood Hazard Area

Statewide, there are 84.4 miles of state roads exposed to event-based flooding. There is a major public safety hazard when residents attempt to drive on flooded roadways. Many state roads serve as evacuation routes to higher ground. Not only will these roads be closed during a flood event and potentially isolate communities, the flood waters may accelerate the degradation of these roads leading to increased repair and replacement costs. Bridges exposed to flood events can be extremely vulnerable due to the forces transmitted by the velocity and by the impact of debris carried by the water. Table 4.7-9 shows the length of state roads in the SFHA by county. The City and County of Honolulu has the greatest number of miles (44.7 miles) exposed, followed by the County of Maui (20.6 miles). A complete list of state roads is included in Appendix X.

Table 4.7-9. State Road Exposure to the 1% Annual Chance Flood Event by County

County	Length (in miles)		
	Total Length	Length in the SFHA	Percent (%) of Total Length
County of Kauaʻi	104.0	14.7	14.2%
City and County of Honolulu	375.3	44.7	11.9%
County of Maui	238.6	20.6	8.6%
County of Hawaiʻi	378.7	4.4	1.2%
Total	**1,096.5**	**84.4**	**7.7%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017
Notes: GIS Geographic Information System
SDOT State Department of Transportation

Critical Facilities

Critical transportation hubs and critical infrastructure located are exposed to the event-based flood hazard. Utility lines commonly follow roads and those located underground may be impacted resulting in disruption of services.

Table 4.7-10 summarizes the total number of critical facilities by core category located in the SFHA by county. The cost to repair or replace flooded critical facilities is an estimated $306 million. The City and County of Honolulu has the greatest number of critical facilities (68) exposed, followed by the County of Maui (42). Table 4.7-11 summaries the critical facilities exposure and potential losses by core category. Water, waste and wastewater systems have the greatest estimated potential loss at $161.8 million, followed by the Energy core category with greater than $75 million.

Table 4.7-10. Critical Facilities Located in the SFHA by County

County	Core Category of Critical Facilities										Total in the SFHA
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	1	1	3	1	0	1	0	4	0	2	13
City and County of Honolulu	4	8	7	14	1	6	2	5	2	19	68
County of Maui	0	2	3	1	0	5	4	4	8	15	42
County of Hawaiʻi	0	0	0	2	5	1	0	1	5	9	23
Total	**5**	**11**	**13**	**18**	**6**	**13**	**6**	**14**	**15**	**45**	**146**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2

Table 4.7-11. Critical Facilities Exposure and Potential Losses by Core Category to the 1% Annual Chance Flood Event

Core Category	Critical Facilities Located in the SFHA				Estimated Potential Loss to the 1% Annual Chance Flood Event (A- and V-Zones)	
	Number of Critical Facilities	Percent (%) of Total Facilities	Replacement Cost Value	Percent (%) of Total Value	Replacement Cost Value	Percent (%) of Total
Commercial Facilities	5	8.3%	$12,446,395	6.0%	$2,723,081	21.9%
Communications	11	8.5%	$32,035,980	6.1%	$4,301,718	13.4%
Emergency Services	13	8.7%	$77,684,370	7.6%	$676,487	0.9%
Energy	18	20.0%	$533,553,615	20.6%	$75,907,789	14.2%
Food & Agriculture	6	15.4%	$84,920,890	10.2%	$11,067,313	13.0%
Government Facilities	13	13.0%	$50,945,510	12.7%	$4,078,617	<1%
Healthcare & Public Health	6	3.1%	$95,015,433	2.8%	$2,368,394	2.5%
Mass Care Support Services	14	4.0%	$160,107,435	1.4%	$2,812,375	1.8%
Transportation Services	15	26.8%	$465,972,480	26.8%	$40,546,219	8.7%
Water, Waste, & Wastewater Systems	45	14.8%	$1,401,120,000	14.8%	$161,840,359	11.6%
Total	**146**	**9.9%**	**$2,913,802,107**	**9.2%**	**$306,322,351**	**10.5%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets by county. A spatial exposure analysis was conducted using the SFHA and estimate potential losses were estimated using Hazus. These results are summarized below.

Population

Over 95,000 residents statewide are located in the SFHA; refer to Table 4.7-12. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. The City and County of Honolulu has the greatest number of people (74,931) and the County of Kauaʻi has the greatest percent of people (9.9%) located in the SFHA. This analysis does not include the number of tourists and visitors in the state; therefore this estimate may be underestimating exposure and vulnerability.

While all people located in SFHA are considered exposed and potentially vulnerable, populations considered most vulnerable include the elderly (persons over the age of 65) and individuals living below the U.S. Census poverty threshold. The City and County of Honolulu has the largest population over 65, with 1.2% exposed and 2.7% of the low-income population exposed to the SFHA. Appendix X summarizes the population exposure to the A-Zone and V-Zone areas.

Table 4.7-12. 2010 U.S. Census Population Located in the SFHA by County

County	Population						
	Total Population	Population in the SFHA	Population Exposed as % of Total Population	Population Over 65 in the SFHA	Population Over 65 Exposed as % of Total	Population with Income <$30K/yr in the SFHA	Population with Income <$30K/year as Percent (%) of Total
County of Kauaʻi	67,091	6,656	9.9%	946	1.4%	1,995	3.0%
City and County of Honolulu	953,207	74,931	7.9%	10,970	1.2%	25,827	2.7%
County of Maui	154,924	8,173	5.3%	1,106	0.7%	2,361	1.5%
County of Hawaiʻi	185,079	5,456	2.9%	877	0.5%	2,088	1.1%
Total	**1,360,301**	**95,216**	**7.0%**	**13,899**	**1.0%**	**32,271**	**2.4%**

Source: U.S. Census 2010; Hazus 4.2
*The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaiʻi . To convert households to residents, three people per house*hold was used.

Floods and their aftermath present numerous threats to public health and safety:

- **Vehicles in Flood Waters**— Flood waters can carry large amounts of debris potentially increasing the damage they do.
- **Unsafe food**—Floodwaters can 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.
- **Contaminated drinking and washing water and poor sanitation**—Flooding impairs clean water sources with pollutants; pollutants also infiltrate into the groundwater contaminating potable water. Flooded wastewater treatment plants and private sewage disposal systems can be overloaded, resulting in backflows of raw sewage becoming a cause of disease.
- **Mosquitoes and animals**—Floods provide new breeding grounds for mosquitoes in wet areas and stagnant pools; deceased animals can carry viruses and diseases if not disposed of timely and properly.
- **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. 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 the use alternative fuels in enclosed or partially enclosed spaces can lead to carbon monoxide poisoning.
- **Hazards when reentering and cleaning flooded homes and buildings**—Flooded buildings can pose significant health and physical hazards to people entering them including live electrical wires, gas leaks, flood debris, and hazardous materials.
- **Mental stress and fatigue**—People who live through a devastating flood can experience long-term psychological impact.

General Building Stock

Economic losses to the State of Hawaiʻi from event-based flooding include but are not limited to: general building stock damage, agricultural losses and business interruption. These losses will negatively affect the tax base. Damage to general building stock can be quantified using Hazus. Other economic components such as loss of facility use, functional downtime, and social economic factors are less quantifiable. For the purposes of this analysis, the general building stock damage is discussed further.

Low-lying urban areas have the greatest vulnerability to a flood event. To estimate the potential losses by county, the Hazus flood model and default general building stock provided by the model were used. This analysis has been refined since the 2013 HMP due to the updated and improved flood hazard areas and flood depth grids across the state. Table 4.7-13 summarizes the estimated potential losses to the general building stock by county.

Hazus estimates $2.5 billion in statewide potential damages to the general building stock inventory associated with the 1% annual chance flood event. Although this loss represents only 1% of the State's total building replacement cost value, the area flooded comprises of some of the most valued in the state. The City and County of Honolulu is estimated to experience the greatest loss; nearly $2 billion in building damages (repair or replacement costs), of which $1.5 billion of the damages are in the V-zone. The cost to repair or replace buildings in the County of Kaua'i is estimated an estimated $282 million; and an estimated $204 million in the County of Maui. Hazus estimates $93 million in building loss for the County of Hawaiʻi. Appendix X summarizes the exposure and potential losses to the 1% Annual Chance Flood A-Zone and V-Zone areas.

Table 4.7-13. General Building Stock Exposure and Potential Losses to the 1% Annual Chance Flood Event

County	Total Replacement Cost Value	Replacement Cost Value in the SFHA	% of Total in the SFHA	Estimated Potential Loss to the 1% Annual Chance Flood Event (A-and V-Zones)		Estimated Potential Loss to Buildings in the V-Zones	
				Replacement Cost Value	Percent (%) of Total	Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$13,287,882,000	$1,510,657,000	11.4%	$282,379,000	2.1%	$146,778,000	1.1%
City and County of Honolulu	$164,787,212,000	$18,295,042,000	11.1%	$1,944,614,000	1.2%	$1,533,898,000	0.9%
County of Maui	$31,320,693,000	$2,233,402,000	7.1%	$204,455,000	0.7%	$102,798,000	0.3%
County of Hawaiʻi	$33,326,392,000	$1,673,237,000	5.0%	$93,133,000	0.3%	$35,91,000	0.1%
Total	**$242,722,179,000**	**$23,712,338,000**	**9.8%**	**$2,524,581,000**	**1.0%**	**$1,819,391,000**	**0.7%**

Source: Hazus v4.2; State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal 2017
Notes: GIS Geographic Information System
SFHA Special Flood Hazard Area

The NFIP data are also a useful tool to determine areas vulnerable to flood. Table 4.7-14 summarizes the NFIP policies, claims, and repetitive loss buildings in each county. Severe repetitive loss statistics were not provided for the 2018 HMP Update. The City and County of Honolulu has the highest number of repetitive loss properties (107), followed by the County of Hawaiʻi (45). The County of Kauaʻi has the greatest total losses paid as of 2017. These statistics do not include the April 2018 flood event.

Table 4.7-14. NFIP Statistics for the State of Hawaiʻi

County	Number of Policies	Insurance In Force	Number of Paid Losses	Total Losses Paid	Repetitive Loss Buildings				
					2013	2018			
					Total	Total	A-Zone	V-Zone	Outside the Floodplain
County of Kauaʻi	5,365	$1,115,241,400	652	$37,093,919	19	19	12	2	5
City and County of Honolulu	38,077	$8,815,199,700	1,500	$29,733,112	97	107	53	13	31
County of Maui	12,240	$2,658,756,600	301	$6,319,516	36	35	20	5	10
County of Hawaiʻi	4,363	$1,035,377,300	501	$18,240,427	45	45	13	25	4
Total	**60,045**	**$13,624,575,000**	**2,954**	**$91,386,974**	**197**	**206**	**98**	**45**	**50**

Source: FEMA Region IX, NFIP Regulations and Compliance, 2/19/2018; State of Hawaiʻi HMP 2013

Over the performance period of the 2013 HMP, the number of repetitive loss properties has increased from 197 to 206 (an approximate 5% increase). The City and County of Honolulu is the only county to experience an increase in repetitive loss properties; 10 properties over the last five years. The County of Maui experienced a decrease of one property. The number of repetitive loss properties in the Counties of Kauaʻi and Hawaiʻi have remained the same since 2013. However, as noted above, these statistics do not include the April 2018 flood event (DR-4365).

Land Use Districts

Table 4.7-15 shows the square miles of special flood hazard areas in each State Land Use District statewide; refer to Appendix X for results by county. Agricultural District lands and Urban District lands have the greatest area exposed to A-zone flooding in the State, 34.2 and 20.6 square miles, respectively. This is not surprising for two reasons 1) productive agricultural lands tend to be located along steams as rivers as sediment build up and accumulation from prior flood events results in fertile soil and 2) floodplain mapping is generally conducted in areas that are developed or are likely to be developed in the future. Conservation District lands and Urban District lands have the greatest area exposed to V-zone flooding in the State, 14.4 and 8 square miles respectively. This is also not surprising as urban development in the State tends to be situated along the coast and Conservation District lands contain valuable environmental resources, which are often located in coastal areas. Additional discussion of exposure and vulnerability of Conservation District lands and their exposure and vulnerability to Event Based Floods can be found in the Environmental Resources section below.

Table 4.7-15. State Land Use Districts Located in the Special Flood Hazard Area

Land Use District	Total (square miles)	Square Miles in the SFHA	Percent (%) of Total Area
Agricultural	2,942.8	36.9	1.3%
Conservation	3,156.3	23.9	0.8%
Rural	16.1	1.9	12.0%
Urban	319.7	28.6	8.9%
Total	**6,434.9**	**91.4**	**1.4%**

Source: FEMA

Notes: Total area was calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline were downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
FEMA Federal Emergency Management Agency
GIS Geographic Information System
SFHA Special Flood Hazard Area

Environmental Resources

Environmental resources are valuable assets to the environment and overall economy in the State. Coral reefs and wetlands provide a coastal buffer and protect from wave and flood impacts. However, flooding may adversely impact the natural environmental including: beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks and open space; and loss of coastal structures (sea walls, piers, bulkheads, bridges, or buildings) (FEMA 2007). Flash floods often result in increased sediment deposited in the nearshore environment negatively impacting coral reefs from sedimentation and stormwater runoff (University of Hawaiʻi 2014).

Environmental resource areas, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands and parks and reserves are vulnerable to event-based flooding. The area of each environmental resource located in the SFHA was calculated and is summarized in Table 4.7-16.

Table 4.7-16. Environmental Resources Located in the SFHA

Environmental Resource	Total Square Miles of Resource	Resource Area in the SFHA (square miles)	Percent (%) of the Total Resource Area
Critical Habitat[a]	915.2	2.6	0.3%
Wetlands	260.0	24.4	9.4%
Parks and Reserves	2,607.7	15.1	0.6%
Total[b]	**3,837.6**	42.1	**1.1%**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; HWMO 2013
a. Critical area mileage includes the combined area of coverage of individual critical habitat areas
b. Total square miles may be over reported as some environmental asset areas may overlap.
Sq. Mi. = Square miles.
Reefs were excluded from the analysis because they are under water and thus 100% exposed to a flood hazard.

Cultural Assets

Many Native Hawaiian cultural resources are located near the shoreline and may be impacted by event-based flooding. Structures that experience damage would result in displaced residents in need of shelter or new homes. Less than 3% of the Hawaiian Home Lands is in the 1% Annual Chance Flood areas (this includes the A-Zone, V-Zone and SFHA) in all four counties (see Table 4.7-17).

Table 4.7-17. Hawaiian Home Lands Located in the SFHA

County	Area (in square miles)		
	Total Area	Land in the SFHA	Percent (%) of Total Area
County of Kauaʻi	32.0	0.3	1.0%
City and County of Honolulu	10.9	0.2	1.9%
County of Maui	92.6	2.3	2.5%

County	Area (in square miles)		
	Total Area	Land in the SFHA	Percent (%) of Total Area
County of Hawai'i	190.3	1.1	0.6%
Total	**325.8**	**3.9**	**1.2%**

Source: State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal 2017
Notes: GIS Geographic Information System
SFHA Special Flood Hazard Area

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Potential or Projected Development

The special flood hazard areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.7-19 below; refer to Section 3 for more information on projected development areas). The results of this assessment indicate none of the HCDA Community Development Districts and only a very small amount of the Maui Development Projects areas are located in special flood hazard areas. Approximately 68.8% of the Enterprise Zones statewide are located in special flood hazard areas. Most of the exposed area, 50.4 square miles, is located in A-zone special flood hazard areas. Each county participates in the National Flood Insurance Program and has a flood damage prevention regulations in place that regulates how development can occur in mapped special flood hazard areas. Future development in these areas will be required to adhere to flood damage prevention standards. If new development occurs in areas that currently support natural and beneficial floodplain functions, such as in upland conservation areas, impacts to event based flooding may be seen throughout the associated watershed.

Other Factors of Change

Climate change is certain to alter flood dynamics in the State. Changes in the timing and intensity of rainfall may impact inland and stormwater flooding, changes in wind and storm patterns may impact coastal flooding, and sea level rise will increase the areas exposed to coastal and some inland flooding as well as flood heights in some areas. For more information on how climate change will impact event based flooding, please refer to Section 4.2 (Climate Change and Sea Level Rise).

Table 4.7-18. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in Special Flood Hazard Areas

County	Area (in square miles)								
	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
A-Zone									
County of Kauaʻi	-	-	-	-	-	-	252.3	14.1	5.6%
City and County of Honolulu	7.4	0.0	0.0%	-	-	-	288.3	14.5	5.0%
County of Maui	-	-	-	27.6	0.0	0.0%	1,016.7	13.7	1.4%
County of Hawaiʻi	-	-	-	-	-	-	1,286.6	8.0	0.6%
Total	**7.4**	**0.0**	**0.0%**	**27.6**	**0.0**	**0.0%**	**2,843.9**	**50.4**	**1.8%**
V-Zone									
County of Kauaʻi	-	-	-	-	-	-	252.3	1.4	0.6%
City and County of Honolulu	-	-	-	-	-	-	288.3	3.3	1.1%
County of Maui	-	-	-	27.6	0.02	0.1%	1,016.7	6.7	0.7%
County of Hawaiʻi	7.4	0.0	0.0%	-	-	-	1,286.6	7.0	0.5%
Total	**7.4**	**0.0**	**0.0%**	**27.6**	**0.02**	**0.1%**	**2,843.9**	**18.4**	**0.6%**
Special Flood Hazard Area									
County of Kauaʻi	-	-	-	-	-	-	252.3	15.5	6.2%
City and County of Honolulu	-	-	-	-	-	-	288.3	17.8	6.2%
County of Maui	-	-	-	27.6	0.02	0.1%	1,016.7	20.4	2.0%
County of Hawaiʻi	7.4	0.0	0.0%	-	-	-	1,286.6	15.1	1.2%
Total	**7.4**	**0.0**	**0.0%**	**27.6**	**0.02**	**0.1%**	**2,843.9**	**68.8**	**2.4%**

Notes: Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (2) Maui Development Projects GIS layer from Maui County Planning Department (3) Enterprise Zones from Community Economic Development Program, DBEDTS Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal

HCDA Hawaiʻi Community Development Authority
SFHA Special Flood Hazard Area

SECTION 4. RISK ASSESSMENT

4.8 Hazardous Materials

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Hazardous materials incidents that occurred in the State of Hawai'i from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update.
- The capability information regarding the State Emergency Response Commission and the Hawai'i Emergency Planning and Community Right to Know Act was removed, to focus more on the hazard itself.
- The profile and vulnerability assessment have been updated to include the most up-to-date information on the numbers of chemical facilities and Superfund sites, the addition of information on pipelines, and the consideration of both fixed-sites and in-transit hazardous materials.
- A qualitative vulnerability assessment of damage to state assets and critical facilities from hazardous materials incidents is provided at the State level.
- A qualitative vulnerability assessment is provided at the county level of risk to the population, general building stock, and environmental/cultural resources from hazardous materials incidents.
- Discussion of future changes that may impact State vulnerability has been added.

4.8.1 Hazard Profile

Hazard Description

"Hazardous substances" include materials and wastes that are considered severely harmful to human health and the environment, as defined by the United States Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (commonly known as Superfund). Many hazardous materials are commonly used substances which are harmless in their normal uses, but are quite dangerous if released in concentration. The EPA designates more than 1,300 substances as hazardous and subject to the reporting requirements under the Emergency Planning and Community Right-to-Know Act (EPCRA), CERCLA, and/or Clean Air Act (CAA). This number does not include all hazardous chemicals for which material safety data sheets are required (EPA 2015). Because relevant legislation uses the term "hazardous substance," but the emergency management and response community typically uses the term "hazardous materials," for the purpose of this hazard profile, "hazardous materials" and "hazardous substances" are used interchangeably.

According to CERCLA, the definition of a hazardous substance includes the following:

- Any element, compound, mixture, solution, or substance designated as hazardous under Section 102 of CERCLA.

- Any hazardous substance designated under Section 311(b)(2)(a) of the Clean Water Act (CWA), or any toxic pollutant listed under Section 307(a) of the CWA. There are over 400 substances designated as either hazardous or toxic under the CWA.
- Any hazardous waste having the characteristics identified or listed under Section 3001 of the Resource Conservation and Recovery Act (RCRA).
- Any hazardous air pollutant listed under Section 112 of the Clean Air Act (CAA), as amended. There are over 200 substances listed as hazardous air pollutants under the CAA.
- Any imminently hazardous chemical substance or mixture which the EPA Administrator has "taken action under" Section 7 of the Toxic Substances Control Act (TSCA) (EPA 2013).

If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures and other properties, as well as the environment. Many products containing hazardous substances are used and stored in homes and these products are shipped daily on highways, waterways, and pipelines. There are two general types of hazardous material incidents:

- ***Fixed-site hazardous substances (materials and waste) incident*** is the uncontrolled release of materials from a fixed-site capable of posing a risk to health, safety, and property as determined by RCRA. It is possible to identify and prepare for a fixed-site incident because federal and state laws require those facilities to notify state and local authorities about what is being used or produced at the site. Hazardous materials at fixed-sites are regulated by the EPA.

  The EPA chooses to specifically list substances as hazardous and extremely hazardous, rather than providing objective definitions. Hazardous substances, as listed, are generally materials that, if released into the environment, tend to persist for long periods and pose long-term health hazards for living organisms. Extremely hazardous substances, while also generally toxic materials, represent acute health hazards that, when released, are immediately dangerous to the lives of humans and animals and cause serious damage to the environment. When facilities have these materials in quantities at or above the threshold planning quantity (TPQ), they must submit “Tier II” information to appropriate state and/or local agencies to facilitate emergency planning.

- A ***hazardous materials transportation incident*** is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by the U.S. Department of Transportation (U.S. DOT) Materials Transport regulations. Transportation incidents are difficult to prepare for because there is little, if any, notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur anywhere within the State. Transportation of hazardous materials on highways involves tanker trucks or trailers, and are responsible for the greater number of hazardous substance release incidents. Transportation of hazardous materials, such as imported petroleum products, occurs on navigable waters via ships and barges. Hazardous materials in transit are regulated by the U.S. DOT, and transportation of hazardous waste is regulated by the Hawai’i Department of Health (DOH).

  The U.S. DOT regulations define hazardous materials as a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under Section 5103 of federal hazardous materials transportation law (49 U.S. Code [U.S.C.] 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 Code of Federal Regulations [CFR] 172.101), and materials that meet the defining criteria for hazard classes and divisions. When a substance meets the DOT definition of a hazardous material, it must be transported in accordance with safety regulations providing for appropriate packaging, communication of hazards, and proper shipping controls.

The Emergency Planning and Community Right-to-Know Act (EPCRA) was passed by Congress in 1986 (Title III of SARA). The EPCRA establishes requirements for federal, state and local governments, Indian tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The Community Right-to-Know provisions help increase public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment. There are four key provisions to the EPCRA, which include:

- ***Emergency planning*** – Local governments are required to prepare chemical emergency response plans, and to review plans at least annually. State governments are required to oversee and coordinate local planning efforts. Facilities that maintain Extremely Hazardous Substances (EHS) on-site in quantities greater than corresponding threshold planning quantities (TPQs) must also cooperate in preparing emergency plans.
- ***Emergency release notification*** – Facilities must immediately report accidental releases of EHSs and other hazardous substances, as defined under CERCLA. Any release of these substances in quantities greater than their corresponding reportable quantities must be reported to state and local officials.
- ***Hazardous chemical storage reporting requirements*** – Facilities handling or storing any hazardous chemicals, as defined under Occupational Safety and Health Administration (OSHA), must submit Material Safety Data Sheets (MSDSs), or Safety Date Sheets (SDSs), to state and local officials and fire departments. Facilities must also submit an inventory form for these chemicals to state and local officials and local fire departments.
- ***Toxic chemical release inventory (TRI)*** – Facilities must complete and submit a toxic chemical release inventory form (Form R) each year. Form R must be submitted for each of the over 600 TRI chemicals that are manufactured or other used above the applicable threshold quantities.

As part of the requirements for hazardous chemical storage reporting, facilities must submit annually an Emergency and Hazardous Chemical Inventory Form to the local emergency planning committee (LEPC), the state emergency response commission (SERC), and the local fire department. Facilities provide either a Tier I or Tier II inventory form; however, most states require Tier II inventory forms. The forms need to be submitted on or before March 1 each year for information on chemicals present at the facility in the previous year.

In 1993, the State of Hawaiʻi enacted the Hawaiʻi Emergency Planning and Community Right-to-Know Act (HEPCRA) which is modeled after the federal EPCRA. Hawaiʻi Administrative Rules for implementing HEPCRA regulations became effective in November 2010. Similar to EPCRA, HEPCRA has four major provisions: (1) emergency response planning, (2) emergency release reporting, (3) hazardous chemical storage and Tier II reporting, and (4) toxic release inventory reporting. The Hawaiʻi Department of Health (DOH)'s Hazard Evaluation and Emergency Response (HEER) Office carries out the requirements of EPCRA, as well as HEPCRA.

In addition to traditional hazardous materials stored or transported, on-site sewage disposal systems (OSDS) that provide wastewater treatment for multiple homeowners need to be maintained properly. The lack of maintenance or a physical impact to these systems can lead to an environmental release potentially contaminating nearby waterbodies and drinking water sources, and compromising public health. The DOH's Clean Water Branch administers the Nonpoint Source management program, which includes the oversight of OSDSs, and develops the State's Nonpoint Source Management Plan with watershed-specific strategies to control pollution (DOH 2015).

Location

Hazardous materials are widely stored and transported throughout the State of Hawaiʻi. An event involving hazardous materials release can occur anywhere; for this reason, the location of a hazardous materials release is classified as either being at a fixed site or in-transit. A fixed site hazardous materials release occurs at facilities that store and/or use hazardous materials and include refineries, warehouses, portside facilities and harbors and Superfund sites. An in-transit hazardous materials release occurs while a hazardous material is being transported from one location to another along major highways, navigable waters, or via pipelines.

Fixed-Site Hazardous Materials

Serious hazardous materials incidents—those causing hospitalizations, deaths, and large-scale economic loss and environmental damage—are generally the result of a series of improbable events involving large quantities of material and are, thus, relatively rare and difficult to predict. Tier II reporting reveals the location and identity of large quantities of hazardous materials in storage and use. As of the date of this 2018 HMP Update, there are 1,026 Tier II reporting facilities in the State of Hawaiʻi (see Table 4.8-1).

***Table 4.8-1*. Hazardous SARA Tier II Reporting Facilities**

County	Tier II Reporting Facilities
County of Kauaʻi	124
City and County of Honolulu	472
County of Maui	184
County of Hawaiʻi	246
Total	1,026

Source: Hawai'i DOH HEER 2018

Superfund Sites

In response to concerns regarding health and environmental risks, Congress established the Superfund program in 1980 to clean up sites in which hazardous materials were released and ultimately abandoned. The Superfund program is locally administered by the EPA in cooperation with the Hawai'i DOH HEER Office.

Federal regulations, including CERCLA and the Superfund Amendments and Reauthorization Act (SARA), required that a National Priorities List (NPL) of sites throughout the United States be maintained and revised at least annually (SARA amended CERCLA on October 17, 1986). The NPL is a list of sites of national priority among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the

United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation. As of the date of this 2018 HMP Update, there are three NPL (Superfund) sites in Hawaiʻi, all located in the City and County of Honolulu (EPA 2018).In addition to the federal NPL sites, the Hawai'i DOH Response Program List of Priority Sites presents all sites in the State identified for potential or known non-emergency response actions managed by the HEER Office Site Discovery, Assessment, and Remediation Section Remedial Project Managers (RPMs). Sites are categorized as a potential hazard when sampling data indicate that contaminant concentrations exceed Hawaiʻi Environmental Action Levels. The list for the fiscal year 2017 includes 572 sites statewide that are managed within the HEER Office. Of those sites, 75 are listed as high priority, 207 as medium priority, 265 as low priority, and 14 as no further action unrestricted. For the full list of sites, refer to https://health.hawaii.gov/opppd/files/2017/12/128D-128E.pdf (State of Hawaiʻi Department of Health 2017b).

Both Superfund sites and identified high-priority sites increase the State's risk to impacts from other hazards such as flooding, storm surge, and erosion that can cause the migration or spread of hazardous materials throughout the environment. Adversely impacting both public and environmental health, and adding significant complications to recovery efforts following a disaster that impacts a superfund site or high-priority site if identified hazardous materials are not properly contained.

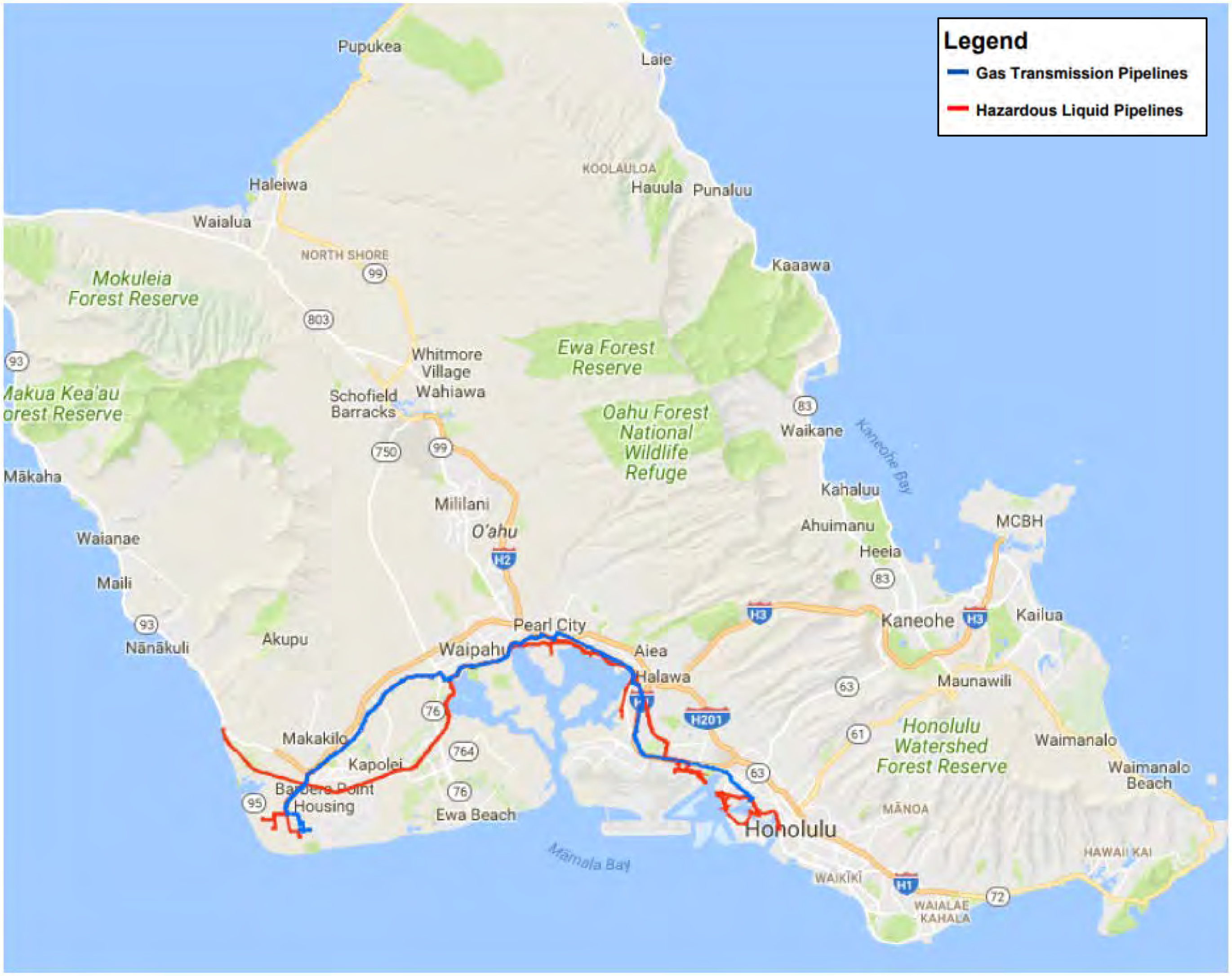
In-Transit Hazardous Materials

Incidents involving hazardous substances in transit can occur anywhere in the State. The primary mode of transportation on island is via the highway network. The State of Hawaiʻi has a widespread highway network in which hazardous materials may be transported.

Hazardous substances can also be transported via ships, barges and pipeline in Hawaiʻi. Refinery feedstock and refined petroleum products are imported to the State via navigable waters. There are two crude oil refineries on the leeward coast of O'ahu, in the vicinity of Campbell Industrial Park, that can produce a broad range of refined petroleum products. Because there are no inter-island pipelines to transport these products, refined petroleum products are loaded at Honolulu harbor terminals onto fuel barges for distribution to the other islands (U.S. Energy Information Administration 2017).

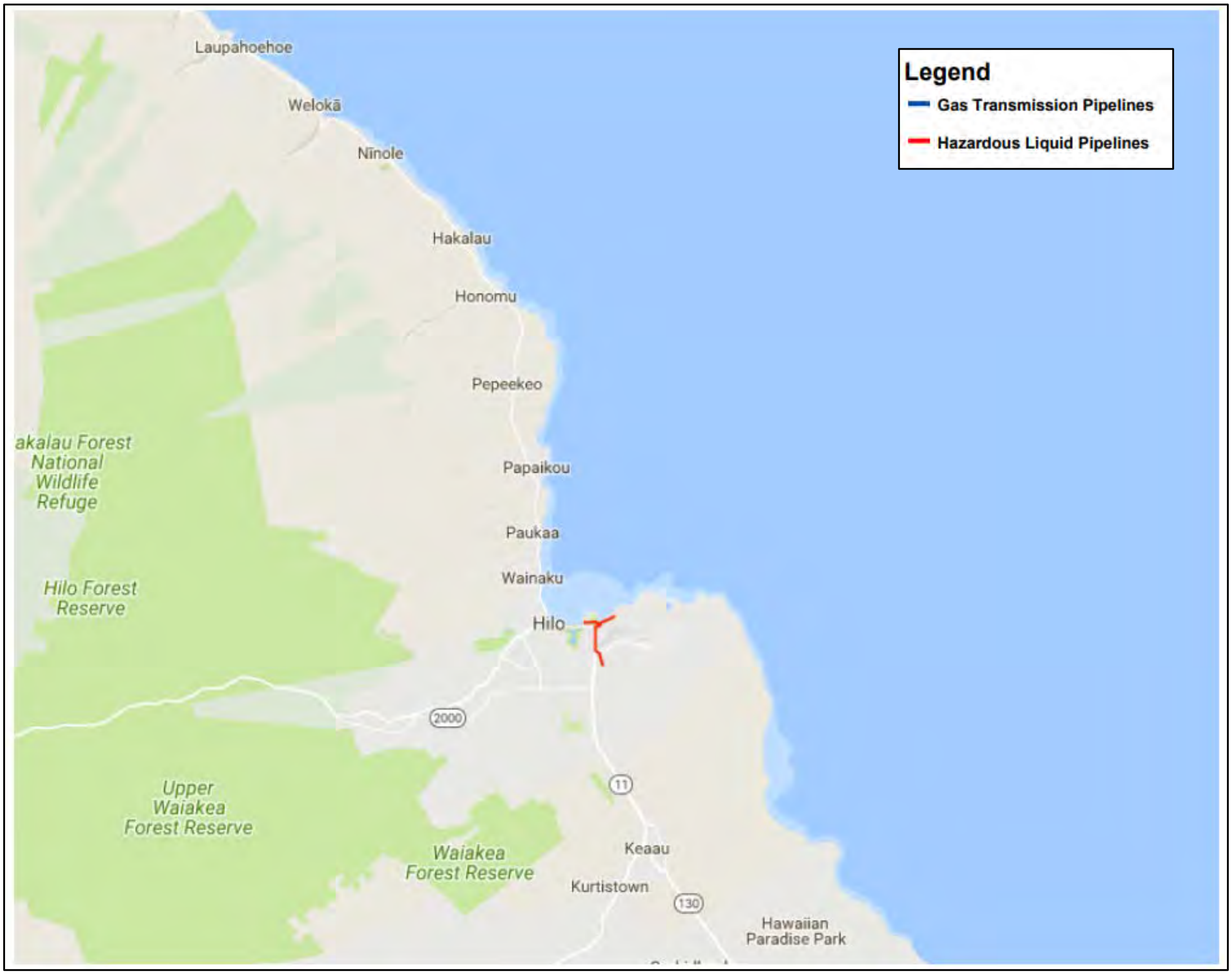
On the Island of O'ahu, petroleum is transported via pipeline from two crude oil refineries to other locations on the island (U.S. Energy Information Administration 2017). As of 2016, there were 95 miles of refined petroleum product pipeline on the Island of Oʻahu (Pipeline and Hazardous Materials Safety Administration [PHMSA] 2017a). Figure 4.8-1 and Figure 4.8-2 show the gas transmission and hazardous liquids (refined petroleum products) pipelines. In addition, Hawaiʻi Gas operates over 1,000 miles of gas distribution pipeline, delivering synthetic natural gas to nearly 28,000 customers, and provides propane gas to 40,000 more customers on the Island of Oʻahu and other islands (Hawaiʻi Gas 2017).

Figure 4.8-1. Petroleum and Gas Transmission Pipelines in the City and County of Honolulu



Source: PHMSA 2017b

Figure 4.8-2. Petroleum and Gas Transmission Pipelines in the County of Hawaiʻi



Source: PHMSA 2017b

EXTENT

The extent of a hazardous substance release will depend on whether it is from a fixed or in-transit (mobile) source, the volume of substance released, duration of the release, the toxicity and properties of the substance, and the environmental conditions (for example, wind and precipitation, terrain, etc.).

Hazardous substance releases can contaminate air, water, and soils, possibly resulting in death and/or injuries. Dispersion can take place rapidly when the hazardous substance is transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

With a hazardous substance release, whether accidental or intentional, several potentially exacerbating or mitigating circumstances will affect its severity of impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact a release has on the surrounding environment. Primary and secondary containment or shielding by sheltering-in-place measures protects people and property from the harmful effects of a hazardous substance release. Exacerbating conditions, characteristics that can enhance or magnify the effects of a hazardous substance release, include:

- Weather conditions, which affect how the hazard occurs and develops (such as wind speed and direction)
- Micro-meteorological effects of buildings and terrain, which alters the dispersion of hazardous substances in compliance with applicable codes (such as building or fire codes)
- Mechanical failures (such as fire protection and containment features), which can substantially increase the damage to the facility itself and to surrounding buildings
- Land use, population and building density will be factors contributing to the extent of exposure and impacts incurred.

The severity of a hazardous material incident is dependent not only on the circumstances described above, but also with the type of substance released, distance from the release, and the related response time for emergency response teams to stabilize and contain the release. Generally, areas closest to a release are at the greatest risk, due to their exposure to higher concentrations of the substance and the limited warning time before being impacted. However, depending on the substance/material, a release can rapidly travel great distances or remain present in the environment for long periods of time (e.g. centuries to millennia) allowing for greater dispersal, increasing the spatial extent of impact.

Warning Time

Warning time for a hazardous materials incident can be sudden without any warning (such as an explosion), or may develop slowly (such as a leaking container). Facilities that store extremely hazardous substances are required to notify local officials when an incident occurs. Local emergency responders and emergency management officials determine the need to evacuate the public or whether to advise people to shelter in place. Similar to on-site hazardous substances incidents, the amount of warning time for incidents associated with hazardous substances in-transit varies based on the nature and scope of the incident. If an explosion or hazardous materials release does not occur immediately following an accident, there may be time for warning adjacent neighborhoods and enough time to facilitate appropriate protective actions.

PREVIOUS OCCURRENCES AND LOSSES

The 2013 HMP discussed hazardous material incidents that occurred in the State of Hawaiʻi through 2012. For this 2018 HMP Update, hazardous material incidents (in-transit and fixed-site) were summarized between January 1, 2012, through December 31, 2017. For events prior to 2012, please refer to Appendix X. This section is divided into the different forms of hazardous substance releases (fixed-site and in-transit).

Fixed-Site Hazardous Materials

The release of hazardous materials has occurred frequently throughout the State. Releases are reported to the Hawai'i DOH HEER Office. Table 4.8-2 shows the number of releases reported to the HEER Office in 2012 through 2017. In the five-year period between 2012 and 2017, there have been 2,065 instances of fixed-site hazardous material releases, equating to over one incident per day across the state over a five-year period.

Table 4.8-2. Hazardous Materials Releases Reported to the HEER Office by County, 2012 to 2017

Year	County of Kauaʻi	City and County of Honolulu	County of Maui	County of Hawaiʻi	Total
2012	8	291	45	34	**378**
2013	10	301	56	29	**396**
2014	14	275	45	45	**379**
2015	3	158	18	18	**341**
2016	9	205	63	33	**310**
2017	16	214	57	35	**261**
Total	**60**	**1,444**	**284**	**194**	**2,065**

Source: State of Hawaiʻi Department of Health 2017a

In-Transit Hazardous Materials

The Pipeline and Hazardous Materials Safety Administration (PHMSA) tracks in-transit hazardous material releases through its nationwide database. Regulations in 49 CFR 171.15 and 171.16 govern situations where hazardous materials are released and the resulting required notifications and reporting. Unless they are properly reported, it is difficult to identify and track past hazardous materials releases that occur in-transit. Between 2012 and 2017, there were 14 highway incidents and three pipeline incidents reported, according to PHMSA's database (PHMSA 2017a). Further information on these incidents is listed in Table 4.8-3.

Table 4.8-3. In-Transit Hazardous Material Incidents from 2012 to 2017

Date of Incident	Event Type	Counties Affected	Impacts
June 25, 2012	Vehicular Incident (highway)	Hawaiʻi	4,000 gallons of jet fuel released; $209,254 in damages
January 10, 2013	Excavation Damage (pipeline)	Honolulu	20 gallons of naphtha released; $52,040 in damages
October 23, 2013	Excavation Damage (pipeline)	Honolulu	$172,747 in damages
November 15, 2013	Vehicular Incident (highway)	Hawaiʻi	1,900 gallons of fuel released; $60,776 in damages

Date of Incident	Event Type	Counties Affected	Impacts
December 16, 2013	Burst Gasoline Line	Hawaiʻi	Burst gasoline line in downtown Hilo led to the partial activation of the Hawaiʻi County Emergency Operations Center.
February 16, 2015	Corrosion (pipeline)	Honolulu	1,300 barrels of refined petroleum product spilled; $2,816,000 in damages
June 15, 2015	Excavation Damage (pipeline)	Honolulu	1 injury; $613,900 in damages
September 2, 2017	Vehicular Incident (highway)	Honolulu	1 fatality and 1 injury; $66,700 in damages; 1,500 gallons of liquefied petroleum gas released

Source: PHMSA 2017c; State of Hawaiʻi 2018

FEMA Disaster Declarations

Between 1954 and 2017, FEMA has not included the State of Hawaiʻi in any hazardous material-related disasters (DR) or emergencies (EM) declarations.

PROBABILITY OF FUTURE HAZARD EVENTS

Since there have been no federal declarations for hazardous material incidents in the State of Hawaiʻi, all events reported earlier in this section that occurred between 2012 and 2017 were used to calculate the probability of future occurrences. Based on the extrapolation of data available on the occurrence of previous events, the State of Hawaiʻi experiences over 300 hazardous material incidents each year. Therefore, there is a 100 percent chance of a hazardous material incident occurring in any given year in the State. However, as was the case for historical events in the State, the magnitude of the incidents expected to occur will vary widely from very minor releases to the potential for major events in which thousands of gallons of hazardous materials may be released.

Impacts of Climate Change on Future Probability

As discussed in Section 4.1 (Climate Change) and Section 4.6 (Event-Based Flood), it is highly likely that changing future conditions will exacerbate current conditions and increase future event-based flood risk. Sites that store hazardous materials that are at risk from current flooding will become more vulnerable with climate change and sea level rise. Flooding during a storm event could cause releases of hazardous materials if they are not properly stored or contained. The release of these hazardous materials may expose the nearby population, harm water quality and the overall environmental and economic health of the area.

In terms of sea level rise, septic tanks, cesspools, and other on-site sewage disposal systems (OSDS) as well as other hazard materials/waste storage and disposal sites are located along the coast. The projected rise in sea level will eventually result in the failure of the OSDS, unable to operate properly they will contribute to the degradation of nearshore water quality. Additionally, a release from OSDS could change disease risk for coral reefs and negatively impact nearby coral and coastal resources. Refer to Section 4.1 (Climate Change) regarding the sea level rise projections for the State of Hawaiʻi (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017).

4.8.2 Vulnerability Assessment

Overall, it is difficult to quantify potential losses due to hazardous material incidents because of the many variables that must be considered, including but not limited to the specific hazardous substance, quantity, location, time of day, meteorological conditions, surrounding environment and emergency response and cleanup capabilities. Potential impacts may be local, regional, or statewide depending on the magnitude of the event and level of service disruptions. A qualitative assessment is discussed below.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to hazardous material incidents.

State Assets

Potential losses to state buildings caused by a hazardous materials release is difficult to monetize. The degree of damages to the asset depends on the scale of the incident. Generally speaking, all 6,095 state buildings are potentially vulnerable to a hazardous materials release. State assets proximate to Tier II facilities or NPL sites, or transportation corridors that permit the transport of hazardous materials have an increased risk of exposure. Depending upon the incident, state employees may need to evacuate the building if exposure may impact human health. This may result in loss of productivity that can be measured by days and dollar equivalency. In terms of building-related and property damage, damage may include but not limited to damage to heating, ventilation and air conditioning (HVAC) systems due to the corrosive effects of some chemicals; and/or contaminated soil, groundwater and nearby waterbodies.

All state roads that permit the transport of hazardous materials are potentially at risk of an incident. Transportation carriers must have response plans in place to address accidents, otherwise the local emergency response team will step in to secure and restore the area. Quick response minimizes the volume and concentration of hazardous materials that disperse through air, water and soil. Hazardous material releases may lead to road closures until response and clean-up efforts are completed. This may impact access to communities, commuting to work, and impact the ability to deliver goods and services efficiently.

Critical Facilities

Similar to state assets, potential losses to critical facilities caused by a hazardous materials release is difficult to monetize. The degree of damages to the asset depends on the scale of the incident. Critical facilities need to remain in operation before, during and after disaster events. Loss of use will impact the services they provide to the state which may have public safety and economic implications. Ports and harbors are critical points of entry that need to remain open and operational to maintain the vital just in time shipping logistics required to sustain each island. In the event of a large-scale hazardous materials release resulting in port closures, there will be cascading impacts statewide.

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets. Each county's vulnerability and potential loss will vary greatly depending not only on the type and intensity of the release. The local HMPs were reviewed and their discussion of hazardous material incidents are summarized below:

- **County of Kauaʻi**—In the 2015 Kauaʻi County HMP, hazardous materials are briefly discussed in the individual hazards section (County of Kauaʻi 2015). The County of Kauaʻi has 124 Tier II facilities.
- **City and County of Honolulu**—The City and County of Honolulu has the greatest number of Tier II facilities compared to the other counties (472 facilities). The three NPL sites in the State of Hawaiʻi are located in the City and County of Honolulu. In addition, the oil refineries and pipelines are on the island.
- **County of Maui**—In the 2015 Maui County HMP, technological hazards and human-caused hazards (including hazardous materials) were not addressed as stand-alone hazards in the plan. According to the plan, Maui County has seven EPA-designated TRI facilities that are considered critical infrastructure operations. Damage to these facilities (as well as damage to the 184 Tier II facilities in the county) could have a detrimental effect on environmental and cultural resources. One of the TRI facilities is in the 6-feet sea level rise scenario and coastal zone and three are in the evacuation area for Wailuku Water 6 dam. One facility is within the 1-percent annual chance (100-year) flood zone. A hazardous materials spill from these facilities could spill into streams, rivers or storm sewers (Maui County 2015).
- **County of Hawaiʻi**—The 2015 Hawaiʻi County Multi-Hazard Mitigation Plan lists 10 sites in the County of Hawaiʻi that may be eligible for possible listing under the NPL (Hawaiʻi County 2015). These facilities are managed by the DOH HEER Office. In addition, there are 246 Tier II facilities on the County of Hawaiʻi.

Population

All counties in the State of Hawaiʻi have Tier II facilities. For the purposes of this assessment, the entire population is exposed and could potentially be impacted by a hazardous materials release—a fixed-site hazardous material release, in-transit hazardous material release, or both. When hazardous substances are released in the air, water or on land they may contaminate the environment and pose greater danger to human health. The general population may be exposed to a hazardous substances release through inhalation, ingestion or dermal exposure. Exposure may be either acute or chronic, depending upon the nature of the substance and extent of release and concentration. The populations considered most vulnerable include the elderly (persons over the age of 65), the young, pregnant women and people who are ill or immunocompromised.

Population living and/or working near facilities that produce, store, or transport hazardous substances are at higher risk to exposure. In particular, populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the type of release and environmental conditions, people may be evacuated as a precaution or instructed to shelter-in-place. Section 4.9 discusses the unique terrain in the State and how this impacts wind effects and speeds in each county which can plan a role in the dispersion of airborne chemical releases.

Populations living and/or working near major transportation routes (such as Interstates H1, H2, H3, and H201) are more vulnerable to a hazardous materials release because of the potential for chemicals to be transported on these major thoroughfares. Hazardous substances can also be transported via pipeline. There are petroleum and gas transmission lines on the City and County of Honolulu, and the County of Hawaiʻi (Figure 4.7-1 and Figure 4.7-2). The closure of waterways, ports, harbors, airports, highways or refineries as a result of a hazardous materials release has the potential to impact the ability to deliver goods and services efficiently, and could have cascading economic impacts to other islands.

General Building Stock

Hazardous material releases can damage and destroy public, commercial, and private property. Losses include both direct and indirect costs. Direct costs can be defined as the cost of materials, property damage, response cost, and remediation/cleanup cost for a specific release. All other costs and losses from hazardous material releases are indirect. These include (1) loss of productivity as a result of damage to land, facilities, or interruption of services, (2) loss of access to recreation lands and facilities, (3) cost of lost human productivity due to injury and death, (4) damages to ecosystems, and (5) the cost of litigation as a consequence of the release.

Damages to transportation infrastructure and their closure is not uncommon following a hazardous materials release. Similar to the fixed-site hazardous materials release, the greatest risk to population and the built environment would be from an explosion from hazardous materials in transport. Proximity, intensity and the structural integrity of the building itself are all factors in the subsequent vulnerability and expected damage.

Environmental Resources

A hazardous substance release, whether fixed-site or in-transit can negatively impact the natural environment. Depending on the nature and amount of the substance, the release may contaminate the air, water, or soil potentially causing concern for direct human and animal exposure, recreational usage, crop irrigation, and fish and wildlife consumption.

Water contamination, whether surface water, groundwater or marine, is an immediate concern from a hazardous materials release potentially impacting potable water supplies, wildfire and recreational activities. Hazardous material releases could also significantly impact soils including agricultural lands. Depending on the characteristic of the hazardous material and/or the volume of product involved, the affected area can be as small as several square feet or as large as many square miles that require soil remediation. Such environmental damage can linger for decades and result in extensive remediation costs.

Coral reef ecosystems are fragile and are extremely vulnerable to environmental stresses including runoff and oil spills. Runoff from land-based pollution sources that include hazardous materials such as runoff that carries sediment, high levels of nutrients from agricultural areas, sewage outflows, pollutants such as petroleum products and pesticides as a result of hazardous materials releases. The degree of damage will depend upon the coral species, life stage and exposure. Impacts can result in bleaching, which can damage or kill coral depending upon the severity and duration of the environmental stress (NOAA 2007a; NOAA 2007b).

Cultural Assets

Loss of and harm to native species and ecosystems as a result of a hazardous materials release will adversely impact the Hawaiian cultural traditions and practices, which are closely tied to the natural environment. Hawaiian fishponds may be impacted by a hazardous materials release. Depending on the material, the release may kill the fish species or the bioaccumulation of pollutants can affect animals high on the food chain long after a release. Additionally, site remediation efforts following a hazardous material release can result in adverse impacts to archeological resources and sensitive cultural areas in the attempt to remove and/or excavate contaminated sediments from an affected area.

FUTURE CHANGES THAT MAY IMPACT STATE VULNERABILITY

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

As development continues and populations increase, the risk for a hazardous material release and the potential impacts to the population, infrastructure, and environmental and cultural resources will increase as well. The number and types of hazardous chemicals stored in and transported through the State will likely continue to increase. As the population grows, the number of people vulnerable to the impacts of hazardous materials spills and transportation incidents will increase. Population and business growth along major transportation corridors increases the vulnerability to transportation-related hazardous material spills. Growth increasing commercial and residential density near fixed-site hazardous materials facilities will also increase vulnerability.

SECTION 4. RISK ASSESSMENT

4.9 Health Risks

2018 HMP Update Changes

- The hazard profile has been enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Information has been added on dengue fever, chikungunya, rat lungworm, water-borne illnesses and Legionnaires' disease. The mumps have been removed from the risk assessment due to the low severity of this disease it is not likely to result in a state of disaster.
- Information of health risk events that occurred in the State of Hawai'i from January 1, 2012 through December 31, 2017, were researched for this 2018 HMP Update.
- Information has been added on the World Health Organization (WHO) pandemic phases.
- A qualitative vulnerability assessment was developed to summarize impacts to state assets, critical facilities, the population, general building stock, environmental resources and cultural assets from health risks.
- Discussion of future changes that may impact State vulnerability has been added.

4.9.1 Hazard Profile

The State is vulnerable to natural hazards. Health-related impacts have occurred with natural hazards, especially where water quality is compromised. Climate-related extreme events have resulted in gastrointestinal illness, respiratory problems (especially from wildfires), and vector-borne outbreaks, such as dengue fever. It is important to consider potential health-related disasters, and to factor these considerations in disaster risk reduction efforts and hazard mitigation planning. These and other risks to human health that occur as a result of natural hazard events are discussed throughout Section 4 (Risk Assessment). This section focuses on the infectious disease, pandemic flu, and bioterrorism hazards that may impact the State of Hawaii's resident and visitor populations. A discussion on volcanic emissions and volcanic ash, which are hazardous to human health, are discussed in Section 4.14 (Volcanic Hazards); human health impacts related to contaminated flood water is discussed in Section 4.7 (Event-Based Flood).

Hazard Description

The following provides a brief description of the health risks of concern in the State of Hawai'i. It should be noted that this is not a comprehensive assessment of all health risks that may impact Hawaii's residents and visitors, but it simply intended as a brief overview of risks and vulnerability in the State.

Vector-Borne Disease

Vector-borne diseases account for more than 17% of all infectious diseases worldwide. Vectors are living organisms that can transmit infectious diseases between humans or from animals to humans (WHO 2017). The most common known disease vector is mosquitoes and other biting insects.

Dengue Fever

Dengue fever is a viral disease that is transmitted by *Ades* mosquitos (Hawaiʻi DOH 2015). In the Western Hemisphere, the *Ades aegypti* mosquito is the most common transmitter of the virus, while the 2001 dengue outbreak in Hawaii was caused by the *Ades albopictus* mosquito (CDC 2009). Symptoms appear 5 to 7 days after being bitten by a mosquito that is infected with the virus, and include high fever, rash on the arms and legs, body aches, and headache. Dengue fever is not transmitted directly from one person to another, however mosquitos can transmit the disease by biting an infected individual and becoming a carrier of the virus, capable of infecting other people.

Chikungunya

Chikungunya is a viral disease spread by being bitten by the same types of mosquitos as those that carry Dengue fever and Zika (Hawaiʻi DOH 2016). Symptoms include fever, severe joint pain, headache, muscle pain, joint swelling, nausea, vomiting, redness around the eyes, and rash. Individuals who have been infected generally recover in 1 to 2 weeks. It cannot be passed from one person to another. Though there are no vaccines or specific treatment procedures, death from chikungunya is not common.

Zika

Zika is a viral illness that can be spread to people through mosquito bites. It was first discovered in a monkey in the Zika forest of Uganda in 1947. Before 2015, outbreaks were reported in areas of Africa, Southeast Asia, and the Pacific Islands. In 2015, outbreaks of Zika were reported in Brazil and other South American countries. As of April 2018, there have been no cases of locally-acquired Zika infections in Hawaiʻi (Hawaiʻi DOH 2018).

People are infected with Zika virus primarily through the bite of an infected *Aedes aegypti* or *Aedes albopictus* mosquito, which are the same mosquitoes that spread dengue fever and chikungunya. The mosquito becomes infected when it bites a person who is already infected with the Zika virus. It takes a week or more for the Zika virus to replicate in the mosquito; then the mosquito can transmit the virus to a new person (Hawaiʻi DOH 2018).

Rat Lungworm

Rat lungworm is a disease caused by a parasitic nematode (roundworm parasite) called *Angiostrongylus cantonensis* and is a disease that can affect the brain and spinal cord (Hawai'i DOH 2017). The adult form of *A. cantonensis* is only found in rodents. However, infected rodents can pass larvae of the worm in their feces. Snails, slugs, and certain other animals (including freshwater shrimp, land crabs, and frogs) can become infected by ingesting these larvae; these are considered intermediate hosts. Humans can become infected with rat lungworm if they eat (intentionally or otherwise) a raw or undercooked infected intermediate host, thereby ingesting the parasite. Sometimes people can become infected by eating raw produce that contain small infected snails or slugs. Rat lungworm is not spread person-to-person.

Rat lungworm can cause a rare type of meningitis (eosinophilic meningitis). While some infected people may not have any symptoms or only have mild symptoms, others infected may develop symptoms that are much more severe. Symptoms usually start 1 to 3 weeks after exposure to the parasite, but have been known to range anywhere from 1 day to as long as 6 weeks after exposure. There is no specific treatment for the disease and symptoms usually last between 2 to 8 weeks (Hawai'i DOH 2017).

Water-Borne Disease

Water-borne diseases are conditions caused by pathogenic micro-organisms that are transmitted in water. Disease can be spread from swimming, washing, drinking water, or eating food exposed to infected water.

Leptospirosis

Leptospirosis is a bacterial disease that affects humans and animals. It is caused by bacteria of the genus *Leptospira*. Humans can get leptospirosis through direct contact with urine from infected animals or through water, soil, or food contaminated with their urine. In humans it causes a wide range of symptoms, and some infected persons may have no symptoms at all. Symptoms of leptospirosis include high fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice (yellow skin and eyes), red eyes, abdominal pain, diarrhea, or a rash. If the disease is not treated, the patient could develop kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, and respiratory distress. In rare cases death occurs. Many of these symptoms can be mistaken for other diseases. Leptospirosis is confirmed by laboratory testing of a blood or urine sample.

Leptospirosis occurs worldwide but is most common in temperate or tropical climates. It is an occupational hazard for many people who work outdoors or with animals, for example, farmers, sewer workers, veterinarians, fish workers, dairy farmers, or military personnel. It is a recreational hazard for campers or those who participate in outdoor sports in contaminated areas and has been associated with swimming, wading, and playing in contaminated steams and waterfalls. The incidence is also increasing among children who live in urban areas.

Legionnaires' Disease

Legionnaires' disease is caused by *Legionella*, a type of bacterium found naturally in freshwater environments. *Legionella* becomes a health concern when it grows and spreads in human-made building water systems not properly maintained (CDC 2016). Legionnaires' disease is a very serious type of pneumonia caused by inhalation of small droplets of water containing the bacteria. Early symptoms of Legionnaire's disease include muscle aches, headaches, loss of appetite, tiredness, and cough; and are often followed by chills, diarrhea, and high fever. Symptoms of Legionnaire's disease can be difficult to distinguish form other cases of pneumonia and typically begin to occur 5 to 6 days after exposure to *Legionella* bacteria, however can occur anywhere between 2 and 10 days (Hawai'i DOH 2016).

Outbreaks of Legionnaires' disease are often associated with large or complex water systems, like those found in hospitals, hotels, and cruise ships. The disease is typically treated with antibiotics that kill the bacteria in the body. Most people who get sick with Legionnaires' disease require hospital treatment and make a full recovery. However, about 1 out of 10 people who get Legionnaires' disease die from the infection (CDC 2016).

Pandemic Flu

There are numerous types of pandemic flu and the strains of the virus continue to mutate and change. Novel influenza represents the emergence of new subtypes of the influenza virus that have not previously been identified and represent a class of viruses against which there is little to no pre-existing immunity or vaccine. Each county has been required to develop procedures for dealing with this type of "disaster" threat. While many of the recommendations include social distancing, it is important to plan for the eventuality of a pandemic to determine how to maintain businesses and services to prevent economic collapse in addition to the health threats.

H5N1 or Avian Flu

Avian influenza is an infection caused by avian influenza (bird flu) viruses. These influenza viruses occur naturally among birds. Wild birds worldwide carry the viruses in their intestines, but usually do not get sick from them. However, avian influenza is very contagious among birds and can make some domesticated birds, including chickens, ducks, and turkeys, very sick and kill them.

Infected birds shed influenza virus in their saliva, nasal secretions, and feces. Susceptible birds become infected when they have contact with contaminated secretions/excretions or with surfaces that are contaminated with secretions/excretions from infected birds. Domesticated birds may become infected with avian influenza virus through direct contact with infected waterfowl or other infected poultry, or through contact with surfaces (such as dirt or cages) or materials (such as water or feed) that have been contaminated with the virus.

Scientists are concerned that H5N1 virus one day could be able to spread easily from one person to another. Because these viruses do not commonly infect humans, there is little or no immune protection against them in the human population. If H5N1 virus were to gain the capacity to spread easily from person-to-person, an influenza pandemic (worldwide outbreak of disease) could begin. For more information about influenza pandemics, see the U.S. Government webpage dedicated to the flu virus at www.flu.gov.

H1N1 or Swine Flu

During the period from 2007 to 2010, there were incidents of swine flu (H1N1) outbreaks in the State of Hawaiʻi. Of particular concern is the 2009 outbreak of H1N1 Pandemic that resulted in several deaths from the flu. Similar to other outbreaks, the virus spread with international travelers. This is particularly concerning for the State since it is among the most remote places on the planet, and it will be difficult to sustain livelihoods should the State lose connection with the United States mainland or international travel.

Bioterrorism

The Center for Disease Control (CDC) defines a bioterrorism attack as the deliberate release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants. These agents are typically found in nature, but it is possible that they could be changed to increase their ability to cause disease, make them resistant to current medicines, or to increase their ability to be spread into the environment. Biological agents can be spread through air, water, or food. Terrorists may use biological agents because they can be extremely difficult to detect and may not cause illness for several hours to several days. Some bioterrorism agents, such as the smallpox virus, can be spread from person-to-person and some, such as anthrax, cannot.

LOCATION

The State's central location between the continental United States and Asia, with hundreds of thousands of visitors each month, leads to considerable exposure to and potential for the introduction of new or re-emerging health risks. Health events can cover a wide geographic area and can affect large populations, including any of the Hawaiian Islands. Size and extent of an infected population depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals. Locations with higher density populations are more susceptible to outbreaks, as disease can be transmitted easier between people due to their proximity to infected individuals. Additionally, facilities that group vulnerable populations, such as day cares, schools, senior centers and medical facilities may also contribute to disease transmission.

EXTENT

Severity of a disease depends on a number of factors. These include the size of the vector populations (the population size and distribution of insects or animals capable of transmitting a disease, e.g. mosquito-borne illnesses), aggressiveness of the disease, ease of transmission, and factors associated with the impacted community (e.g., access to medical care, demographic data, and population density). High-risk populations considered more vulnerable to various health hazards are described in the vulnerability assessment.

The magnitude of an infectious disease outbreak is also related to the ability of the public health and medical communities to stop the spread of the disease. Most disease outbreaks that cause catastrophic numbers of deaths are infectious in nature, meaning that they are spread from person to person. The public health and health care providers in Hawaiʻi routinely utilize known and established methods to reduce morbidity and mortality from infectious disease. However, the capacity of the health care system is limited and varies from county to county.

The severity of the impact of influenza depends on the nature of the outbreak- that is, if it is pandemic flu or seasonal flu. Pandemic flu should not be confused with seasonal flu. Seasonal flu is a less severe concern because of its regularity of occurrence and predictability. Table 4.9-1 lists key differences between pandemic and seasonal flus.

Table 4.9-1. Seasonal Flu Versus Pandemic Flu

Seasonal Flu	Pandemic Flu
Happens annually and usually peaks in January or February.	Rarely happens (three times in 20th century).
Usually some immunity built up from previous exposure.	People have little or no immunity because they have no previous exposure to the virus.
Usually only people at high risk, not healthy adults, are at risk of serious complications.	Healthy people may be at increased risk for serious complications.
Healthcare providers and hospitals can usually meet public and patient needs.	Healthcare providers and hospitals may be overwhelmed.
Vaccine available for annual flu season.	Vaccine probably would not be available in the early stages of a pandemic.
Adequate supplies of antivirals are usually available.	Effective antivirals may be in limited supply.
Seasonal flu-associated deaths in the U.S. over 30 years ending in 2007 have ranged from about 3,000 per season to about 49,000 per season.	Number of deaths could be high (U.S. death toll during the 1918 pandemic was approximately 675,000).
Symptoms include fever, cough, runny nose, and muscle pain.	Symptoms may be more severe.
Usually causes minor impact on the general public; some schools may close and sick people are encouraged to stay home.	May cause major impact on the general public, such as widespread travel restrictions and school or business closings.
Manageable impact on domestic and world economy.	Potential for severe impact on domestic and world economy.

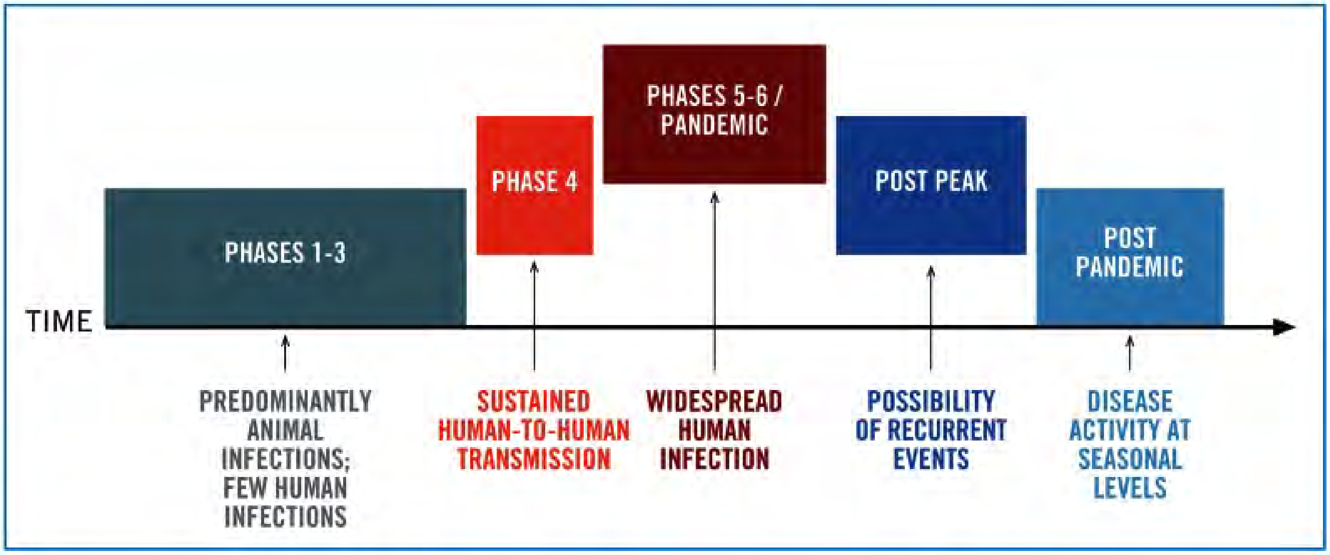
Source: www.flu.gov 2015

WHO described a series of pandemic phases in 1999 (revised in 2005 and 2009) to provide a global framework and aid in pandemic preparedness and response planning. In addition to facilitating implementation of preparedness recommendations, the phases also help provide greater understanding of when an event is considered to have reached pandemic levels. The six phases are described as follows:

- **Phase 1:** No viruses circulating among animals have been reported among humans.
- **Phase 2:** An animal influenza virus circulating among domesticated or wild animals has caused known infection in humans and is now considered a potential pandemic threat.
- **Phase 3:** An animal or human-animal novel influenza virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, such as close contact between an infected person and an unprotected caregiver.
- **Phase 4:** Verified human-to-human transmission of an animal or human-animal novel influenza virus is able to cause "community-level outbreaks." The ability to cause sustained disease outbreaks in a community marks a significant upwards shift in the risk of a pandemic. Any country that suspects or has verified such an event should urgently consult with WHO so that the situation can be jointly assessed and a decision made by the affected country if implementation of a rapid pandemic containment operation is warranted. Phase 4 indicates a significant increase in risk of a pandemic but does not necessarily mean that a pandemic is a forgone conclusion.
- **Phase 5:** There has been human-to-human spread of the virus into at least two countries in one WHO region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent, and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short.
- **Phase 6:** The pandemic phase is characterized by community-level outbreaks in at least one other country in a different WHO region, in addition to the criteria defined in Phase 5. Phase 6 indicates a global pandemic is underway.

Conclusion of Phase 6 leads to the post-peak period, wherein pandemic levels decrease in most countries with surveillance capabilities. Despite a decrease in activity, countries still must be prepared for additional waves of the pandemic. Pandemic waves can be separated by a period of months, leading to a long recovery time to guarantee entry of the pandemic into the post-pandemic phase (WHO 2009). Figure 4.9-1 shows the six phases of pandemic influenza described by WHO.

Figure 4.9-1. Pandemic Influenza Phases



Source: WHO 2009

Health-related events, such as pandemics, are inevitable and arrive with very little warning. Identification, containment and treatment of pandemic outbreaks and even cases of bioterrorism are further complicated by the highly transient nature of the tens of thousands of daily visitors, the State's isolation, and the associated delay in importing the necessary medical supplies, medicines and resources (Kauaʻi County 2015).

Air travel could increase the speed of spread of a new virus and decrease the time available for implementing interventions. Passengers travelling through the State's airports are monitored for disease by airline crews, the federal Transportation Security Administration (TSA) staff, and State health officials. The Centers for Disease Control and Prevention (CDC) staff responds to reports of illnesses on airplanes, cruise, and cargo vessels at international ports of entry. The CDC operates a quarantine station at the Daniel K. Inouye International Airport in Honolulu. The station's jurisdiction includes all ports in Hawaii, Guam, American Samoa, the Freely Associated States and the Commonwealth of the Northern Mariana Islands (CDC 2017). The CDC .

Outbreaks are expected to occur simultaneously throughout much of the United States, potentially limiting the availability of Federal and or inter-state assistance in the form of human and material resources that usually occur in response to other disasters. Warning time for a pandemic influenza outbreak will depend on the origin of the virus, virus incubation time (the duration required before an individual begins to develop symptoms of an illness), and the amount of time needed to identify the virus.

Previous Occurrences and Losses

The Hawaiʻi State Department of Health Disease Outbreak Control Division (DOCD) maintains case records on a wide variety of health risks. In 2015, the most recent comparison data available (Hawaiʻi DOH 2016a), State data shows 7,477 cases of influenza, representing the highest number of cases of any health agent tracked by the DOCD. The State also saw 215 cases of dengue fever in 2015, and 54 in 2016 (238 of these cases were in the outbreak on Hawaiʻi County). Table 4.9-2 shows significant health events that have occurred in the State between

2012 and 2017. Records of health risks prior to 2012 as documented in the 2013 HMP are provided in Appendix X.

Table 4.9-2. Health Risk Events in the State of Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
September 11, 2015 to March 17, 2016	Dengue Fever Outbreak	Hawaiʻi	264 confirmed cases of dengue fever. 238 were residents, and 26 were visitors.
2017	Mumps Infection	Honolulu, Hawaiʻi, Kauaʻi, Maui	There were 760 confirmed cases of mumps in 2017. 602 were in Honolulu County, 106 were in Hawaiʻi County, 49 were in Kauaʻi County, and 3 were in Maui County.

Sources: Hawaiʻi DOH 2016b, 2017a, 2017d

Table 4.9-3 shows the number of reported cases of notifiable diseases (diseases for which statistics are provided to the CDC to monitor national public health) in Hawaiʻi. For this 2018 HMP Update, this includes dengue fever, chikungunya, leptospirosis, Zika, mumps, and influenza.

Table 4.9-3. Reported Cases of Notifiable Diseases in the State of Hawaiʻi

Disease	2012	2013	2014	2015	2016	2017
Dengue Fever	7	10	14	209	54	15
Chikungunya	Not reported	Not reported	22	6	4	1
Zika	Not reported	Not reported	Not reported	6	22	9
Leptospirosis	11	17	24	22	34	26
Mumps	1	0	1	4	10	760
Influenza (lab-confirmed)	2,811	5,086	5,382	7,477	5,129	9,053

Source: Hawaiʻi DOH 2018

FEMA Disaster Declarations

Health risks and vulnerabilities are factored into the consideration for issuance of a FEMA Disaster Declarations in the event of any emergency for any hazard. There have been no FEMA Disaster Declarations for health risks and vulnerabilities in the State of Hawaiʻi.

DHHS Public Health Emergency Declarations

Public Health Emergency Declarations are made at the discretion of the Secretary of the U.S. Department of Health and Human Services (DHHS) under Section 319 of the Public Health Services (PHS) Act. There have been no DHHS Public Health Emergency Declarations issued for the State of Hawaiʻi.

Probability of Future Hazard Events

The best predictor of the probability of future health risks is the State's history of such events. The State can expect several cases of mosquito-borne illnesses each year, with periodic outbreaks (15 years passed between the last two outbreaks of dengue fever). The popularity of the State of Hawaiʻi as a tourist destination will also drive future health events. The Honolulu International Airport's number of annual passengers has risen in each of the last five years (Hawaiʻi Department of Transportation 2017); currently serving 2.5 million international passengers annually (CDC 2017). The Kahului Airport serves 156,000 each year, and Keahole International Airport serves 30,000 each year. Additionally, 67,000 cruise and cargo ship passengers and crew visit the State each year (CDC 2017). As the number of people travelling into and out of the State increases, so too does the possibility of disease transmission.

Additionally, infrastructure and environmental quality have significant contributions to public health. Deterioration of either man-made or environmental systems can result in adverse impacts to public health, increasing the State's vulnerability to public health emergencies.

Impacts of Climate Change on Future Probability

The full extent of the link between climate change and health risks is still being investigated. However, it appears that there is a link between warmer temperatures and increased vector-borne diseases (CDC 2016). Warmer temperatures mean longer warm seasons, and shorter and milder winters, resulting in higher insect production rates. In addition, infectious agents in water will spread on a wider scale as more flooding results from climate change. Floodwaters that remain in small, still pools after flooding has subsided can provide additional habitat for mosquito reproduction. This leads to more mosquitos that can carry diseases such as dengue fever, chickungunya, and Zika. However, research into modeling vector-borne diseases and climate change has yielded varying results (Bernstein 2015).

Studies at the University of Hawaiʻi at Mānoa and at the East-West Center have demonstrated links between climate variability and El Niño Southern Oscillation (ENSO) cycles with outbreaks of dengue fever. Seventy percent of emerging infectious diseases that affect humans are zoonotic; meaning they originate in animals. Many factors lead to the emergence of zoonotic diseases such as habitat destruction, human encroachment and climate change. Climate and habitat change can expand the movement of vectors into new geographic areas. West Nile Virus, chikungunya and the dengue virus have already expanded their geographical footprint due to these changes (Wang and Crameri 2014).

4.9.2 Vulnerability Assessment

No spatial data was available to assess health risk vulnerability. Therefore, a qualitative assessment was conducted.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to health risks.

State Assets

State buildings and roads are not exposed or vulnerable to this hazard. While the actual structures will not be impacted, the effect of absenteeism on state workers will impact the delivery of state services. The impacts and potential losses from this hazard are largely economic and are dependent on the type, extent, and duration of the illness.

Procedures for continuity of government operations will need to be implemented during a public health emergency, such as a pandemic. A CDC model suggests that approximately 10% of the workforce will be ill or caring for an ill family member at the peak of a pandemic disease (United States Department of Health and Human Services 2005). According to Census data, in 2010 there were 51,214 government employees in the state (DBEDT 2010). A 10% absentee rate would mean that a shortage of 5,121 government employees would impact state facilities and thus the services they provide.

Critical Facilities

A pandemic outbreak could result in a temporary closure to ports of entry to the State impacting the State's 'just in time' supply management system and the import and export of goods and vital resources.

Similar to state assets, the actual critical facilities will not be impacted, however the effect of absenteeism on workers will impact the delivery of critical services. Healthcare workers in public health and in direct patient contact are essential during a health risk event. The impacts and potential losses from this hazard are largely economic and are dependent on the type, extent, and duration of the illness. According to Census data, in 2010 there were 50,096 healthcare employees in the state (DBEDT 2010). A 10% absentee rate would mean that a shortage of 5,001 healthcare employees would impact critical health-related facilities and thus the services they provide.

In addition, an increase in hospitalization and emergency room visits may take place as a result of a health risk, creating a greater demand on these critical facilities, their staff and resources. The CDC's model estimates increases of more than 25% in the demand for hospitalization and intensive care unit services, even in a 'moderate pandemic' (United States Department of Health and Human Services 2005).

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of statewide exposure and potential losses to population, general building stock, environmental resources and cultural assets. The County of Kauai was the only county to include health risks in their local HMP.

Population

The entire population, residents and visitors, of the State of Hawaiʻi is exposed and potentially vulnerable to any of the health risks discussed above. Health risks can cover a wide geographic area and can affect large populations. The size and extent of an infected population depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals. Locations with higher density populations are more susceptible to outbreaks, as the disease can be transmitted more easily.

Vulnerable populations, especially the young, pregnant women, the elderly and those who are already ill or who have weaker immune system, are at greater risk for both contracting a disease and suffering fatal or severe consequences. Refer to Section 3.0 (State Profile) which summarizes demographics by county which are exposed to health risks. According to Hawaiʻi Health Survey, the percentage of uninsured Hawaiians for 2012 was 4.6 percent compared to 15.4 percent nationally. In Hawai'i, the percentage of males and females that are uninsured is 5.4 and 3.8 respectively and the below poverty level uninsured is 14.5 percent.

Using the recent statewide outbreak of mumps as a point of reference in terms of impacts, it has been confirmed in both children and adults, both vaccinated and unvaccinated. According to Hawaiʻi State Law, a person who contracts this highly contagious disease should not be allowed to attend school, work or travel for nine days after the start of swollen salivary glands (DOH 2016). As noted in the previous occurrences subsection above, the City and County of Honolulu has the highest number of confirmed cases to date followed by the County of Hawaiʻi.

In addition to the physical impacts of a health risk event, mental health impacts should also be considered. Whether from a natural disaster, pandemic or bioterrorism event, research indicates there is a causal connection between disaster events and mental health consequences (Galea et al 2004). Mental stress and anxiety may be experienced by both the population directly impacted or first responders. Associated economic impacts include health care costs and lost productivity at work or in the home.

General Building Stock and Economy

The general building stock is not exposed or vulnerable to the identified health risks of a disease outbreak as a disease affects only persons susceptible to the illness. However, the general building stock may contribute to the transmission of disease during an outbreak as a result of various design conditions (i.e. homes without window screens are more vulnerable to the spread mosquito-borne diseases), while aging infrastructure of the State's building stock could play a significant role in the spread of water-borne illness, such as Legionnaire's disease.

According to the Hawaiʻi Tourism Authority, tourism is the largest single source of private capital into the State's economy. A health risk such as a pandemic would have a significant impact on the economy. As a point of reference, the State's tourism peaked in 2007 with an average of $35 million in visitor spending per day. However, in 2008, tourism declined due to various economic and social factors, one of which was the H1N1 pandemic. In 2008 the total daily expenditure for the State's tourism decreased to $31 million (Hawaiʻi Tourism Authority 2014).

Environmental Resources and Cultural Assets

The type of health risk will determine the severity of any effect on the environment. A bioterrorism attack may not only impact the general population, but animals and plants as well because agents can spread through the air, water or in food. Livestock and poultry populations may become infected due to a health risk impacting the local economy and available food sources. Bacteria, pathogens, and other pollutants introduced into the local hydrology of the State's water-cycle can also have long-term impacts on water resources, further contributing to adverse public health impacts.

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

As the population characteristics of the State change, there will be more people in age categories that are more susceptible to infectious diseases (elderly and young populations). The ability to withstand impacts will depend on preparedness of the State as well as local communities.

In addition, the continued robust international tourism industry in Hawaiʻi makes it more vulnerable to health risks. Air travel could increase the speed of spread of a new virus and decrease the time available for implementing interventions. Economically, a pandemic or another disease outbreak would likely have a significant impact on tourism as people decrease their travel. Scares of infectious disease and pandemic flu could collapse the tourism economy. Following the September 11, 2001, terrorism event in New York City, the State of Hawaiʻi experienced significant declines in tourism to the State of Hawaiʻi. A similar scenario is likely following a pandemic or disease outbreak (Hawaiʻi State HMP 2013).

SECTION 4. HAZARDS

4.10 High Wind Storms

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- High wind storm events that occurred in Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP update.
- New and updated figures from federal and state agencies are incorporated.
- Provided a qualitative vulnerability assessment at the state level of damage to state assets and critical facilities from high wind events.
- Provided a qualitative vulnerability assessment at the county level of risk to the population, general building stock, and environmental resources and cultural assets from high wind events.
- Included a qualitative vulnerability assessment of high winds in regard to factors that could impact future vulnerability.

4.10.1 Hazard Profile

Wind is defined as the horizontal component of natural air moving close to the surface of the earth. This hazard profile and associated vulnerability assessment addresses high wind storms, in general, while Section 4.10 Hurricane addresses risk from tropical storms and hurricane force winds in more detail.

Hazard Description

Types of Winds

Winds in the State of Hawaiʻi originate from three main sources: trade winds, Kona winds, and hurricanes/tropical storms. High winds from trade winds (which blow 70% of the time), Kona winds (30% of the time), and rare winds from hurricanes and tropical storms passing through Hawaiian waters all affect the State. The hazards from hurricanes and tropical storms are discussed in Section 4.10 Hurricane. This section focuses on the other two wind patterns: trade and Kona.

Trade Winds

The trade wind pattern over the Pacific Ocean is one of the largest and most consistent wind fields in the world and these winds play a major role in defining the climatology of the region. The northeast trade winds prevail over the Hawaiian Islands throughout the year with an average speed of 15.7 mph, with speeds ranging between 10 and 25 mph (Vitousek et al. 2009). Occasional extreme events reach 40 to 50 mph when the subtropical high-pressure cell north of the Hawaiian Islands intensifies (Western Regional Climate Center 2018).

Average wind speeds in the State of Hawaiʻi are the highest during the summer trade wind period (May through September) when trade winds are present 85% to 95% of the time and wind speeds over the ocean exceed 12 miles per hour (mph) 50% of the time. During the winter (October through April), when trade winds are not as prevalent (present 50% to 80% of the time), wind speeds are in excess of 12 mph about 40% of the time (Graza et al. 2011; Western Regional Climate Center 2018).

These persistent winds became known as trade winds long ago when clipper ships carrying cargo depended on the broad belt of easterly winds encircling the globe in the subtropics for fast passage; however, strong, gusty trade winds can cause problems for mariners. Strong trade winds, blowing from the northeast, funnel through the major channels between the islands--Kauaʻi, Kaiwi, Pailolo, Kalohi, ʻAuʻau, and ʻAlenuihāhā Channels—at speeds 5 to 20 knots (about 5.7 to 23.0 miles per hour) faster than the speeds over the open ocean. North Pacific high-pressure systems are responsible for the majority of the gusty trade wind episodes over Hawaiian waters, which commonly persist for several days before tapering off (Hawaiʻi State HMP 2013).

Kona Winds

Kona winds is a Hawaiian term for the stormy, rain-bearing winds that blow over the islands from the southwest or south-southwest in the opposite direction of trade winds. Kona is the Hawaiian word for leeward. When Kona winds blow, the predominant wind pattern is reversed so that the western, or leeward sides of the islands, become windward. This type of wind is associated with a class of extratropical weather systems known as Kona low pressure systems or Kona storms, which develop northwest of the State of Hawaiʻi and move slowly eastward. Kona storms can produce heavy rains, hail, floods, landslides and other severe weather hazards in addition to the high winds discussed in this hazard profile (Businger et al. 1998). Strong Kona winds can last for a day or for a week or more (State of Hawaiʻi HMP 2013; Pacific Disaster Center 2007; Businger et al. 1998).

Wind Speed and Wind Pressure

There are several ways to measure the speed at which air is moving, or wind speed. The most commonly used methodologies for measuring wind speed are (Hawaiʻi State 2013 HMP):

- **The Fastest Mile Wind**—The Fastest Mile Wind speed is the average 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 was historically used in many older building codes and design standards such as the Uniform Building Code (all editions) and the American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures (until the 1993 edition).
- **Sustained Wind**—Sustained Wind is the wind speed averaged over 1 minute. This is the measurement standard used by the National Weather Service.
- **Peak Gusts**—Peak Gusts are the maximum wind gust speeds averaged over a period of two to five seconds. This is the measurement standard used by modern Hawaiian building codes.

It is important to understand though, that it is wind pressure, and not wind speed, that causes wind damage. There are three types of wind pressure: positive, negative, and internal (Hawaiʻi State 2013 HMP):

- **Positive Wind Pressure**—Positive wind pressure is the direct pressure from the force of the wind that pushes inward against walls, doors and windows.

- **Negative Wind Pressure**—Negative wind pressure occurs on the sides and roof of buildings. This negative pressure is also known as lift. Negative pressure causes buildings to lose all or a portion of their roofs and side walls, and pulls storm shutters off the leeward side of a building.
- **Interior Pressure**—Interior pressure increases dramatically when a building loses a door or window on its windward side. The roof feels tremendous internal pressures pushing up from inside the building together with the negative wind pressure lifting the roof from the outside.

LOCATION

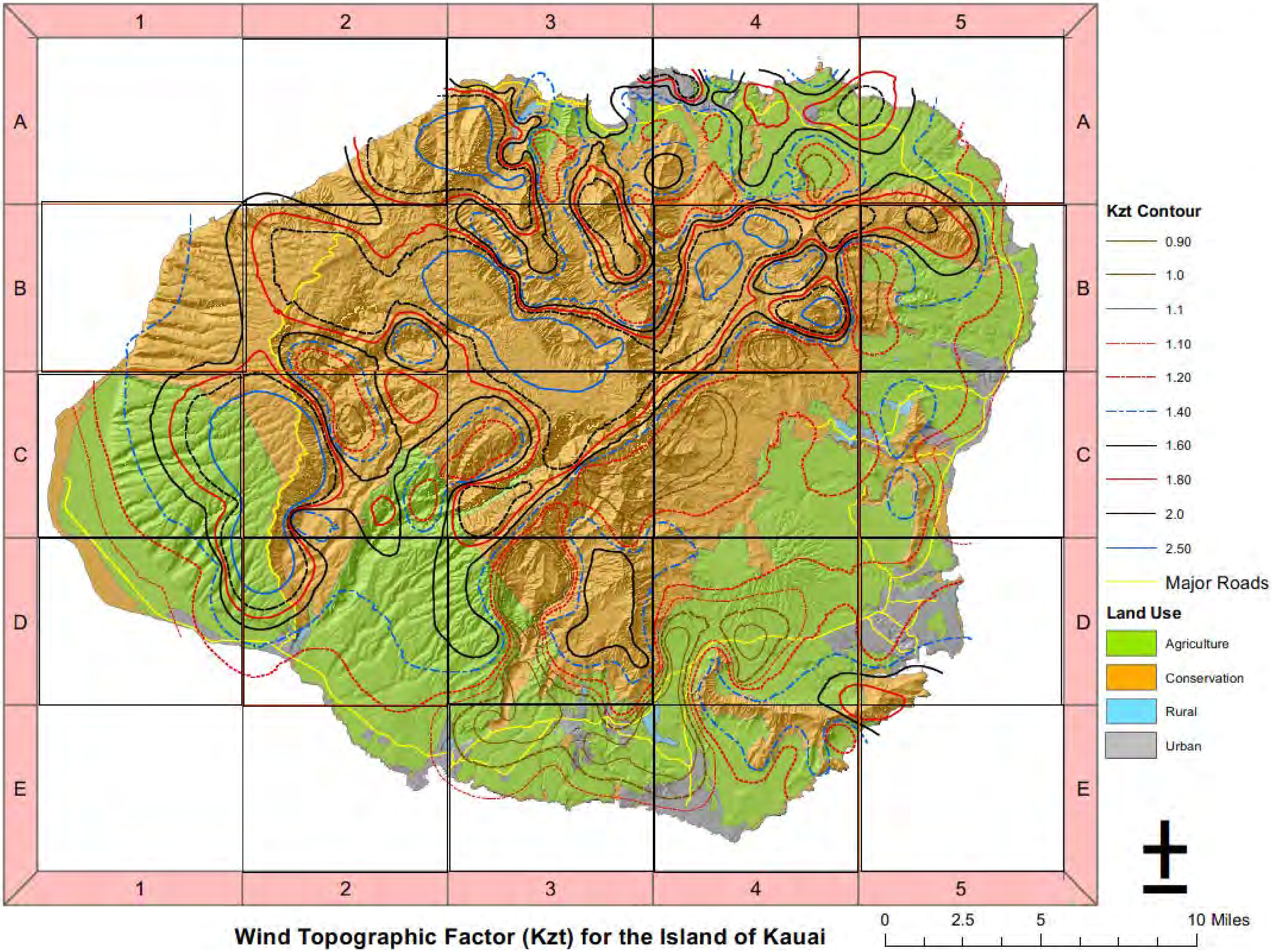
High wind storms can occur anywhere in the State of Hawaiʻi; therefore, the entire State and all its counties are susceptible to the direct and indirect impacts of high wind storms; however, topography plays a significant role in where the impacts of high wind storms are most severe. For example, strong Kona storms bring wind and rain and can cause extensive damage to south- and west-facing shores (Vitousek et al. 2009). The Kāneʻohe-Kahaluʻu area, on the windward coast of the Island of Oʻahu (City and County of Honolulu), has had extensive wind damage due to strong Kona winds (State of Hawaiʻi HMP 2013). In the case of the Island of Maui, trade winds appear to be stronger when passing through the isthmus between the West Maui Mountains and Haleakalā, so that wind speeds at location such as Māʻalaea and north Kīhei may be higher than locations along the island's north shore due to wind channeling that often occurs when wind passes between two mountains or into a valley (Hawaiʻi State HMP 2013). In general, wind speeds vary with height above ground—the higher the elevation, the stronger the wind. As a result, the mountainous areas of the State of Hawaiʻi generally experience the highest wind speeds (State of Hawaiʻi HMP 2013).

Topographic Effects on Windspeed

Wind speed increases over hills, ridges and escarpments (steep slopes or long cliffs). This phenomenon is known as wind speed-up. Because wind speed is related to wind pressure, structures in wind speed-up areas will experience more severe damages than those on located 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 the State of Hawaiʻi has not been well understood and it was not historically considered in any building code used in the State (State of Hawaiʻi HMP 2013).

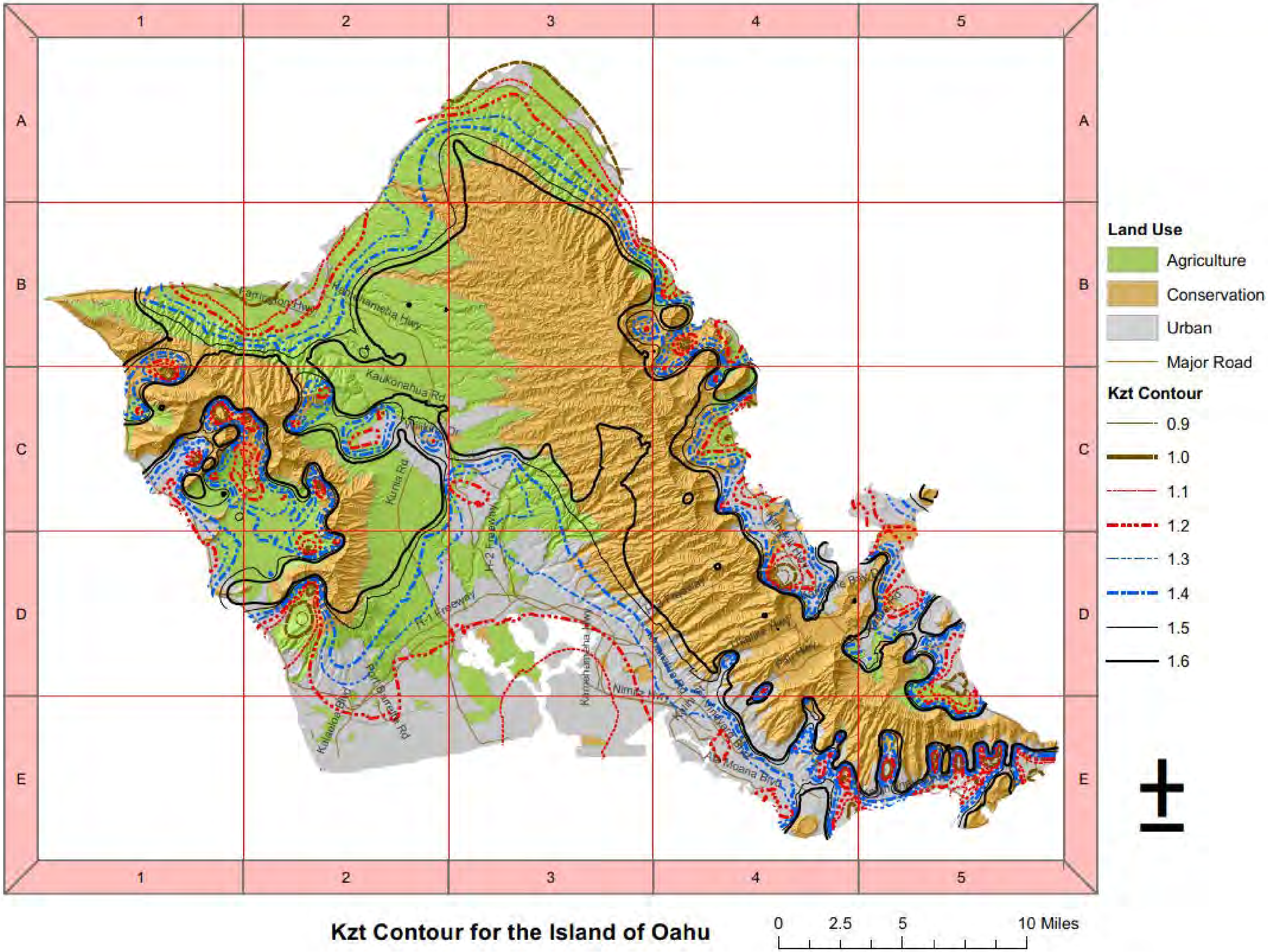
In the early 2000s, an assessment of wind speed-up in the State of Hawaiʻi was conducted and it was determined that existing mapping and standards were insufficient to adequately determine design wind pressures due to the complex topography in the State (Martin & Chock, Inc. No Date). In short, the topography has speed-up effects that cannot be adequately portrayed by a single statewide value of wind speed nor at the macro-scale of a national map. This factor, coupled with the designation of the State of Hawaiʻi as a special wind region in American Society of Civil Engineers (ASCE) standards, resulted in the development of a procedure and associated mapping to determine design wind pressures in the State that could be incorporated into State and county building codes. The State of Hawaiʻi wind design provisions for new construction are included in Appendix W of the Hawaiʻi State Building Code (State Building Code Council 2018). The requirements are complex and include design provisions for windborne debris, ultimate design wind speeds, directionality factors, and exposure categories. Figure 4.10-1 through Figure 4.10-6 show the wind topographic factors for each island that are included in these design requirements. The topographic factor (K_{zt}) acts as a multiplier in determining peak gusts relative to mild, flat terrain. As a result, buildings of all types constructed under this code are built to a uniform level of risk, that is, all occurrences of amplified wind are addressed in the design of that building, so that no building has disproportionate risk (State of Hawaiʻi 2018; Chock et al. 2002).

Figure 4.10-1. Wind Topographic Factor (Kzt) for the Island of Kauaʻi (County of Kauaʻi)



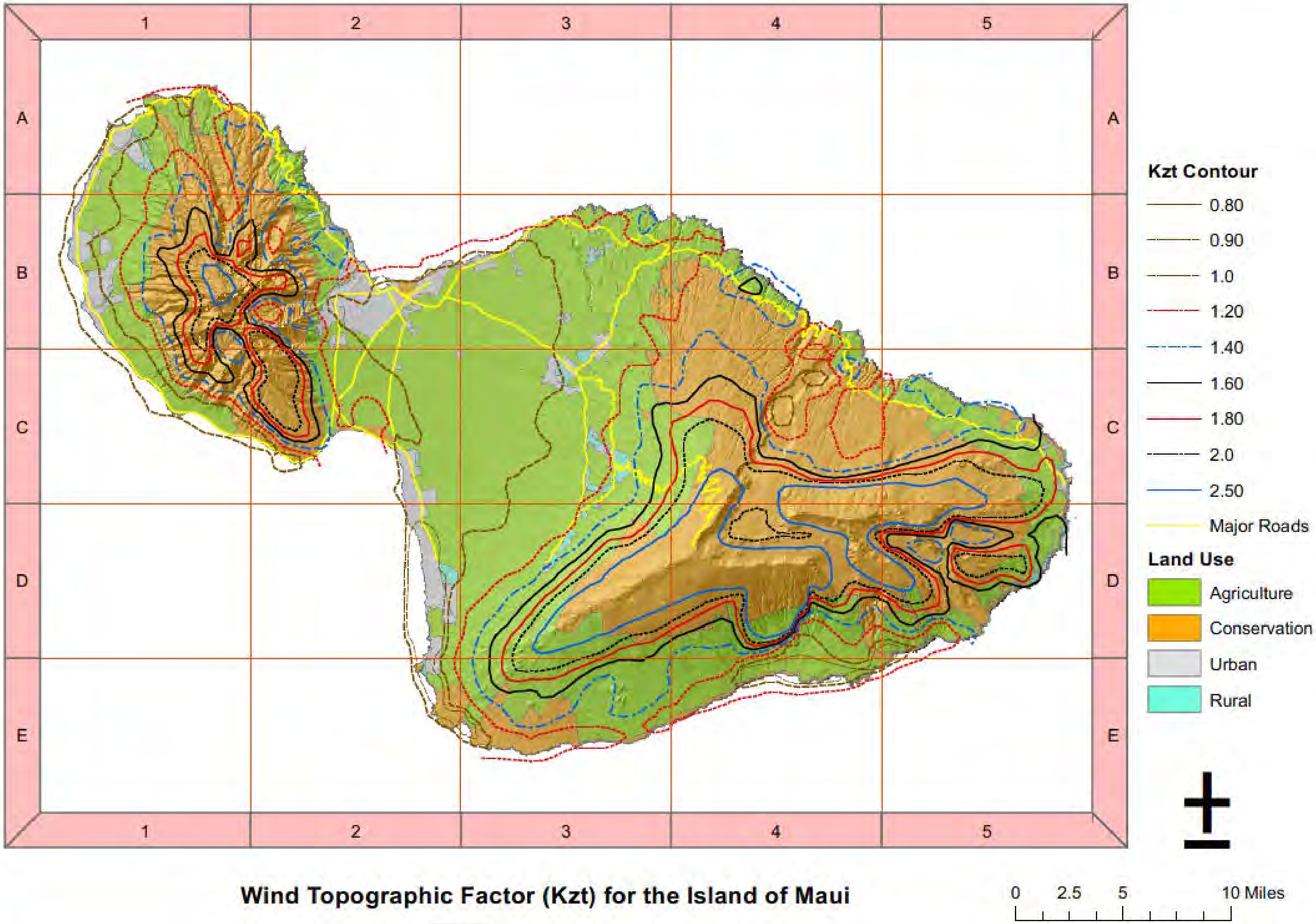
Source: State of Hawaiʻi Department of Accounting and General Services 2018

Figure 4.10-2. Wind Topographic Factor (Kzt) for the City and County of Honolulu



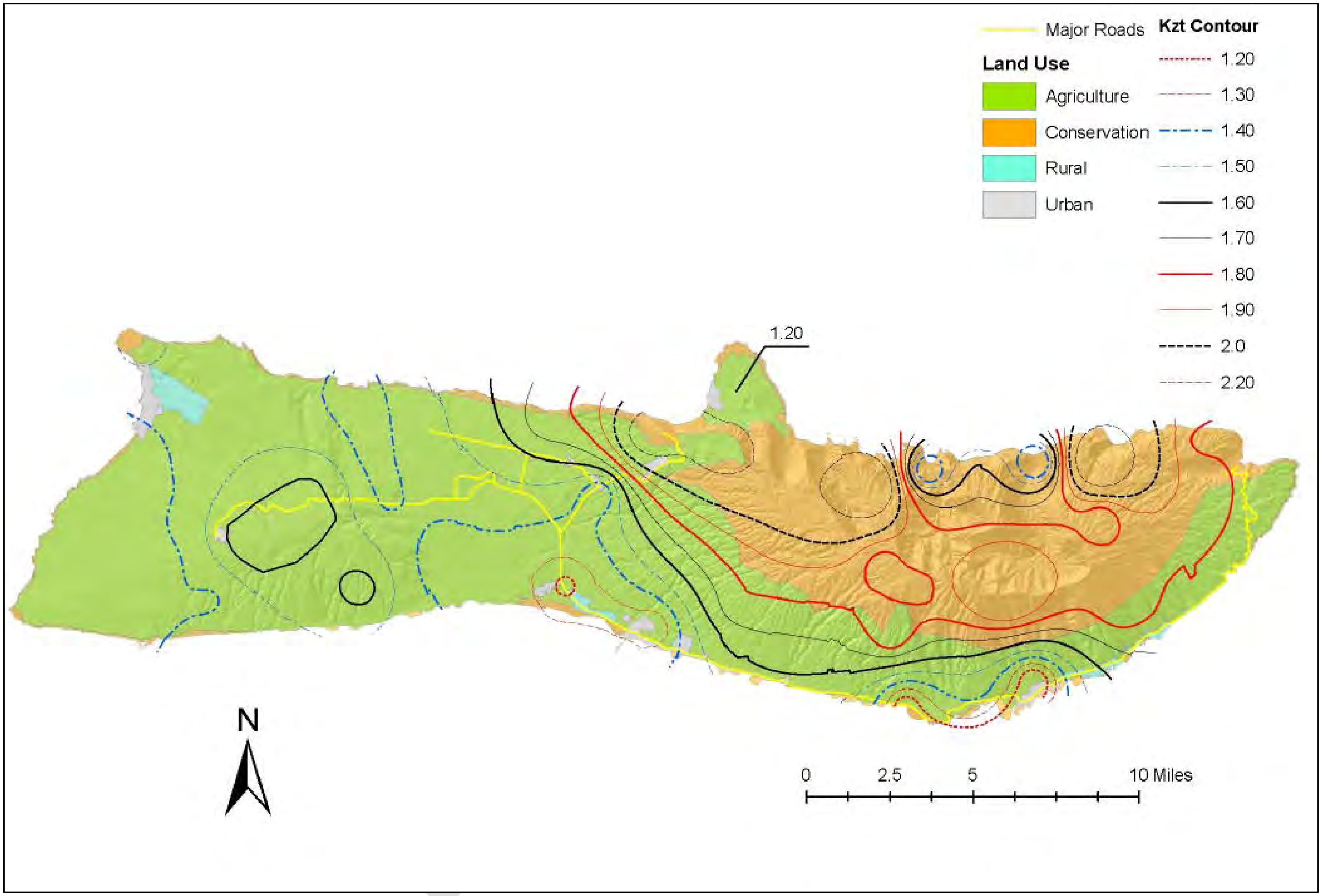
Source: State of Hawaiʻi Department of Accounting and General Services 2018

Figure 4.10-3. Wind Topographic Factor (Kzt) for the Island of Maui (County of Maui)



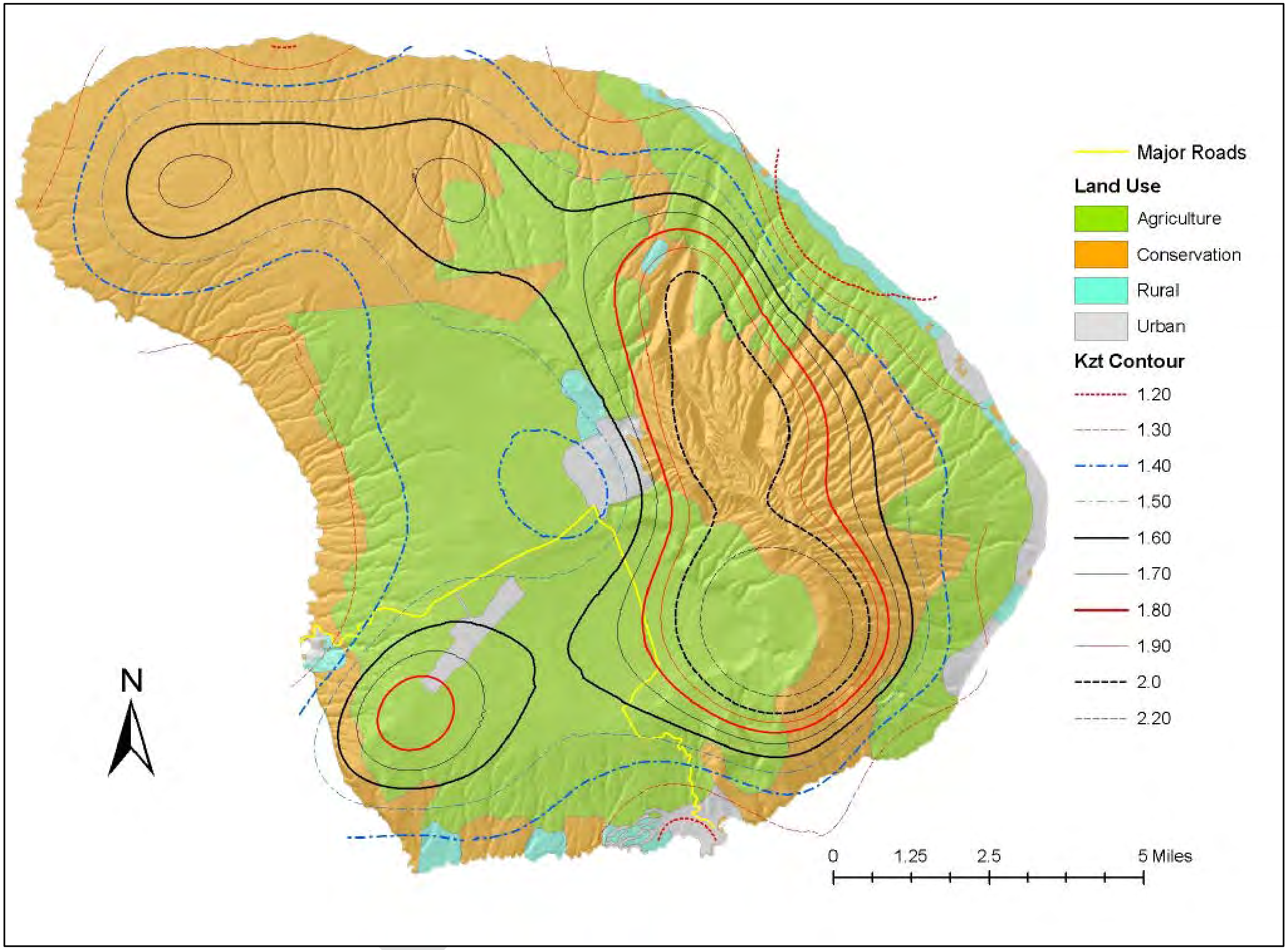
Source: State of Hawaiʻi Department of Accounting and General Services 2018

Figure 4.10-4. Wind Topographic Factor (Kzt) for the Island of Molokaʻi (County of Maui)



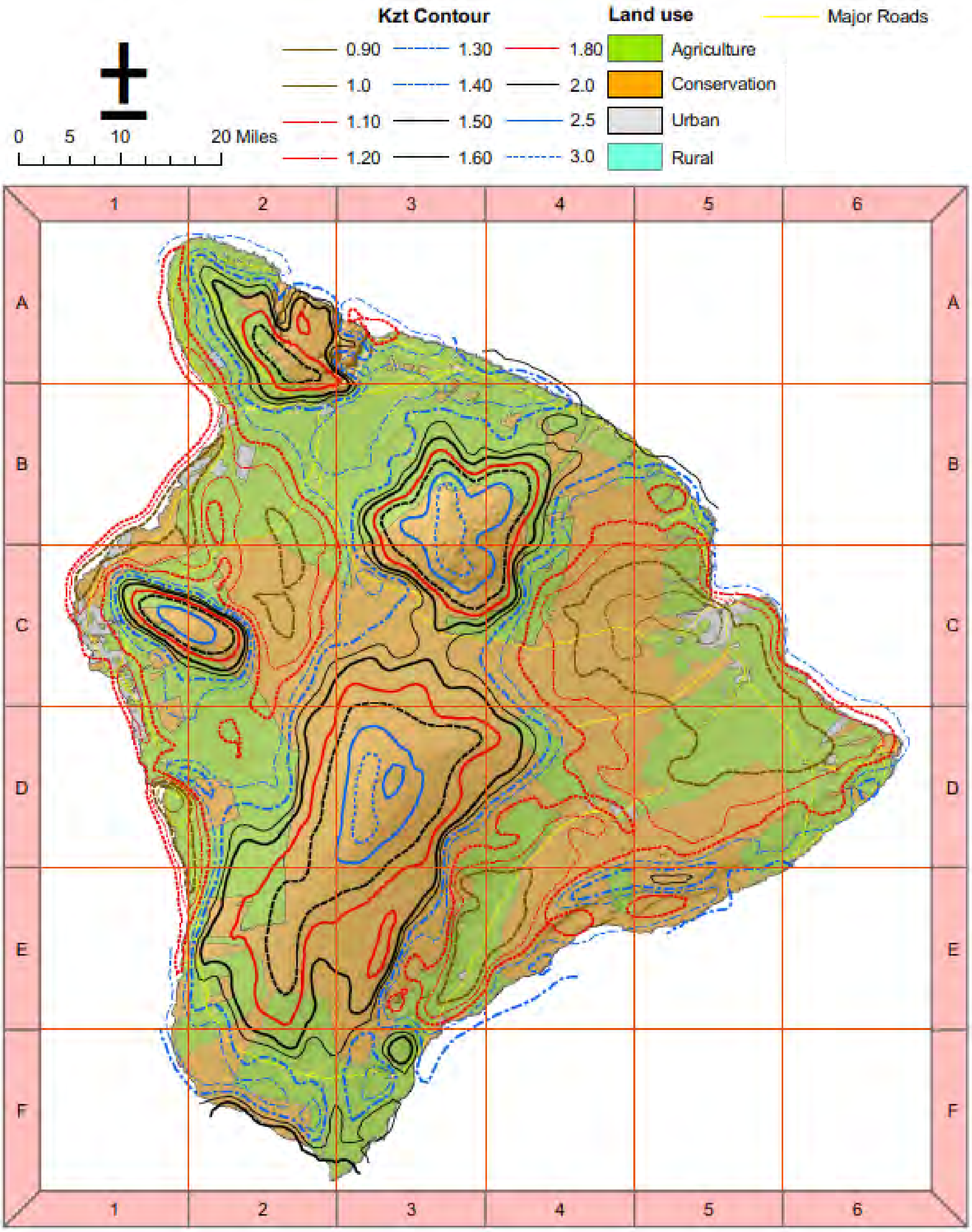
Source: State of Hawaiʻi Department of Accounting and General Services 2018

Figure 4.10-5. Wind Topographic Factor (Kzt) for the Island of Lānaʻi (County of Maui)



Source: State of Hawaiʻi Department of Accounting and General Services 2018

Figure 4.10-6. Wind Topographic Factor (Kzt) for the Island of Hawaiʻi (County of Hawaiʻi)



Source: State of Hawaiʻi Department of Accounting and General Services 2018

EXTENT

High wind events can be a frequent issue throughout the State of Hawaiʻi, with some areas experiencing more events and greater wind speeds than others as evidenced through the Location section of this profile.

The Beaufort wind scale (see Table 4.10-1), still in use today, was developed in 1805 to help sailors estimate the wind speed through visual observations. The scale includes a description of winds and specifications for use both at sea and on land. The average speed of the Trade Winds (15.7 mph) is considered a moderate breeze using this scale. When passing through mountain gaps and over mountains, downsloped Kona wind gusts can reach over 100 mph, which are hurricane-force winds (State of Hawaiʻi HMP 2013).

High wind storms can cause disruptions to power, uproot trees, damage boats, blow roofs off homes and have the potential to damage other structures in the State. However, damage does not typically occur until wind speeds of 40 mph or greater are reached. The State of Hawaiʻi Building Codes references the ASCE 7 Standard for *Minimum Design Loads for Buildings and Other Structures*, which requires that new buildings in the State be designed to withstand a 120 mph sustained wind or wind gusts of 130 mph. This is equivalent to a Category 3 hurricane (see Section 4.10 Hurricane for more information). In addition, the State of Hawaiʻi building code imposes additional requirements for structures to be designed to account for the topographic factors discussed previously (Department of Commerce and Consumer Affairs [DCCA] and Martin and Chock 2015).

Table 4.10-1. Beaufort Wind Scale

Force	Speed mph (knots)	Description	Specifications for use at sea	Specifications for use on land
0	0-1 (0-1)	Calm	Sea like a mirror.	Calm; smoke rises vertically.
1	1-3 (1-3)	Light Air	Ripples with the appearance of scales are formed, but without foam crests.	Direction of wind shown by smoke drift, but not by wind vanes.
2	4-7 (4-6)	Light Breeze	Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.	Wind felt on face; leaves rustle; ordinary vanes moved by wind.
3	8-12 (7-10)	Gentle Breeze	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.	Leaves and small twigs in constant motion; wind extends light flag.
4	13-18 (11-16)	Moderate Breeze	Small waves, becoming larger; fairly frequent white horses.	Raises dust and loose paper; small branches are moved.
5	19-24 (17-21)	Fresh Breeze	Moderate waves, taking a more pronounced long form; many white horses are formed.	Small trees in leaf begin to sway; crested wavelets form on inland waters.
6	25-31 (22-27)	Strong Breeze	Large waves begin to form; the white foam crests are more extensive everywhere.	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
7	32-38 (28-33)	Near Gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	Whole trees in motion; inconvenience felt when walking against the wind.
8	39-46 (34-40)	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift.	Breaks twigs off trees; generally impedes progress.

Force	Speed mph (knots)	Description	Specifications for use at sea	Specifications for use on land
			The foam is blown in well-marked streaks along the direction of the wind.	
9	47-54 (41-47)	Severe Gale	High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility	Slight structural damage occurs (chimney-pots and slates removed)
10	55-63 (48-55)	Storm	Very high waves with long overhanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The tumbling of the sea becomes heavy and shock-like. Visibility affected.	Seldom experienced inland; trees uprooted; considerable structural damage occurs.
11	64-72 (56-63)	Violent Storm	Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.	Very rarely experienced; accompanied by wide-spread damage.
12	72-83 (64-71)	Hurricane	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.	Refer to Saffir-Simpson Hurricane Scale

Source: National Weather Service 2018
Note: The Saffir-Simpson Scale is Discussed in Section 4.10 Hurricane

Warning Time

Meteorologists can often predict the likelihood of a high wind storm event. 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% higher.

The National Weather Service Honolulu Forecast Office issues specific watches, warnings and advisories when weather threatens the State. For high wind storms, the following may be issued:

- **High Wind Watch** is issued when sustained winds exceeding 40 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 when sustained winds are expected to exceed 56 mph and/or frequently gust over 66 mph. If you are in an area for which a High Wind Watch has been issued you should prepare by securing loose objects outdoors that may blow about and avoiding outdoor activity that exposes you to high winds.
- **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 frequently gusting over 66 mph. Wind warnings may be issued up to 24 hours ahead of the onset of high

winds. If you are in an area where a high wind warning is in effect you should avoid activities that expose you to high winds. Loose objects may be blown around. Tree limbs may break and fall. Power lines may be blown down.

- **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 sustained wind range is 45 to 55 mph and/or frequent gusts of 55 to 65 mph. Wind advisories may be in effect for 6 to 12 hours. If you are in an area where a wind advisory is in effect you should secure loose objects that may be blown about outdoors and limit activity that may expose you to high winds.
- **Small Craft Advisory** is issued for the coastal waters when winds of 28 to 37 mph and seas 10 feet or higher are occurring or forecast.
- A **Gale Warning** is issued for coastal, offshore, and high seas areas when winds of 39 to 54 mph not associated with a tropical cyclone are occurring or forecast (NWS 2018).

Previous Occurrences and Losses

High wind events, distinct from tropical cyclones, affect the State of Hawaiʻi on a relatively regular basis. It can be observed from more recent events that the major damage is typically: power outages due to fallen distribution poles; fallen trees, which create debris that often results in damage to structures or other property; and roof damage due to uplift of shingles, tiles or other types of cladding. Occasionally there are deaths associated with the debris and structural collapses. The storms that produce these high winds often have associated flooding and other hazards that provide further damage and losses.

Many sources provided high wind storm events information regarding previous occurrences and losses throughout the State of Hawaiʻi. The 2013 State HMP discussed specific high wind storm events that occurred in Hawaiʻi through 2012. For this 2018 HMP Update, high wind events were summarized between January 1, 2012, and December 31, 2017. Table 4.10-2 includes details of major high wind storm events that occurred in the State between 2012 and 2017. Please note, not all events are captured in the table below. Only major events that resulted in injuries or fatalities, as reported by NOAA NCEI, events that resulted in the activation of the State and/or County EOC, and/or events that led to a FEMA disaster declaration are listed. For events prior to 2012, please refer to Appendix X.

Table 4.10-2. High Wind Storm Events in Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
February 7, 2012	Strong Wind	Honolulu	A cold front moving through Hawaiʻi brought strong winds and heavy rain. The winds downed power lines and trees. In Waikīkī, a tree branch snapped, injuring three people at the International Market Place.
March 9, 2012	Thunderstorm Wind	Kauaʻi and Maui	Significant weather impacted Hawaiʻi, bringing thunderstorms, flash flooding, record-setting hail, and a tornado. There were no reports of fatalities or serious injuries. In Maui County, strong winds destroyed a portion of the roof of the Hana Hotel, causing $25,000 in damages. Maui County had approximately $3.2 million in infrastructure damage from this event. Kauaʻi County had approximately $2 million in infrastructure damage.
February 13, 2015	Strong Wind	Honolulu	Gusty winds moved through Hawaiʻi, downing power lines, utility poles, and trees. The winds damaged roofs and forced roadway closures due to debris. There was one injury reported on Oʻahu (Honolulu County). A firefighter was injured when attempting to secure roof materials in Kāneʻohe in windward Oʻahu.
February 16, 2016	Strong Wind	Honolulu	Strong winds led to power outages, downed trees, and damage to roofs in parts of Oʻahu (Honolulu County), including Mānoa, Aina Haina, Kalihi, and Nuʻuanu. One injury was reported on Oʻahu when a tree fell on a home and pinned a man to his bed.
March 8, 2016	Strong Wind	Honolulu	Gusty north to northeast winds moved over Oʻahu (Honolulu County) and around the State. Power outages, downed trees and power lines were common across the State. On Oʻahu, a downed power line led to road closures. There was one reported injury from of this event. A person was injured at the Koko Head Shooting Complex when the winds blew the roof off the structure and flipped it over.
January 21 to 22, 2017	High Wind	Maui and Hawaiʻi	The Maui and Hawaiʻi County EOCs were partially activated because of this event.
February 11, 2017	Strong Wind	Honolulu	A front moving through the State produced heavy rain and thunderstorms, flash flooding, and gusty winds. This event led to downed power lines and trees, and ponding on roadways. On the south shore of Oʻahu, a tent collapsed at the community college due to the strong winds. Three individuals were injured.
October 23 to 14, 2017	Strong Wind	Honolulu and Maui	Strong winds, heavy rain, thunderstorms, and flash flooding impacted parts of Hawaiʻi. Lightning strikes led to power outages, and gusty winds knocked down trees and power lines. One injury was reported on Oʻahu (Honolulu County) when a tree fell onto a bus stop structure where a woman was standing. In Maui County, wind speeds reached 59 mph.

Sources: *FEMA 2018; NOAA NCEI 2018; SPC 2018*
Note: With high wind storm documentation for Hawaiʻi being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4 1 may not include all events that have occurred in the State and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP update.
EOC *Emergency Operations Center*
FEMA *Federal Emergency Management Agency*
mph *Miles Per Hour*
NCEI *National Centers for Environmental Information*
NOAA *National Oceanic and Atmospheric Administration*
SPC *Storm Prediction Center*

FEMA Disaster Declarations

Between 1954 and 2018, FEMA included the State of Hawaiʻi in 13 wind-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storms, flooding, high surf, mudslides, flash flooding, and landslides. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2018).

Known high wind events that have impacted the State of Hawaiʻi and were declared a FEMA disaster, between 2012 and 2018, are identified in Table 4.10-3. It is recognized that FEMA Declarations may not specify the event as a 'high wind storm' and may refer to the event type as a severe storm, making it challenging to distinguish the declaration from tropical cyclones. For details regarding all declared disasters, refer to Section 4.0 (Risk Assessment Overview).

Table 4.10-3. High Wind-Related Federal Declarations (2012 to 2018)

Year	Event Type	Date Declared	Federal Declaration Number	Counties Affected
2012	Severe Storms, Flooding, and Landslides	April 17, 2012	DR-4062	Kauaʻi and Maui
2016	Severe Storms, Flooding, Landslides, and Mudslides	October 6, 2016	DR-4282	Maui
2018	Severe Storms, Flooding, Landslides, and Mudslides	May 8, 2018	DR-4364	Honolulu and Kauaʻi

Source: FEMA 2018
Note: Hurricane and Tropical Storm declarations are included in Section 4.10 Hurricane.
DR FEMA-designated disaster
FEMA Federal Emergency Management Agency

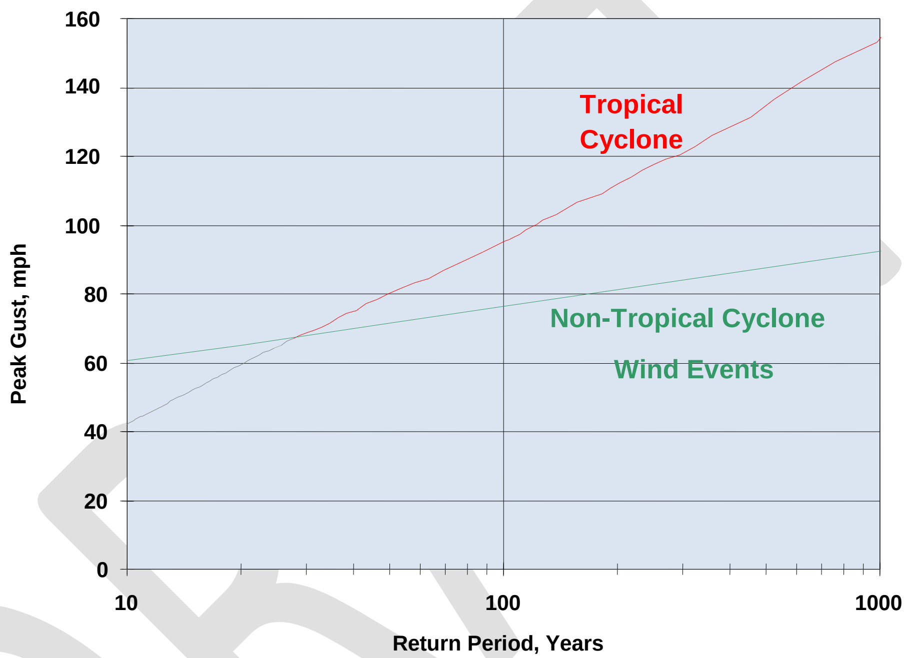
Probability of Future Hazard Events

The distinction between the tropical cyclonic winds and trade and Kona winds is illustrated by the hazard curves for the Hawaiian Islands shown in Figure 4-8. The figure shows that the relatively low wind speeds that occur more frequently are more likely to be from trade and Kona winds while the relatively high but less frequent wind speeds are more likely to be caused by tropical cyclones. The figure shows that winds of 68 mph or less, which can still be very damaging, are more likely to occur due to non-cyclonic winds. Greater wind speeds are more likely to be experienced during a tropical cyclone (tropical depression, storm or hurricane), which are more damaging, however, these events are less frequent (Hawaiʻi State HMP 2013).

For example, at the lower wind speeds, a 60 mph or greater trade wind or Kona wind event is expected to occur once every 10 years, while the 60 mph or greater tropical cyclone is expected to occur once every 20 years. At the higher wind speeds, a 90 mph or greater tropical cyclone is expected to occur 80 years, while a 90 mph or greater trade or Kona storm is expected to be extremely rare and occur only once every 700 to 800 years. Therefore, major structural damage, due to the high winds is more likely to be caused by tropical cyclones in the form of hurricanes. However, damage associated with storms with lower wind speeds, such as: minor structural damage for structures deficient compared to current building standards; non-structural water damage due to windblown rain; flooding associated with wind storms, or; damage to power distribution systems deficient compared to current building standards, is more likely to be caused by trade or Kona wind storms (Hawaiʻi State HMP 2013).

Overall, high wind events will occur regularly as part of severe weather events across the State. As noted earlier, high wind events occur on a relatively regular basis. Based on historical record, the State of Hawaiʻi has experienced 12 FEMA declarations associated with severe storms since 1954. The State can experience a major event that leads to a FEMA declaration once every five years. Looking at all high wind events, between 1955 and 2017, there have been 533 events. Based on this data, the State of Hawaiʻi may experience between an estimated eight and nine high wind events each year (Storm Prediction Center 2018; NOAA NCEI 2018). The State of Hawaiʻi can expect a 100% chance of high wind storms occurring annually.

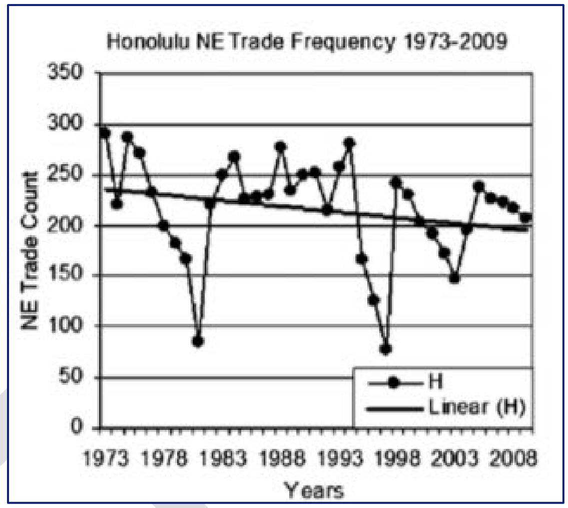
Figure 4.10-7. Wind Hazard Curves for the Hawaiian Islands for Tropical Cyclone and Non-Tropical Cyclone Winds



Source: Hawaiʻi State HMP 2013

Impacts of Climate Change on Future Probability

Although the average atmospheric and land surface temperature are increasing in the State of Hawaiʻi and are projected to continue rising, the rates will vary depending on land uses, topography, and trade wind and precipitation patterns. The effect of climate change on the trade winds, which bring a steady supply of rainfall to the Hawaiian Islands, is a source of uncertainty in local predictions (University of Hawaiʻi at Mānoa Sea Grant College Program 2014). Winds are changing over the Hawaiian Islands. Changes detected in the prevailing wind over the Hawaiian Islands, the northeast trade wind, may shift large-scale pressure and wind patterns that impact the State of Hawaiʻi in the future (Garza et al., 2011).



There are fewer days with northeast trade winds than 40 years ago. Fewer days of northeast trade winds leads to more muggy weather and volcanic haze, resulting in longer-term effects for the state (University of Hawaiʻi at Mānoa Sea Grant College Program 2014; Gutierrez 2012).

Scientists from the University of Hawaiʻi at Mānoa analyzed wind records from 1973 to 2009 at the major airports in the State of Hawaiʻi: Līhuʻe, Honolulu, Kahului and Hilo. They also collected data from four weather buoys in waters around the islands. The study found for Honolulu, northeast trade winds dropped from 291 days per year to 210 days per year over the 40-year period. The two largest decreases occurred in 1981 and 1997. In 1981, a high-pressure system shut off northeast trade winds, causing a major drought in the State. In 1997, the strongest El Niño event ever recorded weakened the northeasterly trade winds (Garza et al. 2011; Live Science 2012).

For details regarding climate change as a distinct hazard and its unique impacts to the State of Hawaiʻi, refer to Section 4.1 (Climate Change).

4.10.2 Vulnerability Assessment

High wind storms can occur anywhere in the State of Hawaiʻi; however, as previously discussed, topography plays a significant role in where the impacts are most severe. Terrain-related amplification of wind speeds have led to significant losses in the state. Kona storm events not only bring high winds, but also large amounts of rain that result in flash flooding, snow at high altitudes, hail and severe thunderstorms. For further discussion on flooding and surge impacts, refer to Sections 4.7 (Event-Based Flood) and Section 4.11 (Hurricane). This vulnerability assessment focuses on the high wind component to these storm events. No spatial data was available for the high wind storm vulnerability assessment. Therefore, a qualitative assessment was conducted and is presented below.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to high wind storm events.

State Assets

As noted earlier, the Hawaiʻi State Building Code requires new structures to be built to withstand a Category 3 hurricane wind speed. Any state buildings that were built before the building code incorporated provisions for wind load and topographic factor are particularly vulnerable. Depending on the severity and duration of the storm, a high wind storm, as described earlier can cause windows and doors to be blown out, roofs to be ripped off and walls to collapse. Although it is unlikely that high winds would directly damage state roads, debris has blocked roads, isolating areas and putting already vulnerable populations at even greater risk.

Critical Facilities

All critical facilities in the State are vulnerable to high wind storms. Loss of utilities is the most common issue with high wind storms. High winds can severely impact power transmission lines as high winds are funneled through changes in terrain causing widespread power outages. For example, in December 26, 2008, the entire electrical grid on the island of Oʻahu (City and County of Honolulu) was blacked out for around 12 hours due to a Kona storm (State of Hawaiʻi HMP 2013). The interruption of power, water, wastewater, as well as critical needed services such as hospitals and other emergency services has cascading impacts residents, visitors and all forms of economic activity.

As summarized in Section 4.2 (Climate Change and Sea Level Rise), the primary transportation arteries for the entry of people and goods to the State is the Daniel K. Inouye International Airport and Honolulu Harbor. In addition, each island has critical points of entry for people and goods located along the coast. Ports, harbors and airports are especially vulnerable to the high wind storm hazard. Damages and closures to these critical facilities will likely be long-term have cascading economic impacts statewide.

Kona wind events, such as the January 1980 storm, have caused the closure of airports. The 1980 storm produced sustained winds of 40-50 mph gusting over 100 mph in certain regions due to topographical features. According to the Hawaiʻi Department of Transportation, anchorage for deep-draft vessels exist outside the Honolulu Harbor in Mamala Bay off Sand Island and west of the Main Channel (also known as Fort Armstrong Channel). However, anchorage is not possible during kona wind conditions (Hawaiʻi DOT 2018).

In February 2017, the HI-EMA conducted a series of workshops to continue its ongoing efforts to address temporary emergency power planning requirements outlined in the 2015 Hawaiʻi Catastrophic Hurricane Plan. As a result, the state identified critical facilities within each county and developed a method to prioritize the allocation of limited generator resources. The critical facilities identified through this process were used in the risk assessment for the 2018 HMP Update (HI-EMA 2017). Exposure and potential impacts to these critical facilities are reported throughout Section 4.0 resulting from natural hazard events.

Economic (monetary) losses due to high wind storms on critical infrastructure such as airports, harbors, water, sewer and power utilities were not calculated due to the variable cost of such infrastructure and the complexity and uncertainty involved based on design, siting and construction. However, estimated costs for the resiliency and hardening of electric power systems are available through the efforts being made after Puerto Rico was struck by Hurricanes Irma and Maria in 2017. These two hurricanes resulted in catastrophic damage to the island and a complete failure of Puerto Rico's power grid. Similar to the State of Hawaiʻi, Puerto Rico also experiences wind speed up due to the differences in terrain across the island. As reported in *Build Back Better: Reimagining and Strengthening the Power Grid of Puerto Rico*, the estimated cost per mile for hardening is $1.25 to $7 million, depending upon if low or high voltage lines are use.

Assessment of Local Vulnerability and Potential Losses

Overall, high wind storms can occur anywhere in the State of Hawaiʻi. In terms of vulnerability, the strong kona storms and associated wind, rain and wave heights can cause extensive damage to the south and west facing shores of the islands. This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental/cultural assets by county.

Population

The entire population, residents and visitors, is considered exposed and could be impacted by high wind storms. Certain areas are more vulnerable because of their geographic location and local weather patterns. For example, people living at higher elevations with large stands of trees or nearby powerlines may be more susceptible to wind damage and loss of power. Kona winds that accelerate down the slopes of mountains, hills and escarpments, historically reaching up to 100 miles per hour, can be very destructive when they reach populated low-lying areas. It is common for trees to be uprooted, signs and utility poles to be overturned, debris to be carried by the winds and for residential roofs to be blown off. Damage can be inflicted on boats caught in the open ocean or anchored in the southwest-exposed anchorages (State of Hawaiʻi HMP 2013).

Kona winds can also bring volcanic fog (vog) from Kilauea in the County of Hawaiʻi up the island chain reaching the County of Maui and City and County of Honolulu. This makes visibility poor and causes eye and respiratory irritation. Refer to Section 4.13 (Volcanic Hazards) for a more detailed discussion of vog and human health impacts.

After high wind events, residents may be displaced or require temporary to long-term sheltering. Vulnerable populations, such as the elderly, low-income and linguistically isolated populations, are most susceptible to high wind storms. This vulnerability is 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. Other risk factors include that power outages can be life threatening to people dependent on electricity for life support. Because these vulnerable populations face various forms of isolation, they are more at risk for secondary effects from the high wind hazard.

General Building Stock

As noted earlier, the Hawaiʻi State Building Code requires new structures to be built to withstand a Category 3 hurricane wind speed. Any structures that were built before the building code incorporated provisions for wind load and topographic factor are particularly vulnerable. More vulnerable locations include: at higher elevations, on leeward sides of islands during Kona winds, on ridge lines, under or near powerlines, or near large trees. Depending on the severity and duration of the storm, a high wind storm, as described earlier can cause windows and doors to be blown out, roofs to be ripped off and walls to collapse.

Spatial data was not available to conduct an exposure analysis based on wind speed zones. When estimating the potential impact to individual structures, the structural integrity, mitigation measures in place, building construction and date of construction should be considered. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Refer to Section 4.10 (Hurricane) for further discussion on impacts resulting from high wind speeds associated with tropical cyclone events for all counties in the state.

Environmental Resources and Cultural Assets

Natural habitats such as forests and waterways are vulnerable to damage from high wind storms. Major damage can occur from downed or uprooted trees, other debris, as well as rivers and streams blocked by various types of debris. Agricultural losses have been reported due to historic Kona wind events; for example macadamia, coffee, foliage and flower farms incurred losses as a result of the January 1980 event in the County of Hawaiʻi.

A Kona storm can bring large amounts of rain in a short period of time to the leeward side of the islands that tend to be drier. In addition, major Kona storm events can bring large wave heights and resulting shoreline change which may impact environmental and cultural assets along the shore (Vistousek et al 2009).

Future Changes that May Impact State Vulnerability

Understanding factors of change that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

All future development in each county and statewide is vulnerable to high wind hazards. However, the ability to withstand impacts from high winds is based in appropriate land use practices and consistent enforcement of codes and regulations for new construction. As older structures are replaced with new structures built to modern building codes overall vulnerability to the high wind storm hazard will decrease.

SECTION 4. RISK ASSESSMENT

4.11 Hurricane

2018 HMP UPDATE CHANGES

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change). New and updated figures from federal and state agencies are incorporated.
- This hazard name has changed to Hurricane from Tropical Cyclones to correspond with the State's Threat Hazard Identification and Risk Assessment (THIRA) but will still include information regarding hurricanes and tropical storms.
- Hurricane and tropical storm events that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update.
- The following have been analyzed: hurricane storm surge and high wind areas per county for exposure to geocoded state assets, critical facilities, population, general building stock, and environmental resources and cultural assets.

4.11.1 Hazard Profile

Hurricanes and tropical storms can bring excessive amounts of rain, strong and damaging winds, storm surge, high waves, erosion along shorelines, and tidal and coastal flooding. While the occurrence of such storms is low in the state, when they do occur, they can have dramatic, damaging, and potentially deadly effects. For the 2018 HMP Update, this profile and associated vulnerability assessment will focus on hurricane-force winds and storm surge and include events identified as hurricanes and tropical storms. Other hazards associated with tropical cyclone events are generally addressed in other hazard sections. Please refer to Section 4.3 (Chronic Coastal Flood) for annual high waves, coastal erosion, and tidal flooding; Section 4.7 (Event-Based Flood) for coastal flooding; and Section 4.10 (High Wind Storm) for high winds.

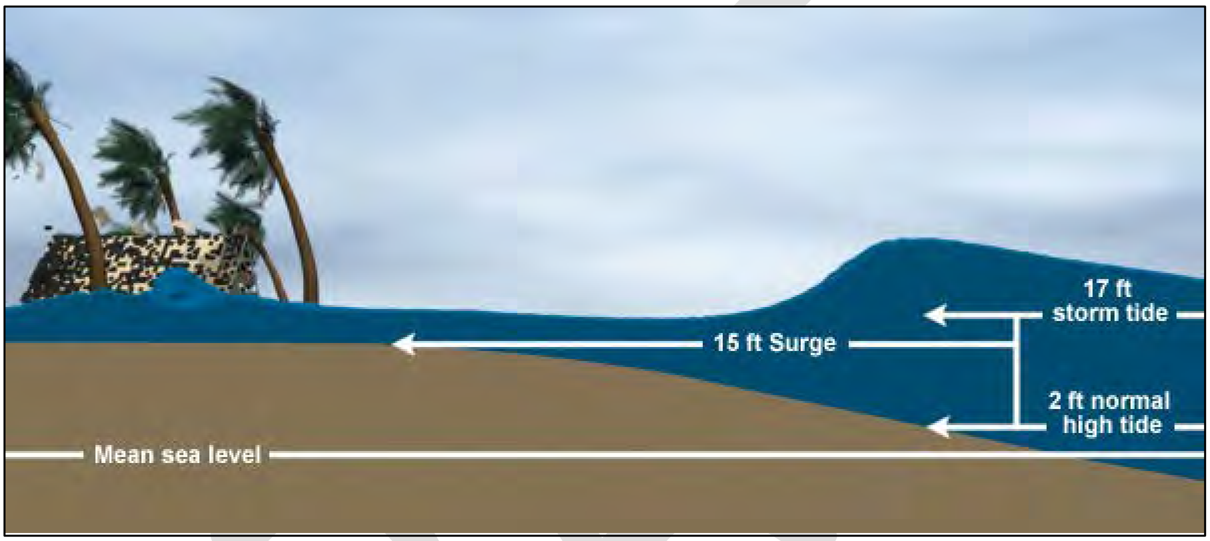
HAZARD DESCRIPTION

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or sub-tropical waters and has a closed low-level circulation. Tropical depressions, tropical storms and hurricanes are all types of tropical cyclones that are distinguished by their sustained wind speeds. These storms rotate counterclockwise in the northern hemisphere around the center and are accompanied by heavy rain and strong winds (NOAA 2013). The weather associated with tropical cyclones typically lasts between 12 and 18 hours; with a slow-moving storm lasting around 24 hours. The State of Hawaiʻi is located in the Central Pacific basin where hurricane season runs from June 1 to November 30.

Storm Surge

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge occurs when water is pushed toward the shoreline by the force of winds from the storm. Friction between the water and the moving air creates drag that, depending upon the distance of water (fetch) and velocity of the wind, can pile water up to depths greater than 20 feet from the shoreline inland. The rise in water level can cause extreme flooding in coastal areas, especially with storm surge coincides with normal high tide (National Hurricane Center 2018) (Figure 4.11-1).

Figure 4.11-1. Storm Surge



Source: National Hurricane Center 2018

All types of tropical cyclones often generate large swells, causing varying degrees of damage. This is characteristic of hurricanes that pass close, but do not directly impact, the State of Hawaiʻi. For example, communities on the Waiʻanae Coast in the City and County of Honolulu suffered severe damage from Hurricanes Iwa and Iniki, yet neither of these storms actually hit the Island of Oʻahu.

According to the National Hurricane Center, there are many factors that contribute to the amount of surge a given storm produces at a given location:

- Central Pressure—lower pressure of the storm will produce a higher surge; however, the central pressure of the storm is a minimal contribution compared to the other factors.
- Storm Intensity—stronger winds will produce higher surge.
- Storm Forward Speed—on the open coast, a faster storm will produce a higher surge. However, a higher surge is produced in bays, sounds, and other enclosed bodies of water with a slower storm.
- Angle of Approach to Coast—the angle at which a storm approaches a coastline can affect how much surge is generated. A storm that moves onshore perpendicular to the coast is more likely to produce a higher storm surge than a storm that moves parallel to the coast or moves inland at an oblique angle.
- Shape of the Coastline—storm surge will be higher when a hurricane makes landfall on a coastline that is curved inward, as opposed to a coastline that is curved outward.

- Size—a larger storm will produce a higher surge. The winds of a larger storm push on a larger area of the ocean. The strong winds of a larger storm tend to affect a larger area than a smaller storm.
- Width and Slope of the Ocean Bottom—higher storm surge occurs with wide, gently sloping continental shelves, while lower storm surge occurs with narrow, steeply sloping shelves.
- Local Features—storm surge highly depends on local features and barriers that will affect the flow of water. In the state, this includes inlets, bays, and rivers (National Hurricane Center 2018a).

Heavy Rain

Hurricanes and other tropical cyclones often produce widespread, torrential rains in excess of six inches, which may result in deadly and destructive flooding. Rainfall amounts are not directly related to the strength of the storm but rather to the speed and size. Slower moving, larger storms produce more rainfall. Additionally, mountainous terrain enhances rainfall from a hurricane (National Hurricane Center 2018b).

Strong Winds

The strongest winds are typically found on the right side of the center of the hurricane. Wind speeds decrease with increased distance away from the center of the storm. Atlantic and Central Pacific hurricanes are classified into five categories according to the Saffir-Simpson Hurricane Wind Scale, which estimates potential property damage according to the hurricane's sustained wind speed. Refer to the Extent section of this profile for details regarding the Saffir-Simpson Scale (National Hurricane Center 2018b).

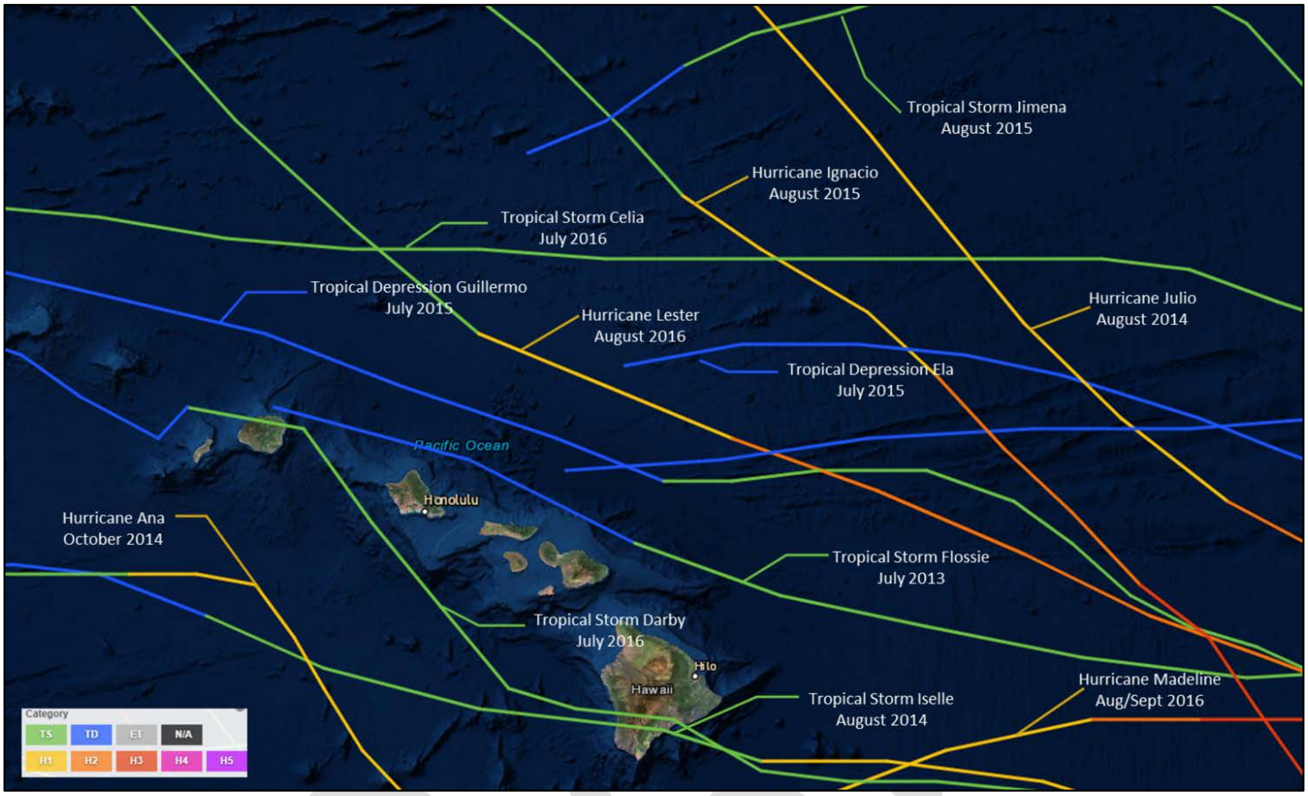
Microbursts and mini-swirls are small, localized wind bursts that can reach speeds of greater than 200 mph. During Hurricane Iniki, damage patterns and debris indicated that there were more than 26 microbursts (sudden intense downdrafts) and two mini-swirls (a violent whirlwind, not tornado) that occurred in the County of Kauaʻi (Hawaiʻi State HMP 2013).

LOCATION

The entire State of Hawaiʻi and its communities are vulnerable to the damaging impacts of hurricanes. Historically, it has been relatively rare for a hurricane to intersect the state; however, large swells and high winds from near-misses are quite common. Every county in the state has been affected by hurricanes and each are at risk to damages from these storms (USGS 2002). The coastal areas of the State of Hawaiʻi are more susceptible to damage caused by a combination of high winds and tidal surge. Inland areas, especially those in the 1% and 0.2% annual chance flood areas, are also at risk to flooding because of heavy rains associated with the storms. Refer to Section 4.6 (Event Based Flooding) for details regarding inland flooding.

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2016 (latest date available from data source). Figure 4.11-2 displays tropical cyclone tracks for the Central Pacific, which includes the State of Hawaiʻi. The figure shows tropical cyclone events that occurred between 2002 and 2016.

Figure 4.11-2. Historical Tropical Storm and Hurricane Tracks, 2002 to 2016



Source: National Hurricane Center 2018

EXTENT

Once a tropical cyclone has been characterized as a hurricane, its intensity is measured by the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage (refer to Table 4.11-1). 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 preventative measures (NOAA 2013b).

Table 4.11-1. Saffir-Simpson Hurricane Scale

Category	Wind Speed (miles per hour [mph])	Storm Surge (feet)	Expected Damage
1	74 to 95	4 to 5	Damaging winds are expected. Some damage to buildings could occur, primarily to unanchored structures (such as school portables). Some damage is likely to poorly constructed signs. Loose outdoor items will become projectiles, causing additional damage. Persons struck by windborne debris risk injury and possible death. Numerous large branches of healthy trees will snap. Some trees will be uprooted, especially where the ground is saturated. Many areas will experience power outages with some downed power poles. Hurricane Iwa (passing just northwest of Kaua'i in 1982) and Hurricane Dot

Category	Wind Speed (miles per hour [mph])	Storm Surge (feet)	Expected Damage
			(landfall on Kauaʻi in 1959) are examples of Category 1 hurricanes that directly impacted the State of Hawaiʻi.
2	96 to 110	6 to 8	Very strong winds will produce widespread damage. Some roofing material, door, and window damage of buildings will occur. Considerable damage to unanchored structures and poorly constructed signs is likely. A number of glass windows in high-rise buildings will be dislodged and become airborne. Loose outdoor items will become projectiles, causing additional damage. Persons struck by windborne debris risk injury and possible death. Numerous large branches will break. Many trees will be uprooted or snapped. Extensive damage to power lines and poles will likely result in widespread power outages that could last a few to several days. There is no record of a Category 2 hurricane directly impacting Hawaiʻi. Elsewhere in the United States, Hurricane Erin (1995, 100 mph at landfall in northwest Florida) and Hurricane Isabel (2003, 105 mph at landfall in North Carolina) are examples of Category 2 hurricanes at landfall.
3 (major)	111 to 129	9 to 12	Dangerous winds will cause extensive damage. Some structural damage to houses and buildings will occur with a minor amount of wall failures. Unanchored structures and poorly constructed signs are destroyed. Many windows in high-rise buildings will be dislodged and become airborne. Persons struck by windborne debris risk injury and possible death. Many 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. There is no record of a Category 3 hurricane directly impacting Hawaiʻi. Elsewhere in the United States, Hurricane Rita (2005, 115 mph landfall in east Texas/Louisiana) and Hurricane Jeanne (2004, 120 mph landfall in southeast Florida) are examples of Category 3 hurricanes at landfall.
4 (major)	130 to 156	13 to 18	Extremely dangerous winds causing devastating damage are expected. Some wall failures with some complete roof structure failures on houses will occur. All signs are blown down. Complete destruction of unanchored structures. Extensive damage to doors and windows is likely. Numerous windows in high-rise buildings will be dislodged and become airborne. Windborne debris will cause extensive damage and persons struck by the wind-blown debris will be injured or killed. Most trees will be snapped or uprooted. Fallen trees could cut off residential areas for days to weeks. Electricity will be unavailable for weeks after the hurricane passes. Hurricane Iniki, which made landfall on Kauaʻi in 1992, is an example of a Category 4 hurricane at landfall in Hawaiʻi.
5 (major)	>157	>18	Catastrophic damage is expected. Complete roof failure on many residences and industrial buildings will occur. Some complete building failures with small buildings blown over or away are likely. All signs blown down. Complete destruction of unanchored structures. Severe and extensive window and door damage will occur. Nearly all windows in high-rise buildings will be dislodged and become airborne. Severe injury or death is likely for persons struck by wind-blown debris. Nearly all trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. There is no record of a Category 5 hurricane directly impacting Hawaiʻi. Elsewhere in the United States, Hurricane Camille (1969, 190 mph at landfall in Mississippi) and Hurricane Andrew (1992, 165 mph at landfall in Southeast Florida) are examples of Category 5 hurricanes at landfall.

Source: Central Pacific Hurricane Center 2017; University of Hawaiʻi 2012
> Greater than

As stated earlier, storm surge inundation from hurricanes can be devastating to areas along the coastline. Table 4.11-2 summarizes the area of coastline that may be potentially inundated by storm surge from hurricane Categories 1 through 4. The City and County of Honolulu has the greatest number of square miles that may be inundated by storm surge.

Table 4.11-2. Storm Surge Inundation Area by County

County	Area (in square miles)								
	Total County Area	Cat 1	Cat 1 Area as % of Total Area	Cat 2	Cat 2 as % of Total Area	Cat 3	Cat 3 as % of Total Area	Cat 4	Cat 4 as % of Total Area
County of Kauaʻi	620.0	4.5	0.7%	5.8	0.9%	10.1	1.6%	12.2	2.0%
City and County of Honolulu	600.7	10.9	1.8%	22.3	3.7%	31.8	5.3%	38.2	6.4%
County of Maui	1,173.5	5.8	0.5%	7.9	0.7%	9.8	0.8%	11.4	1.0%
County of Hawaiʻi	4,028.4	1.9	0.0%	2.5	0.1%	3.7	0.1%	5.3	0.1%
Total	**6,422.6**	**23**	**0.4%**	**39**	**0.6%**	**55**	**0.9%**	**67**	**1.0%**

Notes: Cat 1 Category 1 Hurricane
Cat 2 Category 2 Hurricane
Cat 3 Category 3 Hurricane
Cat 4 Category 4 Hurricane
Source: NOAA National Hurricane Center 2018

Warning Time

Tropical cyclones are a unique weather phenomenon because they can be closely monitored and tracked. As a result, accurate warnings up to days in advance of the event are possible with the track modeling offering possible storm movement up to a week prior. Track forecasts have improved partly due to an increase in the number of satellites, outfitted with more sophisticated weather-monitoring devices. Additionally, supercomputing has increased and computer models used for forecasting keep improving.

The Central Pacific Hurricane Center issues tropical cyclone advisory packages whenever a tropical cyclone is active in the Central North Pacific Basin. If a tropical cyclone is active in the Eastern North Pacific, the National Hurricane Center issues the package. The following provides definitions, as defined by the Central Pacific Hurricane Center, for the tropical cyclone advisory packages.

- **Tropical Cyclone Public Advisory:** The Tropical Cyclone Public Advisory gives the cyclone position in terms of latitude and longitude coordinates and distance from a selected land point or island, as well as the current motion. The advisory includes the maximum sustained winds in miles per hour and the estimated or measured minimum central pressure in millibars and inches. 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 Central Pacific tropical cyclones.** Public advisories are normally issued every six hours. They may be issued every two or three hours when coastal watches or warnings are in effect. Special public advisories may be issued at any time due to significant changes in warnings or in the cyclone.

- **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 coordinates, intensity, and system motion. The advisory contains forecasts of the cyclone positions, intensities, and wind fields for 12, 24, 36, 48, and 72 hours from the current synoptic time. The advisory may also include information on any pertinent storm tides associated with the cyclone. All wind speeds in the forecast advisory are given in knots (nautical miles per hour). They are issued on all Central Pacific tropical cyclones. Special Forecast/Advisories may be issued at any time due to significant changes in warnings or in the cyclone.
- **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. They are issued on all Central Pacific tropical cyclones every six hours. Special Forecast/Advisories may be issued at any time due to significant changes in warnings or in the cyclone.
- **Tropical Cyclone Surface Wind Speed Probabilities:** The Tropical Cyclone Surface Wind Speed Probabilities text product provides probabilities, in percent, of sustained wind speeds equal to or exceeding 34-, 50-, and 64-knot wind speed thresholds. These wind speed probabilities are based on the track, intensity, and wind structure forecasts and uncertainties from the Central Pacific Hurricane Center. These wind speed probabilities are computed for coastal and inland cities as well as offshore locations (e.g., buoys).

Previous Occurrences and Losses

While hurricanes are relatively rare in the State of Hawaiʻi, records have shown that the storms can bring very heavy rainfall and strong, damaging winds that lead to storm surge and extremely high waves. The first officially recognized hurricane in the State of Hawaiʻi was Hurricane Hiki in August 1950. Since 1950, five tropical cyclones have caused serious damage in the state. Hurricane Nina (1957) produced record winds in the City and County of Honolulu. Hurricane Dot (1959) caused damage to the County of Kauaʻi. Hurricane Estelle (1986) produced very high surf on the Islands of Hawaiʻi (County of Hawaiʻi) and Maui (County of Maui), and floods on the Island of Oʻahu (City and County of Honolulu). The County of Kauaʻi also received the brunt of Hurricane Iwa, which struck on November 23, 1982, and produced an estimated $234 million in damage (Storm Evolution and Energetics Research 2018). Hurricane Iniki was a Category 4 hurricane that hit the County of Kauaʻi in September 1992, causing almost $2 billion in damages. In 2015, an El Niño year, the Central Pacific saw 15 named storms (eight hurricanes and five major hurricanes), making 2015 the most active season since 1970 (NOAA 2015).

Many sources provided hurricane and tropical storm information regarding previous occurrences and losses throughout the State of Hawaiʻi. The 2013 HMP discussed specific hurricane and tropical storm events that occurred in the State of Hawaiʻi through 2012. For this 2018 HMP Update, hurricane and tropical storm events were summarized between January 1, 2012, and December 31, 2017. Table 4.11-3 includes details of major hurricane and tropical storm events that occurred in the state between 2012 and 2017. Major events include those that resulted in losses or fatalities, as reported by NOAA National Centers for Environmental Information (NCEI), events that resulted in the activation of the State and/or County Emergency Operations Center (EOC), and/or events that led to a FEMA disaster declaration. For events prior to 2012, please refer to Appendix X.

Table 4.11-3. Tropical Storm and Hurricane Events in the State of Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
July 26 to 30, 2013	Tropical Storm Flossie	Maui and Hawaiʻi	Tropical Storm Flossie affected the state, bringing high surf, thunderstorms, heavy rain, flash flooding and strong winds. Strong winds downed trees and power lines across the State, closing roads and leading to power outages. Widespread power outages were reported on the Islands of Hawaiʻi, Maui and Molokaʻi. There were several injuries reported due to lightning strikes. The state EOC was activated during this event. Total cost of damages was not readily available for this event.
August 4 to 21, 2014	Tropical Storm Iselle (FEMA-DR-4194)	City and County of Honolulu, Maui, and Hawaiʻi	Tropical Storm Iselle brought heavy rain, strong winds, downed trees and wires, and widespread power outages. Overflowing streams flooded roadways in throughout the State of Hawaiʻi. There were over 200 reports of damage to homes and businesses and over 100 reports of infrastructure issues (downed utility poles and power lines; damaged roadways). Agriculture was heavily impacted by the storm with approximately 50% of the state's papaya crop destroyed (an estimated $55 million loss). The storm also caused damage to other crops; including flowers, macadamia nuts, and coffee. Estimated total losses ranged from $148 million to $325 million. On September 5, 2014, Governor Neil Abercrombie requested a major disaster declaration due to Tropical Storm Iselle during the period of August 7 to 9, 2014. The Governor requested a declaration for public assistance for three counties and hazard mitigation statewide. On September 12, 2014, President Obama declared that a major disaster existed in the State of Hawaiʻi. The declaration made public assistance available to state and eligible local governments and certain private non-profit organizations on a cost-sharing basis for emergency work and the repair or replacement of facilities damaged by the Tropical Storm Iselle in the City and County of Honolulu, County of Maui, and County of Hawaiʻi. Total public assistance was estimated at over $8 million, with over $4.9 million obligated.
October 13 to 19, 2014	Hurricane Ana	Kauaʻi and Hawaiʻi	Hurricane Ana brought heavy rain to the Counties of Kauaʻi and Hawaiʻi. The system also generated isolated thunderstorms that moved westward. The swell from the hurricane produced high surf that ranged from 8 to 15 feet along the south shores of the islands. Roads were closed throughout the impacted areas due to flash flooding. The state EOC was fully activated as a result of this event. Overall, there were no reports of significant property damage or injuries associated with Hurricane Ana.
July 31 to August 5, 2015	Tropical Storm Guillermo	Kauaʻi, Maui, and Hawaiʻi	A swell from Tropical Storm Guillermo produced surf of 10 to 20 feet along the east-facing shores of the Islands of Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi. The high surf forced county officials to close beaches in the Counties of Maui and Hawaiʻi. The high water also brought debris onto coastal roads near inundated areas. There were no reports of significant property damage or injuries associated with Tropical Storm Guillermo. County EOCs were partially activated as a result of this event.
August 20 to 24, 2015	Hurricane Kilo	Honolulu, Maui, and Hawaiʻi	On August 20, 2015, from west to east, Hurricane Kilo was located 1,200 miles west-southwest of the City and County of Honolulu. It passed over the southern end of the state, bringing heavy rain, thunderstorms, and flash flooding to the area. Many roads were closed throughout the impacted counties due to flash flooding. Several schools were closed for several days due to flooded roadways and power outages. On Oʻahu (City and County of Honolulu), sewers overflowed

Date(s) of Event	Event Type	Counties Affected	Description
			and water was coming through manholes. Thousands of gallons of water escaped from the sewer system. All county EOCs were monitoring the situation. There were direct impacts to Johnston Island and portions of the Northwestern Hawaiian Islands.
August 26 to September 4, 2015	Hurricane Ignacio	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	On August 30, 2015, from west to east, Hurricane Ignacio was located 515 miles east-southeast of Hilo (County of Hawaiʻi). A swell from the storm generated surf of 10 to 20 feet along the east-facing shores, and 6 to 8 feet along the south-facing shores of all the islands except Lānaʻi. The unusually high surf on eastern shorelines led to the occasional deposited sand and other debris on roadways along the coastlines. There were no reports of serious property damage; however, there was one injury reported on Oʻahu (City and County of Honolulu). All EOCs were monitoring the event. There were direct impacts to Johnston Island and portions of the Northwestern Hawaiian Islands.
September 2 to 9, 2015	Hurricane Jimena	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	On August 30, 2015, from west to east, Hurricane Jimena was located 1,815 miles east-southeast of Hilo. Remnants of Hurricane Jimena moved north of the State. It brought heavy rain and flooding over parts of the State. Roads were closed due to flooding of local streams and creeks. All EOCs were monitoring this event. There were direct impacts to Johnston Island and portions of the Northwestern Hawaiian Islands.
September 22, 2015	Tropical Storm Niala	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	All state and county EOCs were monitoring the event.
October 2 to 5, 2015	Tropical Storm Oho	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	All state and county EOCs were monitoring the event.
October 20 to 23, 2015	Hurricane Olaf	Kauaʻi, City and County of Honolulu, Maui, and Hawaiʻi	A swell from Hurricane Olaf produced surf of 10 to 20 feet along the east-facing shores of the Island of Hawaiʻi, 8 to 12 feet along the east-facing shores of the Island of Maui, and 6 to 9 feet along the south-facing shores of all the major islands of the State of Hawaiʻi. Several roadways were inundated by several inches of water. There were no significant injuries or property damage reported. All EOCs were monitoring the event.

Sources: NOAA-NCEI 2018; FEMA 2018; State of Hawaiʻi 2018; NOAA 2015
Note: Hurricane documentation for the State of Hawaiʻi is extensive and not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.10-3 may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP Update.
DR Major Disaster Declaration (FEMA)
EOC Emergency Operations Center
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic and Atmospheric Administration

FEMA Disaster Declarations

Between 1954 and 2017, FEMA included the State of Hawaiʻi in three hurricane-related disasters (DR) or emergencies (EM). Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2018).

Tropical cyclone events that have affected the state and were declared a FEMA disaster, between 2012 and 2017, are identified in Table 4.11-4. For details regarding all declared disasters, refer to Section 4.1 (Risk Assessment Overview). Refer to Appendix X (Map Atlas) that illustrates the number of tropical cyclone FEMA-declared disasters by county since 1954.

Table 4.11-4. Tropical Cyclone-Related Federal Declarations (2012 to 2017)

Year	Event Type	Date Declared	Federal	Counties Affected
2014	Tropical Storm Iselle	September 12, 2014	DR-4194	Hawaiʻi and Maui

Source: FEMA 2018

Probability of Future Hazard Events

A myth in the State of Hawaiʻi is that the islands that constitute the County of Maui (the Islands of Molokaʻi, Lānaʻi, Kahoʻolawe, and Maui) and the City and County of Honolulu (the Island of Oʻahu) are less vulnerable to a direct hit by a hurricane than the Counties of Kauaʻi and Hawaiʻi. This myth has developed because, until 1950, tropical storms hitting the Hawaiian Islands were not classified as hurricanes. It was not until the advent of weather satellites that the nature of storms in this part of the world was understood to be hurricanes (State of Hawaiʻi HMP 2013). Since 1950, eight tropical cyclones have passed within 65 nautical miles of the State of Hawaiʻi. All islands have been in the direct path of a tropical cyclone at least once (NOAA 2018).

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. A 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 MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events (Dinicola 2009). Utilizing the FEMA Hazus wind model, the peak gust wind speeds for a statewide 100-year MRP event ranges from 88 to 151 mph (Category 1 to 4 wind speeds); and the peak gust wind speeds for a statewide 500-year MRP event ranges from 105 to 173 mph (Category 2 to 5 wind speeds). It is important to note that every hurricane will be unique and wind speeds will vary based on the storm track and present conditions.

For the 2018 HMP Update, the most up-to-date information was collected to calculate the probability of future occurrence of hurricane events, of all magnitudes, in the State of Hawaiʻi. Information from the 2013 State HMP, FEMA, NOAA-NCEI, and the National Hurricane Center were used to identify the number of hurricane events that occurred between 1871 and 2017. Using these resources ensures the most accurate probability estimates possible. Based on historic statistics, the State of Hawaiʻi has a 25.2% chance of a hurricane, of any magnitude (tropical storm, tropical depression, and category 1 through 4 hurricanes), occurring in any given year. Based on historical record, the State of Hawaiʻi has experienced four FEMA declarations associated with hurricanes since

1954. Using these historic statistics, the state may expect to experience a hurricane event that leads to a FEMA declaration once every 16 years (a 3.1% chance of receiving a FEMA declaration in any given year).

Impacts of Climate Change on Future Probability

Hurricanes and tropical storms are projected to grow in average size and strength due to climate change and rise in sea level. Waves generated by these systems are anticipated to cause coastal erosion and flooding, which will be worsened by sea level rise. More frequent El Niño events are also projected, increasing tropical cyclone activity and corresponding waves, flooding, and erosion for the state (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017; Cai et al. 2014). In addition, changes detected in the prevailing wind over the Hawaiian Islands, the northeast trade wind, may shift large-scale pressure and wind patterns that impact the State of Hawaiʻi (Garza et al., 2012). The shift in trade winds may shift the track of future storm events such as tropical cyclones.

For details regarding climate change as a distinct hazard and its unique impacts to the State of Hawaiʻi, refer to Section 4.2 (Climate Change and Sea Level Rise).

4.11.2 Vulnerability Assessment

According to the 2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi Catastrophic Annex, a hurricane of any size and duration may pose a threat to the infrastructure, environment and economy and impact the daily lives of residents. This is because of the State's geographic location and isolation which requires high dependence on maritime cargo to maintain and sustain its economic vitality. In addition, the State is densely populated along its coastal shores. Thus, the State's population, property and economy are highly vulnerable to storm surge and high winds which are the main threats of a hurricane.

Hurricane Hazard Area Definition

Wind – *To assess the state's vulnerability to the hurricane wind hazard, a statewide Category 4 hurricane scenario was run in Hazus to estimate potential losses.*

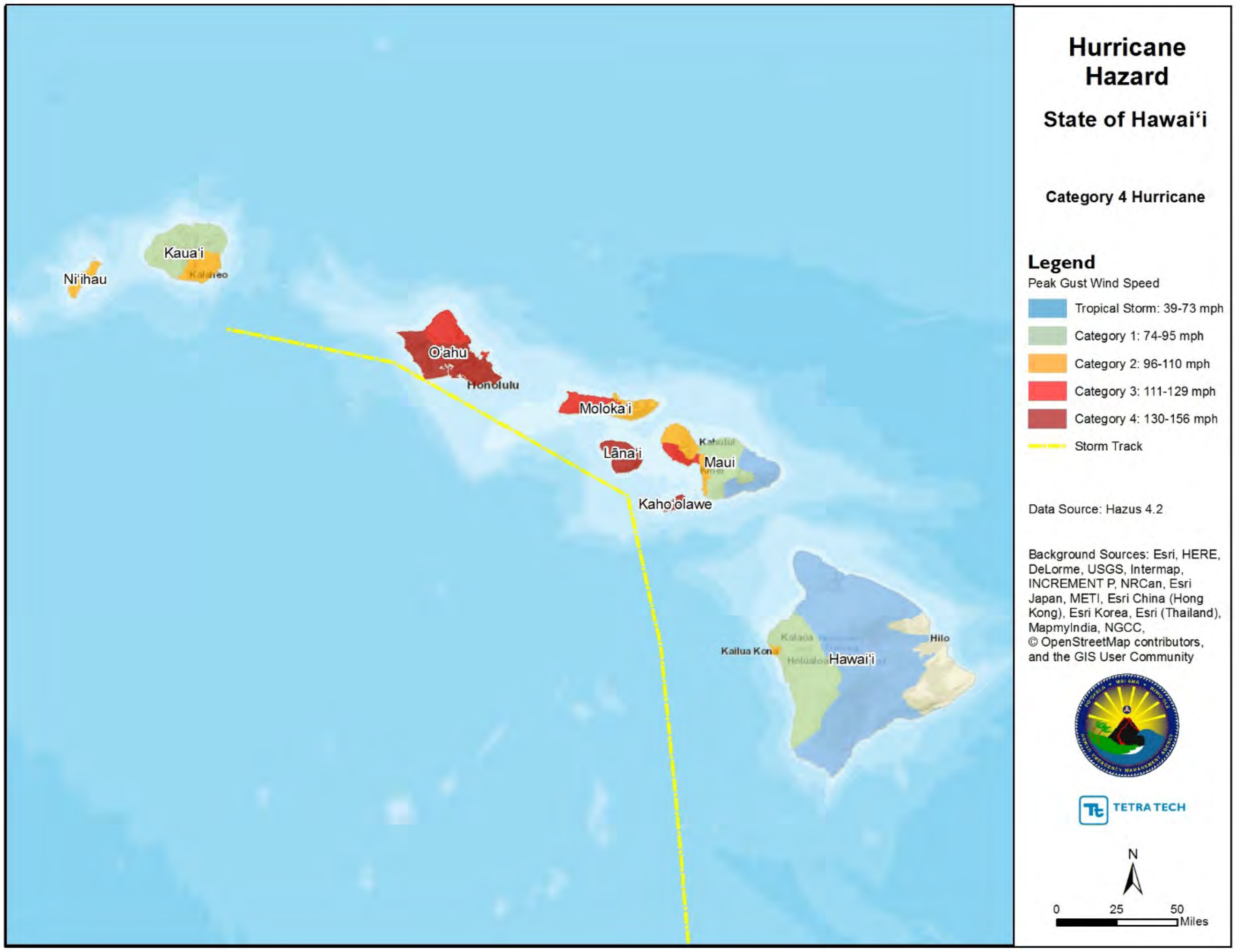
Storm Surge – *To assess the state's vulnerability to storm surge, the Category 4 SLOSH data was used to estimate exposure. The hazard area is called the Category 4 SLOSH Inundation Area.*

** The two datasets referenced above are not directly connected and should be used to evaluate vulnerability separately.*

For the 2018 HMP Update, the following two analyses were conducted to assess hurricane vulnerability:

1. For the wind component of the hurricane hazard, a statewide Category 4 hurricane scenario was run in FEMA's Hazus wind model to estimate potential losses. This scenario was created for the 2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi Catastrophic Annex, with a specific storm track and wind speeds. Figure 4.11-3 below displays the storm track and wind speeds associated with the evaluated scenario. These results are reported below. Four Category 4 county-specific hurricane scenarios were also run in Hazus and general building stock losses and sheltering estimates are included in Appendix X.

Figure 4.11-3. Category 4 Hurricane Statewide Scenario



2. The NOAA National Hurricane Center provided the Sea, Lake and Overland Surges from Hurricanes (SLOSH) Model data for the State of Hawaiʻi. The storm surge inundation areas were created by multiple analysis runs for hurricanes approaching the State of Hawaiʻi from different directions and retaining the highest inundation value at a given location (the maximum of maximums) for each hurricane Category 1 through 4. The SLOSH data is a non-regulatory product, meaning it is not used to determine flood insurance rates. The data promotes storm surge risk awareness. This data was overlaid with the state assets to determine exposure to storm surge.

The two datasets referenced above are not directly connected. The wind data was used to determine general building stock losses, displaced households and shelter needs in the state resulting from a Category 4 hurricane. The storm surge data was used to determine exposure of state assets, critical facilities, population, general building stock, and environmental resources and culture assets to the hazard.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the hurricane hazard.

State Assets

All state buildings are exposed to the wind and rain associated with a hurricane event. The spatial analysis utilizing the SLOSH data determined there are 654 state buildings (10.7%) located in the Category 4 SLOSH inundation area; of which the greatest number are located in the City and County of Honolulu (503 buildings with a replacement cost value of $2.672 billion). The majority of these buildings are occupied by the Department of Education buildings. Table 4.11-5 summarizes the state buildings located in the Category 4 SLOSH inundation area by county; Table 4.11-6 summarizes by agency. Estimated potential losses to state buildings as a result of the storm surge Category 4 hurricane were not calculated as part of the 2018 HMP Update.

Table 4.11-5. State Buildings Located in the Category 4 SLOSH Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total State Buildings	Total Value of State Buildings in Hazard Area	Percent (%) of Total Value
County of Kauaʻi	531	$957,679,537	82	15.4%	$150,412,802	15.7%
City and County of Honolulu	3,472	$16,750,785,426	503	14.5%	$2,672,078,167	15.9%
County of Maui	831	$2,862,316,819	51	6.1%	$159,482,279	5.6%
County of Hawaiʻi	1,261	$4,209,774,236	18	1.4%	$76,190,807	1.8%
Total	**6,095**	**$24,780,556,017**	**654**	**10.7%**	**$3,058,164,055**	**12.3%**

Source: Hawaiʻi State Risk Management Office 2017; NOAA National Hurricane Center 2018
Notes: Total Value = Replacement cost value of the structure and contents
SLOSH Sea, Lake and Overland Surges from Hurricanes

Table 4.11-6. State Buildings Located in the Category 4 SLOSH Inundation Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total State Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	11	16.7%	$162,035,162	17.1%
Dept of Agriculture	70	$133,065,375	0	0.0%	$0	0.0%
Dept of Attorney General	15	$95,151,863	13	86.7%	$24,444,262	25.7%
Dept of Budget & Finance	16	$26,624,294	4	25.0%	$27,501,719	103.3%
Dept of Business, Economic Development and Tourism	25	$612,574,032	3	12.0%	$20,071,906	3.3%
Dept of Commerce & Consumer Affairs	2	$35,611,360	6	300.0%	$529,204,718	1486.1%
Dept of Defense	69	$246,099,477	9	13.0%	$26,767,373	10.9%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total State Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Education	4,090	$9,604,111,443	403	9.9%	$818,917,910	8.5%
Dept of Hawaiian Home Lands	12	$100,471,477	1	8.3%	$4,748,597	4.7%
Dept of Health	44	$387,068,440	3	6.8%	$7,922,830	2.0%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%
Dept of Human Services	130	$420,004,555	29	22.3%	$154,851,502	36.9%
Dept of Labor and Industrial Relations	22	$79,322,626	4	18.2%	$52,739,884	66.5%
Dept of Land and Natural Resources	90	$98,666,185	26	28.9%	$12,052,509	12.2%
Dept of Public Safety	154	$427,884,909	15	9.7%	$32,889,853	7.7%
Dept of Taxation	1	$6,864,408	1	100.0%	$6,864,408	100.0%
Dept of Transportation	68	$2,912,510,888	40	58.8%	$384,036,949	13.2%
Hawaiʻi State Ethics Commission	1	$891,212	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	1	0.9%	$829,553	0.1%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	5	5.8%	$118,247,972	35.5%
Hawaiʻi Public Housing Authority	273	$933,255,767	37	13.6%	$82,190,258	8.8%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%
Hawaiʻi State Public Library System	53	$525,584,082	11	20.8%	$32,473,857	6.2%
Judiciary	41	$511,093,204	7	17.1%	$73,951,176	14.5%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	6	54.5%	$42,915,963	79.5%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawaiʻi	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawaiʻi	637	$5,000,692,783	19	3.0%	$442,505,696	8.8%
Total	**6,095**	**$24,780,556,017**	**654**	**10.7%**	**$3,058,164,055**	**12.3%**

Source: *Hawaiʻi State Risk Management Office 2017; NOAA National Hurricane Center 2018*

Notes *Dept* *Department*
NOAA *National Oceanic and Atmospheric Administration*
SLOSH *Sea, Lake and Overland Surges from Hurricanes*

Roads and bridges are also considered critical infrastructure, particularly those providing ingress and egress for evacuees and those allowing emergency vehicles access to those in need. Throughout the State, roads may become flooded as a result of storm surge inundation. The roads may be undermined or fully submerged under water for a period, thus degrading the integrity of the road and isolating population and communities. Sometimes the damage is apparent—a road that washes away, a sinkhole that appears, a bridge that crumbles, but often the damage is less obvious on the surface. Table 4.11-7 summarizes the length of state road in the Category 1 through 4 hurricane storm surge inundation areas by county. A complete list of state roads located in Category 1 through 4 hurricane storm surge inundation areas is included in Appendix X.

Table 4.11-7. State Roads Exposed to SLOSH Inundation Areas by County

County	Total Length (Sq. Miles)	Cat 1		Cat 2		Cat 3		Cat 4	
		Length	Percent (%) of Total	Length	Percent (%) of Total	Length	Percent (%) of Total	Length	Percent (%) of Total
County of Kauaʻi	104.0	2.6	2.5%	4.2	4.1%	8.9	8.6%	12.5	12.0%
City and County of Honolulu	375.3	14.7	3.9%	26.5	7.1%	34.2	9.1%	43.3	11.5%
County of Maui	238.6	7.3	3.0%	11.7	4.9%	16.9	7.1%	19.9	8.3%
County of Hawaiʻi	378.7	0.1	0.0%	0.1	0.0%	0.4	0.1%	1.8	0.5%
Total	**1,096.5**	**24.6**	**2.2%**	**42.4**	**3.9%**	**60.4**	**5.5%**	**77.4**	**7.1%**

Source: Hawaiʻi Department of Transportation State Routes GIS layer 2017; NOAA National Hurricane Center 2018

Notes:
% Percent
Cat 1 Category 1 Hurricane
Cat 2 Category 2 Hurricane
Cat 3 Category 3 Hurricane
Cat 4 Category 4 Hurricane
GIS Geographic Information System
NOAA National Oceanic and Atmospheric Administration
Sq. Miles = Square Miles
SLOSH Sea, Lake and Overland Surges from Hurricanes

Critical Facility

A hurricane event could result in significant impacts to critical facilities including airports, harbors, transportation and utility infrastructure and other public services. The interruption of these critical services and operations utility will impact resident and visitor travel, and all forms of economic activity. According to the Oahu Metropolitan Planning Organization *Transportation Asset Climate Change Risk Assessment* report, in terms of vessels, there is sufficient warning time associated with a hurricane to direct out to sea until the storm passes. Of greater concern is the effect of storm surge on the piers and storage areas, as well as containers that could fall into Honolulu Harbor, blocking ships from accessing the piers themselves. The largest disruption would be to the supply chain (i.e., food, goods materials and fuel) with cascading impacts statewide (SSFM International 2011).

The Port of Honolulu is the single major supply port for the State. All petrol products arrive by sea. In addition, millions of tons of food and supplies enter the port each year. The ports and electrical systems are interdependent and a disaster event such a hurricane that may close or damage port assets will result in impacts cascading throughout the State (HI-EMA 2018).

The Honolulu International Airport is the largest airport in the state and accommodates approximately 60% of the state's air passengers. The airport is approximately 13 feet above sea level. In the event of a severe hurricane event, it is estimated the airport would experience one-to-two-week downtime from commercial flights and one-to-three days of downtime for emergency response. Due to the City and County of Honolulu's population, tourism and employment base, damage to the airport could have long-term, devastating social and economic consequences to the island and the entire state (SSFM International 2011).

Table 4.11-8 and Table 4.11-9 summarize the critical facilities located in the Category 4 SLOSH inundation area. The City and County of Honolulu has the largest number of critical facilities (134) located within the Category 4 SLOSH inundation area. Of the core critical facility types, the water, waste, and wastewater systems category has the greatest number of facilities exposed. Additional Category 1 through 3 hurricane storm surge analyses on critical facilities are included in Appendix X. Economic loss resulting from impacts to critical facilities was not monetized as part of the 2018 HMP Update.

Table 4.11-8. Critical Facilities Located in the Category 4 SLOSH Inundation Areas by County

County	Core Category of Critical Facilities										Total Number of Facilities in the Hazard Area
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	0	1	4	2	2	2	0	4	2	8	25
City and County of Honolulu	10	17	8	23	1	9	6	13	2	45	134
County of Maui	0	3	4	0	0	5	5	4	7	10	38
County of Hawaiʻi	0	0	0	1	4	1	0	2	5	7	20
Total	**10**	**21**	**16**	**26**	**7**	**17**	**11**	**23**	**16**	**70**	**217**

Source: *Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; NOAA National Hurricane Center 2018*
Notes: *NOAA National Oceanic and Atmospheric Administration*
SLOSH Sea, Lake and Overland Surges from Hurricanes

Table 4.11-9. Critical Facilities Located in the Category 4 SLOSH Inundation Areas by Core Category

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	10	16.7%	$25,019,578	12.1%
Communications	130	$523,848,060	21	16.2%	$55,921,705	10.7%
Emergency Services	149	$1,017,628,710	16	10.7%	$91,293,940	9.0%
Energy	90	$2,591,975,628	26	28.9%	$733,367,393	28.3%
Food & Agriculture	39	$829,869,410	7	17.9%	$82,119,490	9.9%
Government Facilities	100	$399,781,575	17	17.0%	$66,636,460	16.7%
Healthcare & Public Health	193	$3,399,521,375	11	5.7%	$116,740,353	3.4%
Mass Care Support Services	353	$11,497,547,155	23	6.5%	$573,263,005	5.0%

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Transportation Services	56	$1,739,256,960	16	28.6%	$496,930,560	28.6%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	70	23.0%	$2,185,480,320	23.1%
Total	**1,475**	**$31,687,768,838**	**217**	**14.7%**	**$4,426,772,803**	**14.0%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; NOAA National Hurricane Center 2018
Notes: Hazus Hazards-U.S.
NOAA National Oceanic and Atmospheric Administration
SLOSH Sea, Lake and Overland Surges from Hurricanes

Assessment of Local Vulnerability and Potential Losses

For this vulnerability assessment, it is assumed that the entire State of Hawaii's resident and visitor population and property is exposed to the hurricane hazard, though the impact of a hurricane/tropical cyclone on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided.

Population

As noted, the entire population in the State is vulnerable to the hurricane hazard. Downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Storm surge inundation is a significant threat to the population along the coast. To estimate the population that may be impacted by a Category 4 hurricane event, the FEMA Hazus wind model was used to estimate displacement and sheltering needs, and the SLOSH Category 4 spatial layer was used to estimate the population along the coast located in the inundation area. It is recognized that combining the population from these separate analyses may overestimate the vulnerable population. Refer to Table 4.11-10 below.

Table 4.11-10. Estimated Population Impacted by a Category 4 Hurricane

County	Total Population	SLOSH Category 4		Hazus Wind (Category 4)	
		Population Located in the Storm Surge Area	Percent (%) of Total Population	Displaced Households from Wind	Short-Term Sheltering Needs
County of Kauaʻi	67,091	5,974	8.9%	560	126
City and County of Honolulu	953,207	144,981	15.2%	111,830	24,234
County of Maui	154,924	3,808	2.5%	2,179	484
County of Hawaiʻi	185,079	663	0.4%	211	45
Total	**1,360,301**	**155,426**	**11.4%**	**114,780**	**24,889**

Source: U.S. Census 2010; 2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi Catastrophic Annex; NOAA National Hurricane Center 2018
Notes: FEMA Federal Emergency Management Agency

Hazus Hazards-U.S.
NOAA National Oceanic and Atmospheric Administration
SLOSH Sea, Lake and Overland Surges from Hurricanes
It is recognized that combining the population from these separate analyses may overestimate the vulnerable population.

As a result of the statewide Category 4 Hazards-U.S. (Hazus) wind analysis, the City and County of Honolulu has the greatest number of estimated displaced households and the greatest number of short-term sheltering needs. It is important to note that these sheltering estimates are based on Census population. This analysis does not include the tourist and visitor population in the State and therefore sheltering needs may be higher.

Socially vulnerable populations are most susceptible, based on many 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 likely to evaluate their risk and make decisions based on the major economic impact to their family, and may not have funds to evacuate. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available during a storm event.

Floods resulting from a hurricane and its aftermath present numerous threats to public health and safety including unsafe food, contaminated drinking and washing water and poor sanitation, mosquitoes and animals, mold and mildew, carbon monoxide poisoning and mental stress and fatigue. Refer to Section 4.6 (Event-Based Flood) for further details on these impacts. Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to hurricane events.

Land Use Districts

Table 4.11-11 summarizes the square miles and percent of total area in each State Land Use District statewide exposed to the Category 4 hurricane storm surge inundation area; refer to Appendix X for results by County. Overall the City and County of Honolulu has the greatest area of land, with a majority in the Urban District, located in the Category 4 SLOSH inundation area (6.5% of the total land in the County). It is notable that more than 11% of the Urban District land in the State is exposed to storm surge impacts from a Category 4 hurricane, especially when considering that only 2.5% of the Urban District land area statewide is located in coastal high hazard areas with mandatory construction standards that account for wave action (see Section 4.6 Event-Based Flood for more information). The land use with the greatest exposure to Category SLOSH in the Counties of Kauaʻi and Maui is agricultural land. Only a very small amount of Conservation District lands are exposed statewide. Conservation District Lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the Environmental Resources section below.

Table 4.11-11. State Land Use Districts Located in Category 4 SLOSH Inundation Area

Land Use District	Total (square miles)	Square Miles in Category 4 SLOSH Area	% of Total Area
Agricultural	2,942.8	18.1	0.6%
Conservation	3,156.3	11.7	0.4%
Rural	16.1	1.3	8.0%
Urban	319.7	37.5	11.7%
Total	**6,434.9**	**68.6**	**1.1%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal; NOAA National Hurricane Center 2018
Notes: Total area calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
GIS Geographic Information System
NOAA National Oceanic and Atmospheric Administration

General Building Stock

All structures in the Stare are exposed to the hurricane hazard. Hurricane-force winds (74 mph or higher) can destroy buildings and mobile homes. Street signs, roofing material, siding and small items left outside become flying objects during a storm and not only cause property damage but may injure residents. Exposure is particularly severe along the coastline and in areas prone to riverine flooding, due to the heavy rains that accompany these storm events, and or high wind gusts. Damages to buildings can displace people from their homes, threaten life safety and impact a community's economy and tax base.

Once all counties adopt the Hawaiʻi State Building Code, it requires new structures to be built to withstand a Category 3 hurricane wind speed. The Category 4 hurricane storm surge inundation areas may extend beyond the boundaries of regulatory flood zones discussed in Section 4.6, meaning that currently enforced standards offer some level of protection, but are likely not sufficient to prevent damage from a Category 4 hurricane in many areas. Information regarding the year built and current building conditions was not factored into this analysis.

Table 4.11-12 summarizes the number of buildings located in the Category 4 storm surge inundation area based on the spatial analysis and the estimated potential losses to structures from Category 4 winds generated by Hazus. Overall, the City and County of Honolulu has the highest percent (21.8%) of building exposure to Category 4 hurricane storm inundation, followed by the County of Kauaʻi (12.7% of the county total building stock replacement cost value). The Hazus wind analysis estimates greater than $43 billion in potential building loss in the City and County of Honolulu (26.3% of their total building inventory) as a result of the Category 4 hurricane scenario evaluated. All counties are estimated to experience millions in building damages.

Table 4.11-12. General Building Stock Exposure to Hurricane

		SLOSH Category 4		Hazus Wind (Category 4)	
County	Total RCV	RCV in Cat 4 SLOSH area	Percent (%) of Total RCV	Estimated Loss of RCV	Percent (%) of Total RCV
County of Kauaʻi	$13,287,882,000	$1,685,509,000	12.7%	$517,583,242	3.9%
City and County of Honolulu	$164,787,212,000	$35,544,372,000	21.6%	$43,368,365,552	26.3%
County of Maui	$31,320,693,000	$1,737,860,000	5.5%	$1,422,607,990	4.5%
County of Hawaiʻi	$33,326,392,000	$428,845,000	1.3%	$292,099,951	0.9%
Total	**$242,722,179,000**	**39,396,586,000**	**16.2%**	**$45,600,656,734**	**18.8%**

Source: 2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi Catastrophic Annex, NOAA National Hurricane Center 2018; Hazus v.4.2
Notes: Cat Category
FEMA Federal Emergency Management Agency
Hazus Hazards-U.S.
NOAA National Oceanic and Atmospheric Administration
RCV Replacement cost value
SLOSH Sea, Lake and Overland Surges from Hurricanes
The results from the SLOSH and wind analyses cannot be combined to estimate total vulnerability; the SLOSH is an exposure with the total value summed for all buildings; whereas the Hazus wind analysis is an estimate of only structural building damage.

Environmental Resources

The State has numerous environmental resources located along the shore including beaches, wetlands, critical habitats (or habitats that are known to be essential for an endangered or threatened species) and parks and reserves. Further, natural features such as coral reefs, wetlands, beaches and dunes provide protection from storms and rising sea levels (Carey 2014). Impacts to these assets will not only damage the natural environment but also have cascading impacts on the economy. Refer to the *Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report* which further outlines impacts of flooding, storm surge and sea level rise on the natural environment including coral reefs and endangered and threatened species such as the Hawaiian monk seal and Hawaiian green turtle. Table 4.11-13 summarizes the environmental assets located in the Category 4 hurricane storm surge area.

Table 4.11-13. Environmental Assets Located in the Category 4 SLOSH Storm Surge Inundation Area

Environmental Asset	Statewide		
	Total Square Miles of Asset	Square Miles in Hazard Area	% of Total Asset Area
Critical Habitat[a]	915.2	1.0	0.1%
Wetlands	260.0	16.8	6.4%
Parks and Reserves	2,607.7	10.3	0.4%
Total	**3,782.9**	**28.1**	**<1%**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; NOAA National Hurricane Center 2018
Notes: a. Critical area mileage includes the combined area of coverage of individual critical habitat areas
GIS Geographic Information System
NOAA National Oceanic and Atmospheric Administration

Due to its geographic location and isolation, the state faces unique challenges in addressing disaster debris. With limited landfill capacity, advanced planning for large amounts of debris generated by a hurricane, which will include both tree debris and construction debris, is critical.

Cultural Assets

Cultural and historical resources are located near the shore and vulnerable to storm surge inundation. Beaches may erode impacting fishing and cultural practices. Portions of the Hawaiian Home Lands may become flooded due to storm surge inundation. Table 4.11-14 summarizes the area of Hawaiian Home Lands located in the SLOSH Category 1 through 4 hurricane storm surge inundation areas.

Table 4.11-14. Hawaiian Home Lands Located in the SLOSH Category 1 through 4 Storm Surge Inundation Areas

County	Area (in square miles)								
	Total Area	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi	32.0	0.1	0.5%	0.2	0.6%	0.3	1.1%	0.4	1.2%
City and County of Honolulu	10.9	0.0	0.3%	0.0	0.4%	0.1	1.0%	0.1	1.3%
County of Maui	92.6	1.4	1.5%	1.6	1.7%	1.7	1.8%	1.7	1.8%
County of Hawaiʻi	190.3	0.1	0.0%	0.1	0.0%	0.1	0.1%	0.2	0.1%

County	Area (in square miles)								
	Total Area	Cat 1 Hazard Area	Hazard Area as % of Total Area	Cat 2 Hazard Area	Hazard Area as % of Total Area	Cat 3 Hazard Area	Hazard Area as % of Total Area	Cat 4 Hazard Area	Hazard Area as % of Total Area
Total	**325.8**	**1.6**	**0.5%**	**1.9**	**0.6%**	**2.2**	**0.7%**	**2.4**	**0.7%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal; NOAA National Hurricane Center 2018

Notes:

%	*Percent*
Cat 1	*Category 1 Hurricane*
Cat 2	*Category 2 Hurricane*
Cat 3	*Category 3 Hurricane*
Cat 4	*Category 4 Hurricane*
GIS	*Geographic Information System*
NOAA	*National Oceanic and Atmospheric Administration*
SLOSH	*Sea, Lake and Overland Surges from Hurricanes*

FUTURE CHANGES THAT MAY IMPACT STATE VULNERABILITY

Understanding factors of change that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Potential or Projected Development

Category 4 storm surge inundation areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.11-15 below; refer to Section 3 for more information on projected development areas; see Appendix X for Category 1 through 3). The results of this analysis indicate that significant amounts of the HCDA Community Development District areas are exposed to storm surge from a Category 4 hurricane event. In addition, development in coastal areas of the Enterprise Zones throughout the State would be impacted. It is important to note that the Category 4 hurricane storm surge inundation areas may extend beyond the boundaries of regulatory flood zones discussed in Section 4.6, meaning that currently enforced standards offer some level of protection, but are likely not sufficient to prevent damage from a Category 4 hurricane in many areas. This is especially important for areas that experience 1.5 feet or greater wave heights due to their damaging effects on structures.

In addition to storm surge, any new development will be subject to impacts from winds associated with a hurricane event. Building codes for new construction in the State requires greater protection from high wind events than those codes that were previously enforced in the State.

Projected Changes in Population

As the population in the State ages, additional resources may be needed to support evacuation efforts in advance of a hurricane and to support emergency power for medically necessary equipment during and after an event.

Other Factors of Change

As sea levels rise storm surge will reach further inland putting more people and property at risk. The storm surge modeling used for this assessment did not include projected sea level rise; however, increased exposure to storm surge and coastal flooding as a result of sea level rise is discussed in Section 4.2 (Climate Change and Sea Level Rise).

Table 4.11-15. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in Category 4 SLOSH Hurricane Areas

	Area (in square miles)								
County	HCDA Community Development Districts (Total area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kauaʻi	-	-	-	-	-	-	252.3	10.4	4.1%
City and County of Honolulu	7.4	1.4	19.5%	-	-	-	288.3	21.4	7.4%
County of Maui	-	-	-	27.6	0.1	0.2%	1,016.7	11.6	1.1%
County of Hawaiʻi	-	-	-	-	-	-	1,286.6	3.6	0.3%
Total	**7.4**	**1.4**	**19.5%**	**27.6**	**0.1**	**0.2%**	**2,843.9**	**47.1**	**1.7%**

Notes: Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (2) Maui Development Projects GIS layer from Maui County Planning Department (3) Enterprise Zones from Community Economic Development Program, DBEDT
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
% Percent
SLOSH Sea, Lake and Overland Surges from Hurricanes

SECTION 4. RISK ASSESSMENT

4.12 Landslide and Rockfall

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Landslide events, including rockfalls and mudslides, that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for the 2018 HMP Update. Due to the severity of recent events, the April 2018 event is also discussed; however, details regarding monetized impacts are not available at the time of this plan update.
- Landslide susceptibility maps for each county have been added and used to assess exposure in the vulnerability assessment.

4.12.1 Hazard Profile

Hazard Description

Landslide is the broad term that involves the downward and outward movement of soil and/or rock. Landslides may be differentiated by the kinds of materials involved and the type of slope movement. The types of movements are: flows, topples, slumps, slides, creeps and falls (USGS 2004). Figure 4.12-1 illustrates the movement mechanisms in graphical form. For the purposes of the 2018 HMP Update, this section focuses on landslides (inclusive of all types of soil movement and debris flow) and rockfalls.

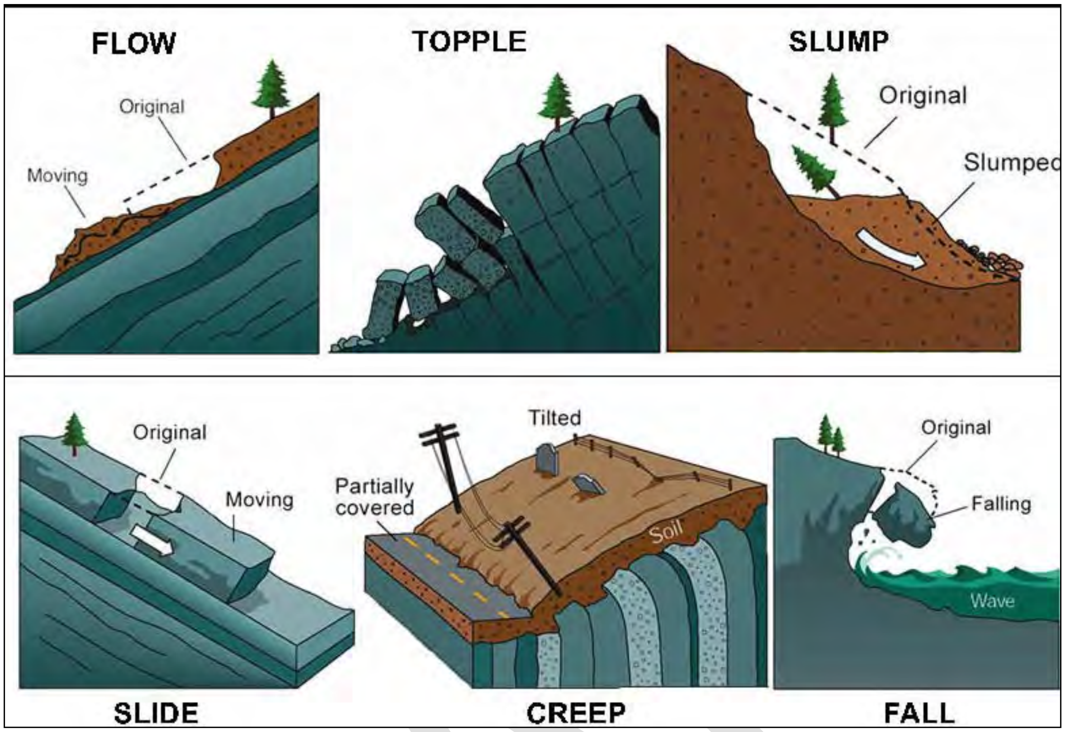
Summary of Key Terms

Landslide – *The movement of a mass of rock and/or soil down a slope.*

Debris Flow (Mudslide) – *A form of rapid mass movement in which a combination of loose soil, rock, organic matter, air, and water mobilize as a slurry that flows downslope.*

Rockfall – *The falling of newly detached mass of rock from a cliff or down a very steep slope.*

Figure 4.12-1. Types of Landslides



Source: State of Hawaiʻi HMP 2013

While there are many factors that cause landslides and rockfalls, the following cause the most damage and are prevalent in the State of Hawaiʻi include: water, seismic activity, volcanic activity and human activity.

- **Water** – Slope saturation by water in the form of intense rainfall, changes in groundwater level, and water level changes along coastlines, earthen dams, and the banks of lakes, reservoirs, and rivers are the primary cause of landslides and rockfalls. Landslides and flooding are closely related because both are related to precipitation, runoff and the saturation of ground from water. They often occur simultaneously in the same area (USGS 2004).
- **Seismic Activity** – Earthquakes occurring in landslide-prone areas greatly increases the likelihood that landslides will occur, either due to ground shaking alone or shaking-caused dilation of soil materials. Rockfalls can also occur as a result of earthquakes because the shaking loosens rocks (USGS 2004).
- **Volcanic Activity** – Landslides caused by volcanoes are some of the most devastating types of landslides. Landslides are common on volcanic cones because they are tall, steep, and weakened by the rise and eruption of molten rock. Magma releases volcanic gases that partially dissolve in groundwater, resulting in a hot acidic hydrothermal system that weakens rock by altering minerals to clay. Furthermore, the mass of thousands of layers of lava and loose fragmented rock debris can lead to fault zones that move frequently (USGS 2004).
- **Human Activity** – Landslides and rockfalls may result directly or indirectly from human activities. Construction activity that undercuts or overloads dangerous slopes, or that redirects the flow of surface or groundwater can trigger slope failures.

Landslides

Landslides are a mass movement of material, where there is a distinct zone of weakness that separates the slide material from the more stable underlying material (USGS 2004). Several features on land may be noticeable prior to a landslide. These features include:

- Springs, seeps, or saturated ground appears in areas usually not wet
- New cracks or unusual bulges in the ground, street pavements, or sidewalks
- Soil moves away from foundations
- Ancillary structures (e.g. decks) tilt or move relative to the house
- Concrete floors or foundations tilt or crack
- Water lines and other underground utilities break
- Telephone poles, trees, retaining walls, or fences tilt
- Roadbeds sink, or drop down (State of Hawaiʻi HMP 2013)

Debris flows, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are common types of fast-moving landslides and occur in a wide variety of environments. Flows are characterized by shear strains distributed throughout the mass of material. Flows are distinguished from slides by high water content and the distribution of velocities resembles that of viscous fluids. These flows are a form of rapid mass movement in which loose soils, rocks, and organized matter, combined with air and water, form slurry that flow down-slope. These flows generally occur during periods of intense rainfall (State of Hawaiʻi HMP 2013).

Rockfall

Rockfall may be initiated through a combination of weathering, fracture and the presence of a steep slope. Physical weathering is the breaking up of rock by physical disintegration. Examples physical weathering are stream erosion, wave erosion or the fragmentation of rock faces caused by the enlargement of fractures. Physical and chemical weathering between rock formation boundaries may be aided by withdrawal of support underlying lava flows. Larger lava tubes may collapse, rendering the surrounding rock unstable and prone to more physical weathering. Wave action occurring during higher sea levels over geologic time may rapidly increase the rate of physical weathering and undermining by removal of loose rock or clinker zones and enlargement of lava tubes and pre-existing fractures. Because of withdrawal of underlying support, stresses on vertical joints and fractures may increase over time, enlarging the fracture/joint spaces, and concurrently increasing the surface area available for chemical weathering (State of Hawaiʻi HMP 2013).

Location

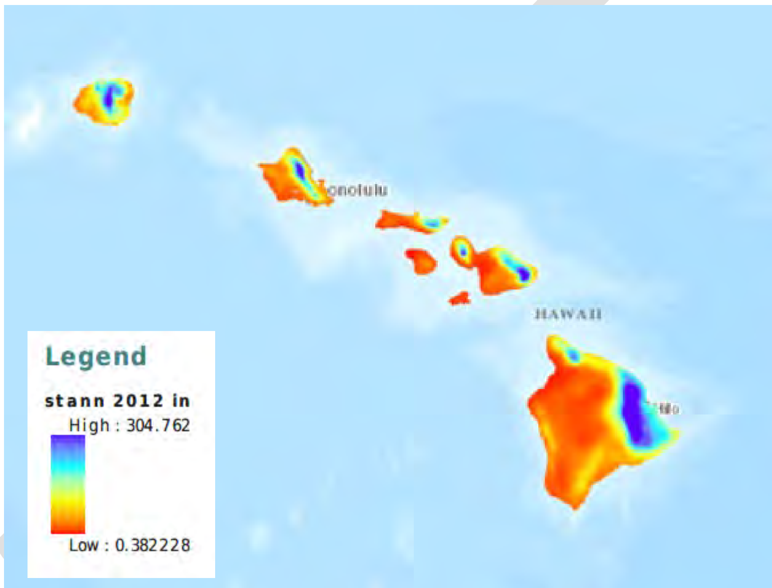
The State of Hawaiʻi has several characteristics that make it susceptible to landslides and rockfalls: steep hillsides, heavy rainfall, and residential development and other types of construction in upland areas. Areas that may be considered prone to landslides and rockfalls may include the following:

- On existing old landslides
- On or at the base of slopes
- In or at the base of minor drainage hollows
- At the base or top of an old fill slope

- At the base or top of a steep cut slope (State of Hawaiʻi HMP 2013)

Heavy or prolonged rainfall is the main source of landslide and rockfall initiation in the state (State of Hawaiʻi HMP 2013). These events generally occur during or immediately after severe rainfall of more than 3 inches in a peak 6-hour period. Figure 4.12-2 illustrates the State of Hawaii's average annual rainfall total in inches from 1920 to 2012. In general, high mean rainfall is found on the windward side of the mountains, and low rainfall prevails in leeward lowlands and on the upper slopes of the highest mountains.

Figure 4.12-2. Average Annual Rainfall in the State of Hawaiʻi, 1920 to 2012



Source: Frazier et al 2015

Wildfire locations and/or vegetation that has been destroyed on slopes are particularly vulnerable to landslides during and after heavy rain events (CDC 2018). Refer to Section 4.14 (Wildfire) for further discussion on high risk wildfire areas in the state.

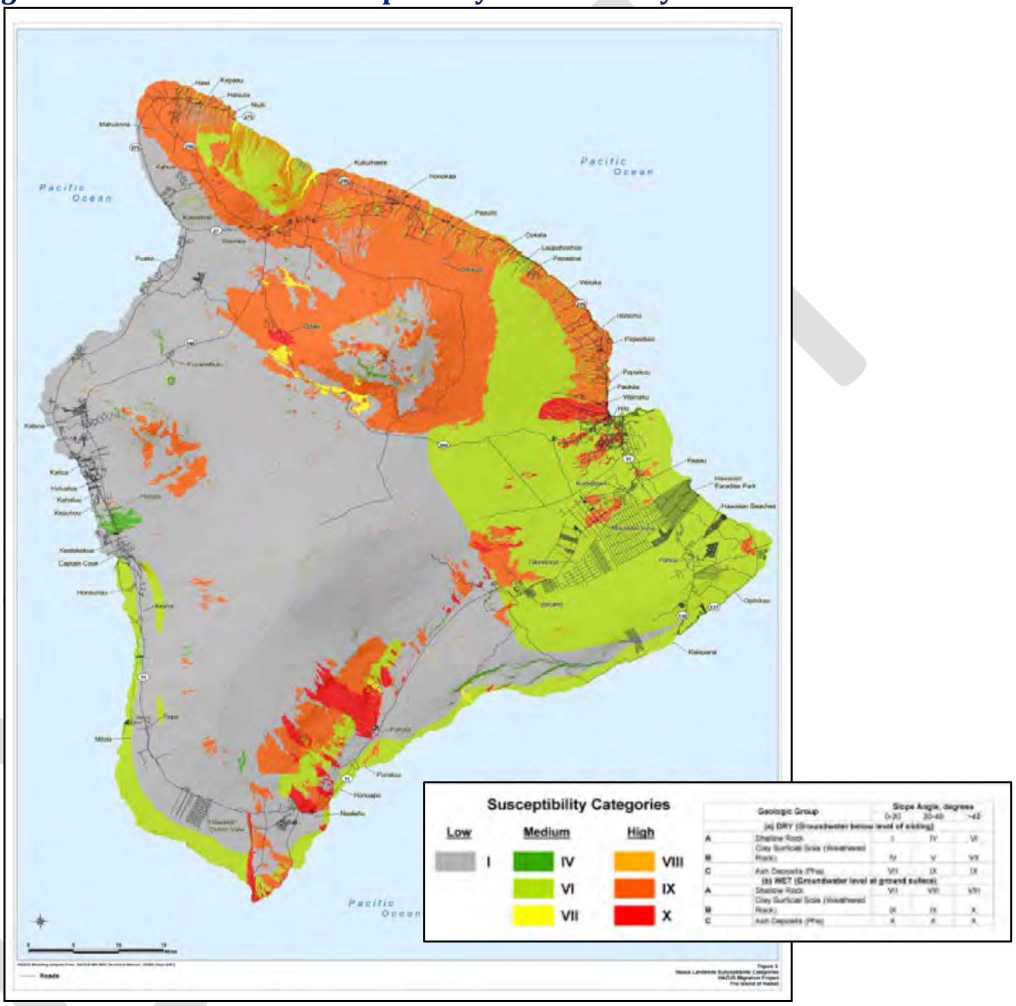
Areas with higher risk to landslide were determined for the County of Hawaiʻi by spatially categorizing slope, soil type and moisture content. The following summarizes the criteria used to characterize landslide susceptibility in the county; refer to Figure 4.12-3 which illustrates the aggregate of these results depicted as high, moderate and low landslide susceptibility areas in the County of Hawaiʻi.

- **Slope**
  - Low Susceptibility – Slope less than 20 degrees
  - Moderate Susceptibility – Slope of 20 to 40 degrees
  - High Susceptibility – Slope greater than 40 degrees
- **Geology**
  - Low Susceptibility - Shallow rock, fresh volcanics
  - Moderate Susceptibility – Clay surficial soils, weathered rock

- High Susceptibility – Weak soft soils, ash deposits, mapped historic slide talus

- **Soil Moisture** - Soil moisture assignments are derived from NOAA rainfall mapping of the island since regional groundwater and soil moisture data is unavailable island wide. Areas receiving greater than 2000 mm (78.7 inches) annual precipitation are considered wet soil, corresponding largely to the windward side of the island. In addition, coastal areas below elevations of 200 feet are considered wet due to potential groundwater seepage gradients from higher elevations, except in the arid Kona coast areas.

***Figure 4.12-3.* Landslide Susceptibility in the County of Hawaiʻi**



Source: State of Hawaiʻi HMP 2013

The County of Hawaii's landslide susceptibility data was provided by the PDC to spatially assess risk for the 2018 HMP Update risk assessment. This data has not been generated for the County of Kauaʻi, City and County of Honolulu and County of Maui. To determine the areas at greatest risk to landslide for these three counties, slope was calculated using a USGS 10-meter DEM. Areas of slope were assigned low, moderate and high landslide susceptibility categories to align with the slope categories for the County of Hawaiʻi. This data is considered suitable for planning purposes only.

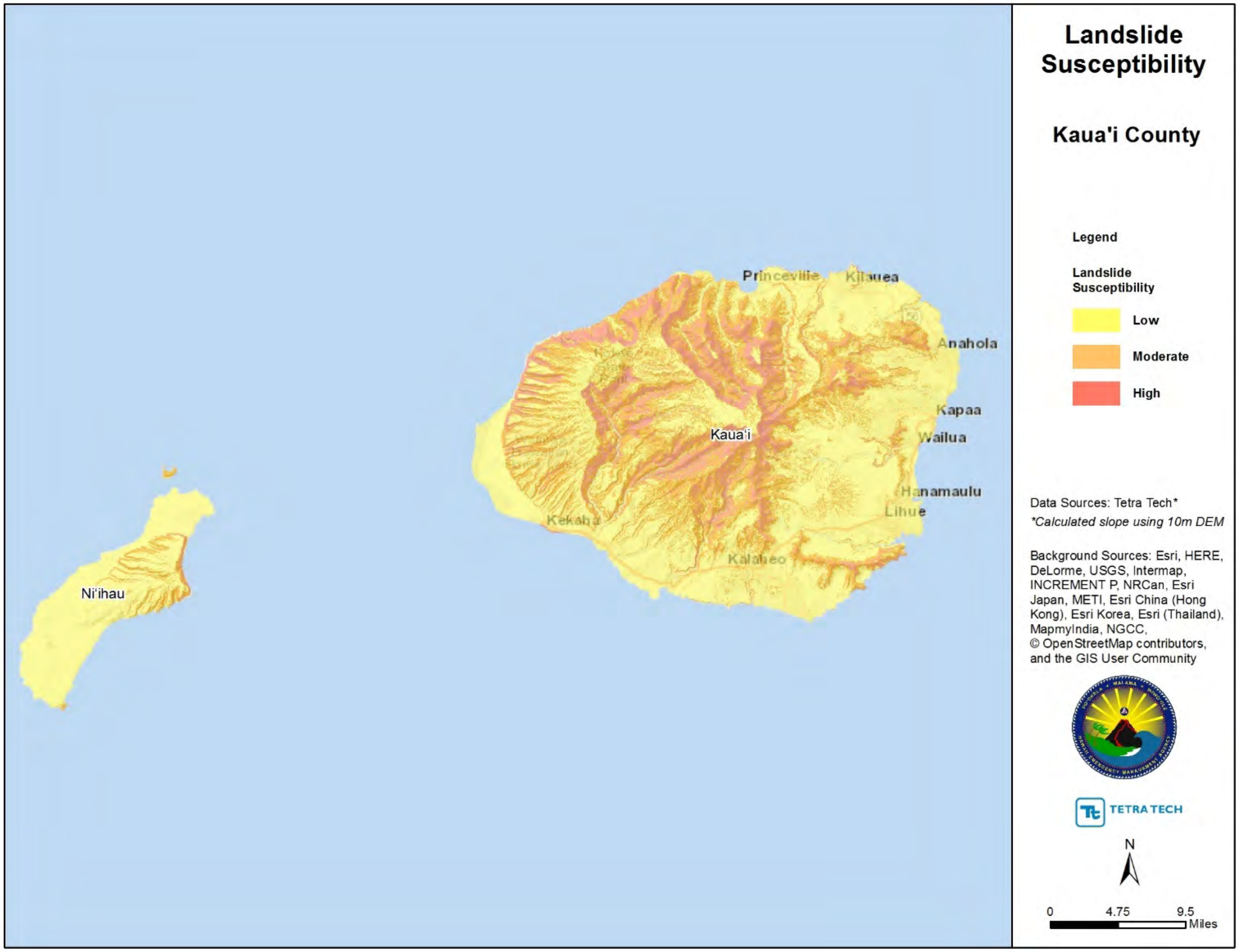
Table 4.12-1 shows the high landslide susceptibility area in square miles and the percent of the total area in each county based on the methodologies described above for each county. The County of Hawai'i has the largest percent (23.5%) of high landslide susceptibility areas. Landslide susceptibility areas that were used for the vulnerability assessment presented later in this section are shown in Figure 4.12-4 through Figure 4.12-7.

Table 4.12-1. High Landslide Susceptibility Area by County

County	Total Area	High Landslide Susceptibility Area	High Susceptibility as Percent (%) of Total Area
County of Kauaʻi	620.0	69.0	11.1%
City and County of Honolulu	600.7	54.9	9.1%
County of Maui	1,173.5	82.5	7.0%
County of Hawaiʻi	4,028.4	944.9	23.5%
Total	**6,422.6**	**1,151**	**17.9%**

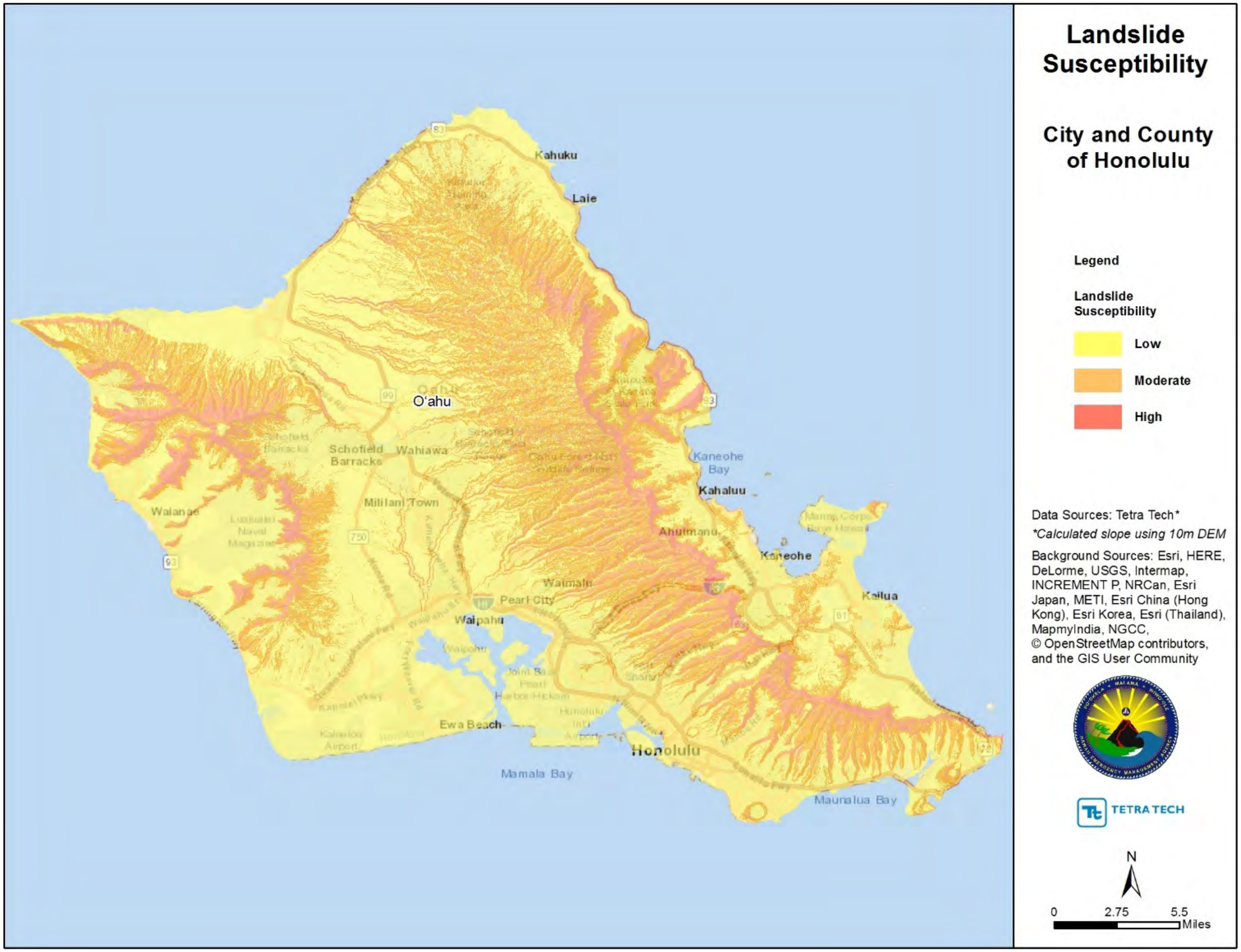
Source: PDC 2017; USGS 2016; State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal

Figure 4.12-4. Landslide Susceptibility in the County of Kauaʻi



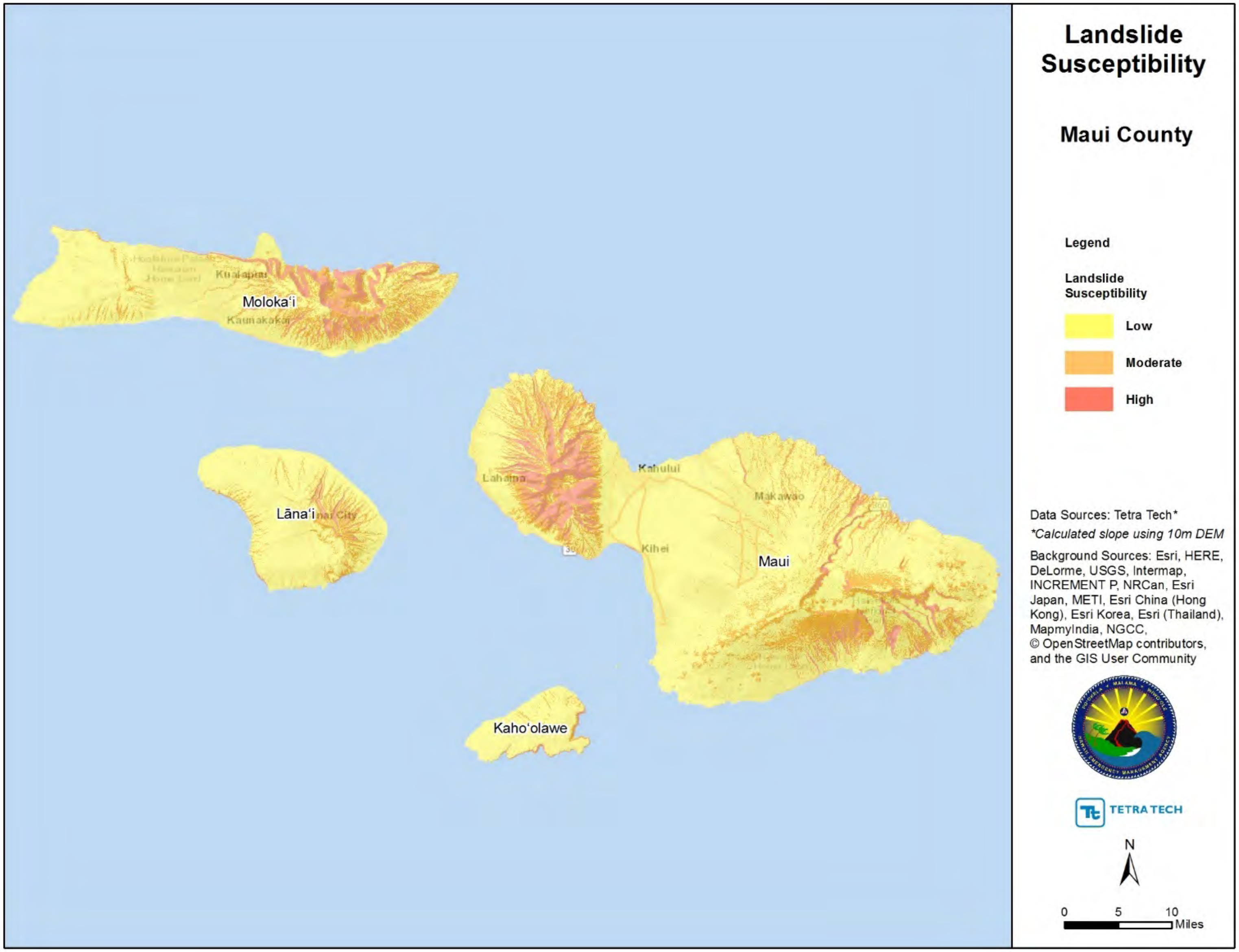
Source: PDC 2017; USGS 2016; State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal

Figure 4.12-5. Landslide Hazard Areas in the City and County of Honolulu



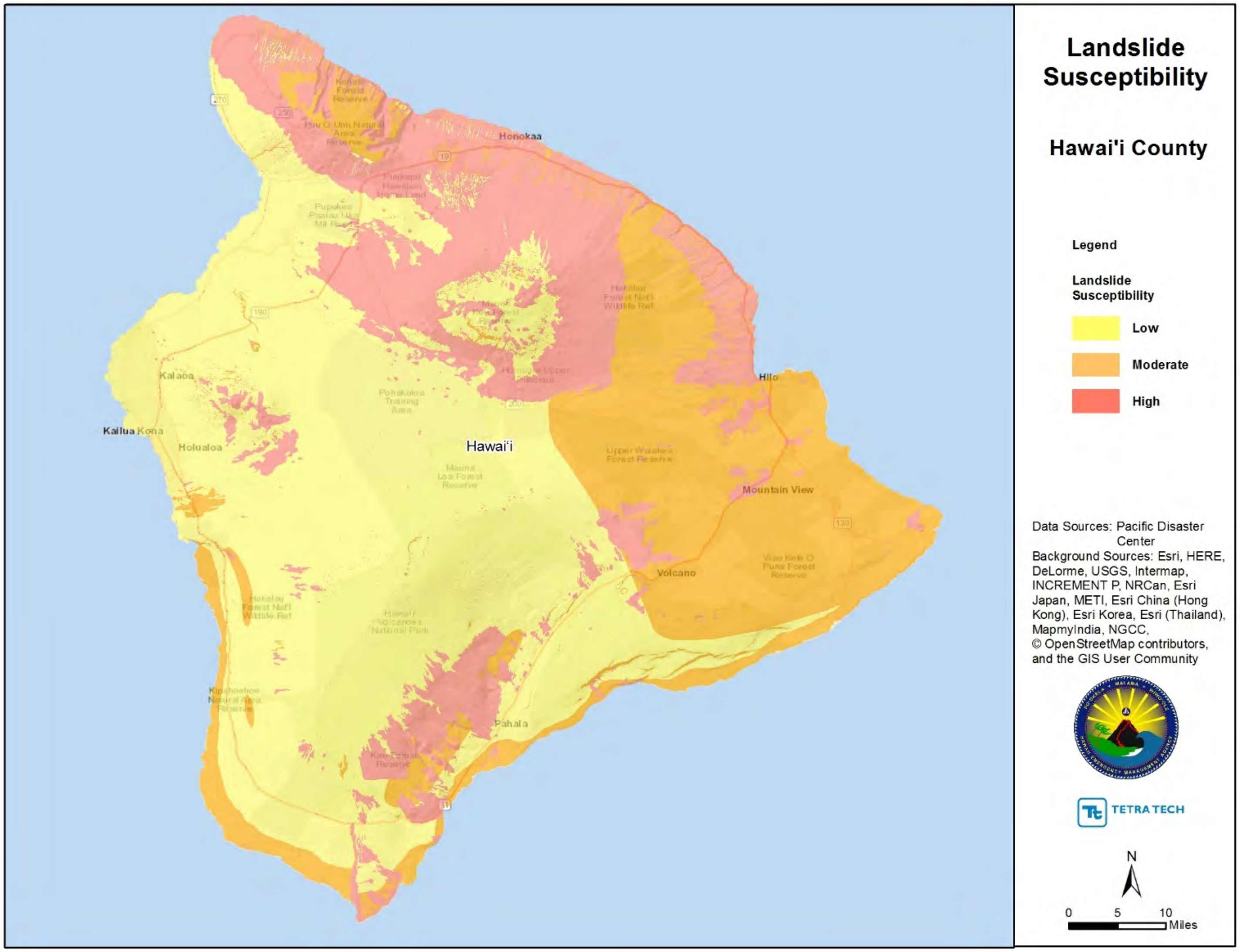
Source: PDC 2017; USGS 2016; State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal

Figure 4.12-6. Landslide Hazard Areas in the County of Maui



Source: PDC 2017; USGS 2016; State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal

Figure 4.12-7. Landslide Hazard Areas in the County of Hawaiʻi



Source: PDC 2017; USGS 2016; State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal

The following provides details, by county, of where landslides typically occur.

- **County of Kauaʻi** – Debris avalanches and slides typically occur on the western side or norther side of the county. Landslides also occur frequently near road cuts. Significant historical landslides have occurred along the highway and coastal roads. High-risk areas include: portions of Kaumualiʻi Highway (State Highway 50) near Kalāheo and Lawaʻi, portions of Kūhiō Highway (State Highway 56) near Anahola and Lumahai, and portions of Kuamoo Road (State Highway 580) near Kapaʻa (State of Hawaiʻi HMP 2013).
- **City and County of Honolulu** – Several key components of debris flows exist in the county: steep hillsides, heavy rainfall, and residential development in upland areas. Significant events that have occurred impacted the eastern part of the Honolulu District and in the Kuliʻouʻou and Hahaʻione valleys. Additionally, 66 highways sites were identified as having high risk of rockfall and 10 were identified as the top high scoring rockfall hazard sites in the City and County. This included: Pali Highway, Kalanianaʻole Highway, Kamehameha Highway, and Farrington Highway (State of Hawaiʻi HMP 2013).
- **County of Maui** – There is a high risk of landslides in the County of Maui caused by the volcanic activity in the County of Hawaiʻi (Maui County HMP 2015). Landslides, debris flows and rockfalls occur along coastal highways in the county, where the road is up against mountain slopes (State of Hawaiʻi HMP 2013).
- **County of Hawaiʻi** - Several areas along the Hāmākua Coast on the island of Hawaiʻi are chronic problem areas for landslides particularly during periods of heavy rainfall. Also, the three major gulches of Maulua, Laupāhoehoe and Kaʻawaliʻi are areas prone to rockfalls (State of Hawaiʻi HMP 2013).

Extent

Landslides and rockfalls are natural events that can vary widely, from a single rock tumbling down a hillside to a major landslide or mudflow that covers several acres. Landslide severity is directly related to the impacts incurred as a result of the event.

The consistency of debris flow ranges from watery mud to thick, rocky mud that can carry large items such as boulders, trees and cars. Debris can also include larger rocks and even boulders causing extensive damage. Debris flows from many different sources can combine in channels where their destructive power may be greatly increased. They continue flowing down hills and through channels, growing in volume with the addition of water, sand, mud, boulders, trees and other materials in the pathway. When the flows reach flatter ground, the debris spreads over a broad area, sometimes accumulating in thick deposits that can wreak havoc in developed areas. Once started, debris flows can travel even over gently sloping ground. The most hazardous areas are valley bottoms, stream channels, areas near the outlets of valleys and slopes excavated for buildings and roads (State of Hawaiʻi HMP 2013).

Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement 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 (Nelson 2015).

Warning time for landslides depends on the geology, the vegetation, and the amount of predicted precipitation for an area. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred (Wieczorek 2009). 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 (USGS 2018).

According to USGS, the interactions and real-time monitoring of rainfall, soil water content and soil water pressure with the aid of numerical modeling, may be used to assist with the development of real-time debris-flow warning systems in the future. The following summarizes recent findings that may assist with predicting landslides:

- Seasonal variation in soil moisture affects the susceptibility of a hillside to landslides.
- Wetness of the soil before a storm that triggers landslides affects the rainfall threshold for an area.
- Low moisture content of hillsides in the dry season allows the hillsides to tolerate much greater amounts of rainfall before sliding than during the wet season.
- Soil does not have to be completely saturated with water for landslides to occur.
- Positive pore-water pressure (which contributes to the initiation of landslides) occurs at select locations on a hillside only briefly (hours) a few times per year during heavy rainfall.
- Measurement of soil water content and water suction or pressure in hillside soils gives a more accurate estimate of slope stability than rainfall or soil water content measurements alone (USGS 2018).

Previous Occurrences and Losses

Many sources from FEMA, USGS, and DLNR provided information regarding previous occurrences and losses associated with landslide and rockfall events throughout the State of Hawaiʻi. The 2013 HMP discussed specific landslide and rockfall events that occurred in the State of Hawaiʻi through 2012 (see Appendix X for events prior to 2012). For the 2018 HMP Update, pervious events for all hazards assessed were summarized between January 1, 2012, and December 31, 2017. However, due to the heavy rains, flooding, and mud/rockslides that caused damages and losses to areas in the City and County of Honolulu and the County of Kauaʻi during the time of the 2018 HMP Update, the April 2018 event was included. Table 4.12-2 lists major landslide and rockfall events that occurred in the state between 2012 and 2017, with the addition of the April 2018 event.

Table 4.12-2. Landslide Events in the State of Hawaiʻi, 2012 to 2018

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
March 3 to 11, 2012	Severe Storms, Flooding, and Landslides (FEMA-DR-4062)	Kauaʻi, Honolulu, and Maui	On March 3 and 4, an upper trough in the vicinity of the Hawaiian Islands brought heavy rain, landslides, and flash flooding to the County of Kauaʻi and the City and County of Honolulu. Numerous roads and bridges were closed throughout the impacted counties due to flooding. The City and County of Honolulu EOC was activated. This event resulted in a FEMA declaration for the counties of Kauaʻi and Maui. A total of $3.6 million in public assistance was approved for the impacted counties.
April 4, 2012	Rockfall	Oʻahu	Boulders fell from loose soil and damaged homes and roadways along Kula Kōlea Place in Kāhili Valley. Three homes were damaged, two severely. There were no injuries, but nine homes were evacuated. Several other boulders on the hillside needed to be stabilized or removed to prevent further damage, at a cost of $150,000.
May 26, 2016	Flash Flood, Landslide	Honolulu	Rocks fell on a portion of the Pali Highway. The Honolulu Emergency Operations Center was activated.
September 11 to 14, 2016	Severe Storms, Flooding, Landslides, and Mudslides (FEMA-DR-4282)	Maui and Hawaiʻi	As a weak tropical disturbance with abundant low-level moisture moved through the Hawaiian Islands, an upper low moved in from the northwest. This combination generated heavy showers and thunderstorms, which then resulted in landslides, mudslides, and flash flooding over the County of Maui. In the County of Hawaiʻi, flash flooding was reported closing roadways in the Mountain View area of the county. Other parts of the State received heavy rainfall as well. Overall damages were estimated at $15 million and created approximately 9,000 truckloads of debris. On September 27, 2016, Governor Ige requested a major disaster declaration due to this event. On October 6, 2016, President Obama declared that a major disaster existed in the State of Hawaiʻi. The County of Maui was included in the declaration. Public assistance for the event reached over $7.4 million.
April 2018	Heavy Rains, Flooding, and Mud & Rock Slides (FEMA-DR-4365)	Honolulu and Kauaʻi	Heavy rains and flooding caused damages and losses to areas in Honolulu and Kauaʻi. According to the NWS, 27.52 inches of rain fell in two days in the Town of Hanalei. In Kauaʻi County, heavy rain caused extensive damage to the slopes adjacent to Kuhio Highway and impacted the communities of Wainiha and Haena. Multiple landslides led to the closure of the road. Numerous road closures reported in the impacted areas. Many homes were damaged or destroyed. American Red Cross conducted damage assessments and distributed clean up kits to residents in Aina Haina, Niu Valley, Kuliouou, Waimanalo, and Kailua. In Kauaʻi County, the American Red Cross opened five shelters. Ten residents from Wainiha were airlifted to be taken to a shelter. Between April 13th and 19th, the Red Cross provided shelter to 110 individuals on Kauaʻi.

Date(s) of Event	Event Type and Federal Disaster Declaration (if applicable)	Counties Affected	Description
			Governor Ige declared the District of Hanalei in Kaua‘i County a disaster area. This declaration provided relief for damage caused by the event. Details regarding monetized impacts are not available at the time of this plan update

Sources: FEMA 2012; Hawai‘i DLNR 2012; McAvoy 2012; Star Advertiser Staff 2012;Tsai 2012; FEMA 2016; Kakesako 2016; KHON2 Web Staff 2016; Office of Governor Ige 2016
Notes: DLNR Department of Land and Natural Resources
FEMA Federal Emergency Management Agency

FEMA Disaster Declarations

Between 1954 and 2018, FEMA included the State of Hawaiʻi in seven landslide/mudslide-related disasters (DR) or emergencies (EM) classified as one or a combination of landslide or mudslide. Generally, these disasters cover a wide region of the state; therefore, they may have impacted several counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2018). Table 4.12-3 lists the FEMA declared landslide/mudslide disaster events between 2012 and 2018.

Table 4.12-3. Landslide and Mudslide-Related Federal Declarations, 2012 to May 2018

Year	Event Type	Date Declared	Federal	Counties Affected
2012	Severe Storms, Flooding, and Landslides	April 18, 2012	DR-4062	Kauaʻi, Maui
2016	Severe Storms, Flooding, Landslides, and Mudslides	October 6, 2016	DR-4282	Maui
2018	Severe Storms, Flooding, Landslides and Mudslides	May 8, 2018	DR-4364	Honolulu and Kauaʻi

PROBABILITY OF FUTURE HAZARD EVENTS

As discussed in detail earlier, landslides and rockfalls are commonly related to precipitation (tropical cyclone events, heavy rain on saturated ground), earthquakes, volcanic activity and human activity. Therefore, landslide and rockfall event frequency is often related to the frequency of these other hazards. Refer to Section 4.5 (Earthquakes), Section 4.10 (Hurricane), and Section 4.14 (Volcanic Hazards) for details regarding the probability of future hazard events for each of these hazards.

Climate Change Impacts

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Climate projections for the State of Hawaiʻi indicate an overall decline in rainfall; however, the state will experience an increase in heavy rain events potentially causing an increase in landslides and rockfalls. Warming temperatures may increase the occurrence and duration of droughts, which could increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors may increase the probability for landslide occurrences.

4.12.2 Vulnerability Assessment

Landslide Hazard Area Definition

To assess vulnerability to the landslide hazard, the *high landslide susceptibility areas were used.*

A statewide assessment was conducted based on landslide susceptibility data from two sources. For County the Hawaiʻi, landslide susceptibility data was provided by the PDC. The data is based on slope, geology and soil moisture as described earlier in this section. For the Counties of Kauaʻi, Maui and the City and County of Honolulu, landslide susceptibility data was not available; therefore, slope was calculated using a USGS 10-meter DEM (USGS 2016). Areas of slope were assigned landslide susceptibility categories as follows to align with the slope categories used by the County of Hawaiʻi:

- Low—slope less than 20 degrees
- Moderate—slope of 20 to 40 degrees
- High—slope greater than 40 degrees

A qualitative discussion regarding rockfall impacts is also included below.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of exposed state assets (state buildings and state roads) and critical facilities to the high landslide susceptibility area. Exposure results to the moderate landslide susceptibility area are presented in Appendix X.

State Assets

There are 357 state buildings located in the high landslide susceptibility area statewide. The greatest number of state buildings exposed are located in the County of Hawai'i (353 buildings with a replacement cost value of $1.775 billion); most of these buildings are occupied by the Department of Education and Hawai'i Health Systems Corporation. The remaining four buildings are located in the City and County of Honolulu. Table 4.12-4 summarizes the state buildings by county and Table 4.12-5. summaries the state buildings by agency located in the high landslide susceptibility area.

Table 4.12-4. State Buildings Located in the High Landslide Susceptibility Area by County

County	High Landslide Susceptibility	
	Number of State Buildings in Hazard Area	Total Replacement Cost Value of State Buildings in Hazard Area
County of Kaua'i	0	$0
City and County of Honolulu	4	$11,561,110
County of Maui	0	$0
County of Hawai'i	353	$1,775,623,914
Total	**357**	**$1,787,185,024**

Source: Hawai'i State Risk Management Office 2017; PDC 2017; USGS 2016; State of Hawai'i GIS layer Trust Land, State of Hawai'i GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System
PDC Pacific Disaster Center
USGS U.S. Geological Survey

Table 4.12-5. State Buildings Located in the High Landslide Susceptibility Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	14	21.2%	$9,484,078	1.0%
Dept of Agriculture	70	$133,065,375	12	17.1%	$10,357,255	7.8%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Attorney General	15	$95,151,863	0	0.0%	$0	0.0%
Dept of Budget & Finance	16	$26,624,294	1	6.3%	$408,119	1.5%
Dept of Business, Economic Development and Tourism	25	$612,574,032	0	0.0%	$0	0.0%
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.0%	$0	0.0%
Dept of Defense	69	$246,099,477	4	5.8%	$12,857,832	5.2%
Dept of Education	4,090	$9,604,111,443	258	6.3%	$1,471,586,403	15.3%
Dept of Hawaiian Home Lands	12	$100,471,477	2	16.7%	$2,270,065	2.3%
Dept of Health	44	$387,068,440	2	4.5%	$1,220,303	0.3%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%
Dept of Human Services	130	$420,004,555	5	3.8%	$7,627,218	1.8%
Dept of Labor and Industrial Relations	22	$79,322,626	2	9.1%	$4,792,826	6.0%
Dept of Land and Natural Resources	90	$98,666,185	0	0.0%	$0	0.0%
Dept of Public Safety	154	$427,884,909	14	9.1%	$32,535,086	7.6%
Dept of Taxation	1	$6,864,408	0	0.0%	$0	0.0%
Dept of Transportation	68	$2,912,510,888	2	2.9%	$1,363,600	0.0%
Hawaiʻi State Ethics Commission	1	$891,212	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	21	19.8%	$171,136,243	14.0%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	0	0.0%	$0	0.0%
Hawaiʻi Public Housing Authority	273	$933,255,767	3	1.1%	$8,864,400	0.9%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Hawaiʻi State Public Library System	53	$525,584,082	4	7.5%	$15,073,630	2.9%
Judiciary	41	$511,093,204	5	12.2%	$6,638,449	1.3%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	0	0.0%	$0	0.0%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawaiʻi	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawaiʻi	637	$5,000,692,783	8	1.3%	$30,969,518	0.6%
Total	**6,095**	**$24,780,556,017**	**357**	**5.9%**	**$1,787,185,024**	**7.2%**

Source: Hawaiʻi State Risk Management Office 2017; PDC 2017; USGS 2016; State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal

Notes:
Dept Department
GIS Geographic Information System
PDC Pacific Disaster Center
USGS U.S. Geological Survey

The State has jurisdiction over many roads and highways in all four counties; many of which are adjacent to rock slopes that are subject to rockfall and landslide events. A Rockfall Hazard Rating System (Publication No. FWHA SA-93-057, November 1993) is a tool that allows transportation agencies to evaluate and rate the risk of rockfall sites and may be used to prioritize construction funds. There are preliminary and detailed rating methodologies. The preliminary rockfall rating is a subjective rating that groups the hazard conditions into three classes (A, B and C) based on historic rockfall activity and the probability the rock falling will reach roadway pavement (U.S. DOT 1993). The detailed rating is based on the 12 categories below.

- Slope height
- Ditch effectiveness
- Average vehicle risk, derived from Average Daily Traffic (ADT)
- Percentage of decision sight distance
- Roadway width

- Structural condition, Case One slopes (movement along discontinuities)
- Rock friction
- Structural condition, Case Two slopes (differential erosion or over-steepening leads to rockfall)
- Difference in erosion rates
- Volume of rockfall event
- Climate and the presence of water on slope
- Rockfall history

The City and County of Honolulu implemented a study to evaluate potential rockfall sites along 79 state highways and roadways, and to develop a systematic rockfall hazard management system for the State of Hawaiʻi utilizing rockfall hazard rating methodology. Overall, 66 highways sites were identified as being at high risk to rockfall (State of Hawaiʻi HMP 2013).

The State of Hawaiʻi Department of Transportation mitigates landslides near roadways by erecting a metal mesh covering around the edge of the cliff. The purpose of these meshes is to prevent rocks and other debris from sliding out onto the highway. Since the identification of the City and County of Honolulu high-risk sites along highways and roads, many have been mitigated to date including along the Diamond Head State Monument trail, completed in December 2017.

Due to the County of Kauai's mountainous terrain, there are few roads that connect the island; many are under the jurisdiction of the State of Hawaiʻi Department of Transportation (e.g., Kuhio Highway and Kaumualii Highway). The roads are connected by bridges and only a few areas for roadway bypass or alternate routes (Kauaʻi County HMP 2015). For this reason, any impacts to main roadways in the county as a result of natural hazard events can have devastating impacts to residents and visitors. Roadway closures due to a landslide or rockfall, as demonstrated by the April 2018 event, can isolate communities; prevent residents from commuting to work; and cut-off access to emergency response services.

The County of Maui has a recurrent history of landslides, debris flows and rockfalls. Most of these types of events have occurred along coastal highways were the road is right up against mountain slopes (State of Hawaii HMP 2013). The Kiholo Bay and Mahukona Earthquakes of October 15, 2006 resulted in several landslides and rockfalls at various locations on the Island of Maui including Piilani Highway (State Highway 30). Similar to other islands, road closures due to a landslide can isolate communities. In some cases, it can take years to fully repair the roadway and reopen for use (County of Maui HMP 2015).

Due to the lack of redundancy in the road network on the County of Hawaiʻi, which has the greatest state road exposure to the landslide hazard, the closure of roads will significantly hamper emergency response and potentially isolate communities. Table 4.12-6 shows the length of State roads in high landslide susceptibility areas by county. The County of Hawaiʻi has the greatest number of miles (146.9 miles) exposed. A complete list of State roads located in the hazard area is included in Appendix X.

Table 4.12-6. State Roads Located in the High Landslide Susceptibility Area by County

County	Length (in miles)		
	Total Length	High Hazard Area Length	Hazard Length as % of Total Length
County of Kauaʻi	104.0	0.2	0.2%

County	Length (in miles)		
	Total Length	High Hazard Area Length	Hazard Length as % of Total Length
City and County of Honolulu	375.3	1.7	0.5%
County of Maui	238.6	1.5	0.6%
County of Hawaiʻi	378.7	146.9	38.8%
Total	**1,096.5**	**150.4**	**13.7%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017; PDC 2017; USGS 2016; State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal

Notes:		
Notes:	*GIS*	*Geographic Information System*
	PDC	*Pacific Disaster Center*
	SDOT	*State Department of Transportation*

CRITICAL FACILITIES

There are 95 critical facilities located in the high landslide susceptibility area (see Table 4.12-7). All of these facilities are located in the County of Hawaiʻi; the majority of which are categorized as Mass Care Support Services. Table 4.12-8 summaries the number and percentage of exposed critical facilities by core category.

Table 4.12-7. Critical Facilities by Core Category Located in the High Landslide Susceptibility Area by County

County	Core Category of Critical Facilities										Total in the Hazard Area
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	0	0	0	0	0	0	0	0	0	0	0
City and County of Honolulu	0	0	0	0	0	0	0	0	0	0	0
County of Maui	0	0	0	0	0	0	0	0	0	0	0
County of Hawaiʻi	4	10	6	0	7	3	19	28	0	18	95
Total	4	10	6	0	7	3	19	28	0	18	95

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2

Table 4.12-8. Critical Facilities Located in the High Landslide Susceptibility Area by Core Category

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	4	6.7%	$9,804,970	4.7%
Communications	130	$523,848,060	10	7.7%	$29,447,180	5.6%
Emergency Services	149	$1,017,628,710	6	4.0%	$42,437,650	4.2%
Energy	90	$2,591,975,628	0	0.0%	$0	0.0%
Food & Agriculture	39	$829,869,410	7	17.9%	$212,329,590	25.6%

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Government Facilities	100	$399,781,575	3	3.0%	$11,617,980	2.9%
Healthcare & Public Health	193	$3,399,521,375	19	9.8%	$274,585,310	8.1%
Mass Care Support Services	353	$11,497,547,155	28	7.9%	$270,766,960	2.4%
Transportation Services	56	$1,739,256,960	0	0.0%	$0	0.0%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	18	5.9%	$558,846,720	5.9%
Total	1,475	$31,687,768,838	95	6.4%	$1,409,836,360	4.4%

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets by county. Similar to the analysis for state assets, a spatial exposure analysis was conducted and the results are summarized below. It is important to note that landslide and rockfall events do not just impact assets located in the defined hazard area. There are cascading impacts to surrounding communities that rely on the assets that are damaged/lost as a result of a disaster.

Population

According to the CDC, health threats from landslides include: 1) trauma caused by the rapidly moving water and debris; 2) broken electrical, water, gas and sewage lines that can lead to injury or illness; and 3) disrupted roadways that can endanger motorists and disrupt transport and access to health care (CDC 2018). To understand the population located in the high landslide susceptibility area, a spatial analysis was conducted using the 2010 U.S. Census data; refer to Table 4.12-9.

The County of Hawaiʻi has the greatest number of people (53,349) located in the hazard area. It is important to note that this analysis does not include the number of tourists and visitors in the State or the impacted population located outside of the high landslide susceptibility area. Historic landslide and rockfall events in the state have caused road closures and bridge failures, isolating residents and preventing access to evacuation routes and medical services. Therefore, this estimate may be underestimating exposure and vulnerability.

Disasters can exacerbate and stress social conditions. Populations considered most vulnerable to natural hazard events include children, the elderly (persons over the age of 65), population with access and functional needs and individuals living below the U.S. Census poverty threshold. The County of Hawaiʻi has the largest population over 65, with 4.9% exposed and 8.5% of the low-income population exposed to the high landslide hazard. Section 3.0 (State Profile) summarizes the state's demographics by county further.

Table 4.12-9. 2010 U.S. Census Population Located in the High Landslide Susceptibility Area by County

County	Population						
	Total Population	Population in Hazard Area	Population Exposed as Percent (%) of Total Population	Population Over 65 in Hazard Area	Population Over 65 Exposed as Percent (%) of Total Population	Income <$30K/yr in Hazard Area	Income <$30K/yr Exposed as Percent (%) of Total
County of Kauaʻi	67,091	0	0.0%	0	0.0%	0	0.0%
City and County of Honolulu	953,207	890	0.1%	117	0.0%	186	0.0%
County of Maui	154,924	0	0.0%	0	0.0%	0	0.0%
County of Hawaiʻi	185,079	53,349	28.8%	9,071	4.9%	15,702	8.5%
Total	1,360,301	**54,239**	**4.0%**	**9,188**	**0.7%**	**15,888**	**1.2%**

Source: U.S. Census 2010; PDC 2017; USGS 2016

Notes: PDC Pacific Disaster Center
USGS U.S. Geological Survey

The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawai'i. To convert households to residents, three people per household was used.

General Building Stock

To further assess what is at risk, each county's general building stock's exposure was examined. The general building stock located in the high landslide susceptibility area is considered exposed and potentially vulnerable. Damages to buildings can displace people from their homes, threaten life safety and impact a community's economy and tax base. Table 4.12-10 indicates that the County of Hawaiʻi has the greatest building replacement cost value located in the high landslide susceptibility area.

Table 4.12-10. General Building Stock Located in the High Landslide Susceptibility Area

County	Total Replacement Cost Value	Replacement Cost Value in Hazard Area	Percent (%) of Total in Hazard Area
County of Kauaʻi	$13,287,882,000	$0	0.0%
City and County of Honolulu	$164,787,212,000	$125,389,000	0.1%
County of Maui	$31,320,693,000	$784,000	0.0%
County of Hawaiʻi	$33,326,392,000	$9,863,569,000	29.6%
Total	$242,722,179,000	9,989,742,000	4.1%

Source: Hazus v4.2, PDC 2017; USGS 2016, State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal 2017

Notes: GIS Geographic Information System
PDC Pacific Disaster Center
USGS U.S. Geological Survey

The Honolulu district in the City and County of Honolulu has the highest concentration of inventoried rock hillslopes. This is due to the high density of development in areas of high topographic relief, which require significant earthwork and grading. More than 1,779 landslides and resulting debris flows have been recognized in aerial photographs of the Honolulu District taken during a period of approximately 50 years (USGS Open-File

Report 93-514). Most of these debris flows caused relatively little direct property damage because they occurred in undeveloped or relatively inaccessible upland areas. However, some of the areas affected by past debris flows have since been developed, and if development continues in these upland areas, the impacts from debris flows in future storms could become even more frequent and costly (State of Hawaiʻi HMP 2013).

The geography in the County of Kauaʻi which includes the two mountains, Kawaikini Peak and Mount Waiʻalʻale, make this one of the rainiest places on earth. The County averages 460 inches of rain annually. Although the exposure analysis does not indicate buildings in the County of Kauaʻi are located in the hazard area, the steep slopes and climatic conditions make the county highly vulnerable to flooding and landslide risk generally resulting in mudslides and rockslides (County of Kauaʻi 2015). In April 2018, flash flooding and mudslides that resulted from over 27.5 inches of rain caused major damage to roads, including Kuhio Highway, and bridges across the mountainous island. Many communities became isolated and homes damaged or destroyed.

Mudslides can cause damage either directly, by colliding with man-made structures, or indirectly, by plugging drainage systems so that flood waters are diverted out of the channels. Debris flows also can sever or cover roads, blocking access to (or egress from) neighborhoods, and thus interfere with emergency operations and evacuations (State of Hawaiʻi HMP 2013).

Land Use Districts

Table 4.12-11 shows the square miles of high landslide susceptibility areas in each State Land Use District statewide; refer to Appendix X for results for each county. Approximately 4.5% of the Urban District lands statewide are located in high landslide susceptibility areas. Urban development on steep slopes or unstable soils could result in adverse visual impacts or hazardous conditions. Most of the vacant lands in the State Urban District with these characteristics are located in valley and hillside neighborhoods. Where hillside locations have stable soil material, the primary impact is aesthetic, since structures built along the slopes tend to be visually prominent and can interrupt the silhouette of the natural ridgeline when viewed from below. Building on the lower slopes of valley walls can also have a visual impact. Where these valley locations have deposits of unstable soils, slow-moving landslides can cause property damage, prompting claims against the City and County of Honolulu - as has happened in Mānoa and Moanalua (State of Hawaiʻi 2013 HMP). The County of Hawaiʻi has more than 14 square miles of Urban District land in high landslide susceptibility areas, accounting for more than 15% of the total Urban District land in the county.

Table 4.12-11. State Land Use Districts Located in High Landslide Susceptibility Areas

Land Use District	Total (square miles)	Square Miles in High Landslide Susceptibility Areas	Percent (%) of Total Area
Agricultural	2,942.8	643.0	21.9%
Conservation	3,156.3	498.5	15.8%
Rural	16.1	0.2	1.2%
Urban	319.7	14.3	4.5%
Total	**6,434.9**	**1,156.1**	**18.0%**

Source: PDC 2017; USGS 2016; State Land Use Commission, 2016
Notes: Total area was calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline were downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
GIS Geographic Information System

Environmental Resources

Natural hazard events, including landslide and rockfall events, can harm the environment. The State's abundant natural resources are one of the many elements that attract visitors to the islands; and as discussed, tourism is a major contribute to the local and state economy.

Landslides can lead to flooding by blocking stream channels or culverts, allowing water to back up and overflow. Landslide events can also lead to overtopping of reservoirs and/or reduced capacity of reservoirs to store water (USGS 2004).

It is challenging to monetize impacts to environmental resources as a result of hazard events. To understand what environmental resources are exposed to the landslide hazard, an exposure analysis was conducted using the critical habitat, wetlands and parks and reserves spatial layers. Results are summarized in Table 4.12-12. As noted, large areas of critical habitats, parks and reserves are vulnerable to a landslide event.

Table 4.12-12. Environmental Resources Located in the High Landslide Susceptibility Area

Environmental Resource	Total Square Miles of Resource (square miles)	Resource Area in the Hazard Area (square miles)	Percent (%) of the Total Asset Area
Critical Habitat[a]	915.2	207.1	22.6%
Wetlands	260	7.3	2.8%
Parks and Reserves	2,607.70	387.6	14.9%
Total[b]	**3,837.60**	**602.0**	**15.7%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi Hawaiʻi GIS Program Geospatial Data Portal; PDC 2017; USGS 2016

Notes: GIS Geographic Information System
PDC Pacific Disaster Center
USGS U.S. Geological Survey

Cultural Assets

Loss of and harm to native species and ecosystems will adversely impact the Hawaiian cultural traditions and practices, which are closely tied to the natural environment. To understand what portion of the Hawaiian Home Lands are exposed to the high landslide susceptibility area, an exposure analysis was conducted. Nearly 60% of the Hawaiian Home Lands in the County of Hawaiʻi are located in the landslide hazard area; followed by 13% of the total land area in the City and County of Honolulu (Table 4.12-13).

Table 4.12-13. Hawaiian Home Lands Located in the High Landslide Susceptibility Area by County

County	Hawaiian Home Lands Area (in square miles)		
	Total Area	Hawaiian Home Lands Located in the Hazard Area	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	32.0	1.3	4.2%
City and County of Honolulu	10.9	1.4	13.3%
County of Maui	92.6	1.4	1.5%
County of Hawaiʻi	190.3	114.0	59.9%
Total	325.8	118	36.3%

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal 2017; PDC 2017; USGS 2016

Notes: *GIS Geographic Information System*
PDC Pacific Disaster Center
USGS U.S. Geological Survey

FUTURE CHANGES THAT MAY IMPACT STATE VULNERABILITY

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

The high landslide susceptibility area was overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.12-14 below and Section 3 [State Profile] for more information on projected development areas). The results of this assessment indicate that more than a third (36.7%) of the Enterprise Areas in the County of Hawaiʻi are located in high landslide susceptibility areas. Generally, county-level land use and development regulations require special assessment and consideration of proposed development on steep slopes, such as soil evaluation or geotechnical and engineering evaluations. Development in these areas may not be outright prohibited, but are likely subject to close examination on a case-by-case basis. While these regulations may prevent development on steep slopes that would be impacted by landslides or contribute to their occurrence, new development in landslide runout areas (that is, areas at the foot of the slide where materials involved in a slide come to rest) or down slope from rockfall areas are not likely to be similarly regulated and may be exposed to risk from the landslide and rockfall hazard.

In addition, incremental build-out of hillsides and lower valley slopes can affect drainage systems, both natural and urbanized. Increased lot coverage by larger buildings and more extensive paving has increased the volume and rate of stormwater discharge. This problem is exacerbated in the interior reaches of the valleys and hillsides, where rainfall is higher. Over the long term, the cumulative impact of greater lot coverage threatens to erode natural stream banks downstream - requiring expensive, aesthetically and ecologically undesirable structural hardening of the drainage channel - or even to exceed the capacity of the drainage system, resulting in flood conditions. To prevent inappropriate development, hillside lands should be placed in preservation or low-density residential zoning districts. Such lands should also be subject to stricter development standards - such as maximum lot coverage and structural stability - than those that apply to level land (Hawaiʻi State HMP 2013).

Table 4.12-14. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones located in the High Landslide Susceptibility Area by County

County	Area (in square miles)								
	Hawaiʻi Community Development Authority District (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as % of Total Area
County of Kauaʻi	-	-	-	-	-	-	1,286.6	471.9	1.8%
City and County of Honolulu	7.4	0.0	0.0%	-	-	-	288.3	19.4	6.7%
County of Maui	-	-	-	27.6	0.1	0.2%	252.3	4.6	6.2%
County of Hawaiʻi	-	-	-	-	-	-	1,016.7	63.3	36.7%
Total	**7.4**	**0.0**	**0.0%**	**27.6**	**0.1**	**0.2%**	**2,843.9**	**559.3**	**19.7%**

Source: PDC 2017; USGS 2016
Notes: Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (2) Maui Development Projects GIS layer from Maui County Planning Department (3) Enterprise Zones from Community Economic Development Program, DBEDTS
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
HCDA Hawaiʻi Community Development Authority

SECTION 4. RISK ASSESSMENT

4.13 Tsunami

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including climate change).
- Tsunami events that occurred in Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update.
- New and updated figures from federal and state agencies are incorporated.
- The Great Aleutian Tsunami (GAT) inundation area was used to assess exposure and vulnerability.

4.13.1 Hazard Profile

Hazard Description

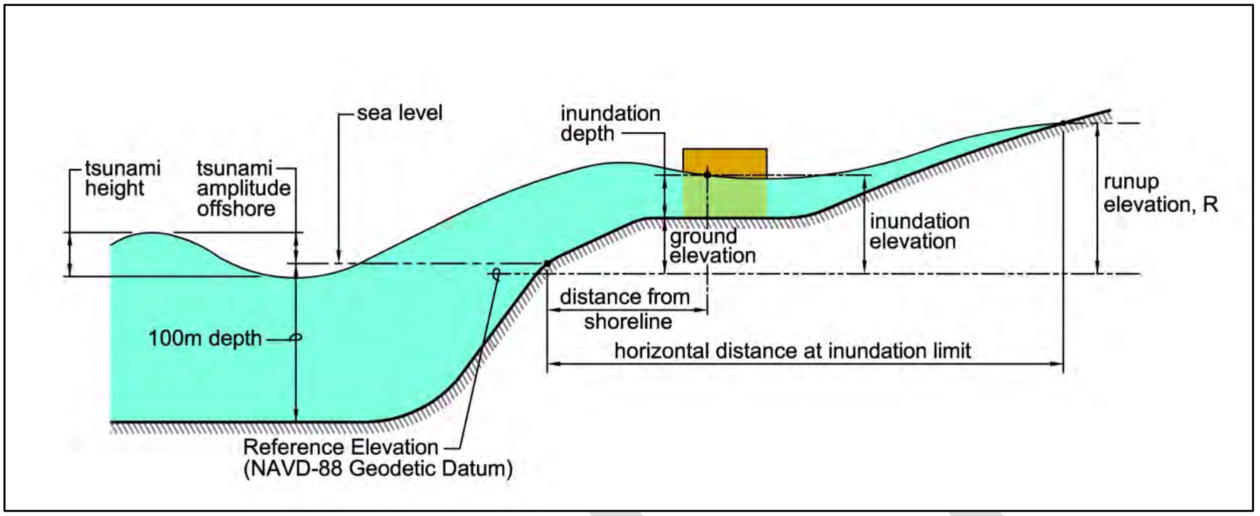
Figure 4.13-1. Arrival of Major Wave at Lāʻie Point (Honolulu), March 1957

Source: NOAA NGDC 2018

Tsunamis are a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite. A tsunami can move hundreds of miles per hour in the open ocean and smash into land with waves as high as 100 feet or more. From the area where the tsunami originates, waves travel outward in all directions. Once the wave approaches the shoreline, it builds in height. The topography of the ocean floor will influence the size of the wave. Figure 4.13-2 illustrates the makeup of a tsunami and associated terminology.

Areas at greatest risk are those less than 25 feet above sea level and within a mile of the shoreline. The most common cause of death associated with tsunamis is drowning. Other hazards associated with tsunamis include flooding, contamination of drinking water, and fires from gas lines or ruptured tanks (International Tsunami Information Center 2018). Although landslides and volcanoes cause some local tsunamis, more than 95 percent of tsunamis result from subduction earthquakes (Hawaiʻi State HMP 2013).

Figure 4.13-2. Illustration of Tsunami Terminology



Source: Hawaiʻi State HMP 2013 (Courtesy of ASCE 7 Tsunami Loads and Effects Subcommittee)

The earthquakes associated with tsunamis are referred to as “tsunamigenic” earthquakes. The association between earthquakes and tsunamis results from the fact that both are generated by the tectonic displacement of the earth’s crust. 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 acting under the influence of gravity, attempts to regain its equilibrium (Hawaiʻi State HMP 2013). Refer to Section 4.5 (Earthquakes) for details on the earthquake hazard.

The main factor that determines the initial size of a tsunami is the amount of vertical sea floor deformation resulting from subduction zone earthquakes. The earthquake’s magnitude, depth, fault characteristics, and coincident slumping of sediments or secondary faulting control the size of the tsunami (Hawaiʻi State HMP 2013).

Tsunamis are characterized as shallow-water waves—that is the ratio between the water depth and its wave length gets very small. Shallow-water waves are different from wind-generated surf waves. Wind-generated waves usually have a period (time between two successional waves) of 5 to 20 seconds and a wavelength (distance between two successional waves) of about 100 to 200 meters (300 to 600 feet). A tsunami wave can have a period in the range of five minutes to two hours and an open ocean wavelength in excess of 100 miles. It is because of their long wavelengths that tsunamis behave as shallow-water waves. From the area where the tsunami originates, waves travel outward in all directions. Once the wave approaches the shore, it builds height.

When a tsunami finally reaches the shore, it may appear as a rapidly rising or falling tide, a series of breaking waves, or even a bore (a step-like wave with a steep breaking front). Although most people imagine a tsunami as a large, steep wave breaking on the shore, tsunamis generally appear as an advancing tide without a developed wave face and produce rapid flooding of low-lying coastal areas. Reefs, bays, entrances to rivers, undersea features and the slope of the beach all help to modify the tsunami as it approaches the shore. Because the long-period wave can bend around obstacles, the tsunami can enter bays and gulfs having the most intricate shapes. Experience has shown that wave heights increase in bays that narrow from the entrance to the head, but decrease in bays that have narrow entrances. Unlike storm waves, tsunami waves may be very large in embayments, actually experiencing amplification in long funnel-shaped bays. However, shorelines protected by reefs typically do not sustain extensive damage from tsunamis as the reefs disperse the wave energy. Islands in a group may “shadow” one another reducing the tsunami effect. Small islands may experience reduced runup as the tsunami waves may refract around them (USGS 2002; State of Hawaiʻi 2013).

LOCATION

Tsunamis are a threat to life and property for all those living along or near the coastline. They can strike anywhere along the coastline of the State of Hawaiʻi. At sea level on the coast there is no safe place during a tsunami. On low-lying shorelines such as in the river and stream valleys that characterize so much of Hawaiʻi, a tsunami may occur as a rapidly growing high tide that rises over several minutes, and inundates low coastal regions. The return of these flood waters to the sea causes much damage. At headlands the refractive focusing of the wave crest leads to energy concentration and high magnitude runup (Hawaiʻi State HMP 2013).

The entire state (all islands) may be impacted by a tsunami. A worst-case scenario for the State is a magnitude 9+ earthquake in the eastern Aleutian Islands. The tsunami from such an earthquake would produce extensive flooding of lowlands throughout the entire State of Hawaiʻi. This extreme tsunami was modeled to understand potential impacts on the State and is called the Great Aleutian Tsunami (GAT). Very roughly, the expected recurrence interval for a GAT is 1,000 years (Hawaiʻi News Now 2014).

The GAT inundation data was provided by the PDC for analysis in the 2018 HMP Update. Table 4.13-1 shows the GAT inundation area in square miles and the percent of the total area by county. In general, the GAT inundation area is larger than the coastal flood inundation area depicted on FEMA FIRMs (discussed in Section 4.6). The City and County of Honolulu has the largest area that may be inundated (61 square miles), followed by the County of Kauaʻi.

Table 4.13-1. GAT Inundation Area by County

County	Area (in square miles)		
	Total Area	Hazard Area	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	620.0	32.8	5.3%
City and County of Honolulu	600.7	61.0	10.2%
County of Maui	1,173.5	28.9	2.5%
County of Hawaiʻi	4,028.4	20.2	0.5%
Total	**6,422.6**	**143.0**	**2.2%**

Source: PDC 2017
Notes: PDC Pacific Disaster Center

Figure 4.13-3. Great Aleutian Tsunami Inundation Area in the County of Kaua'i

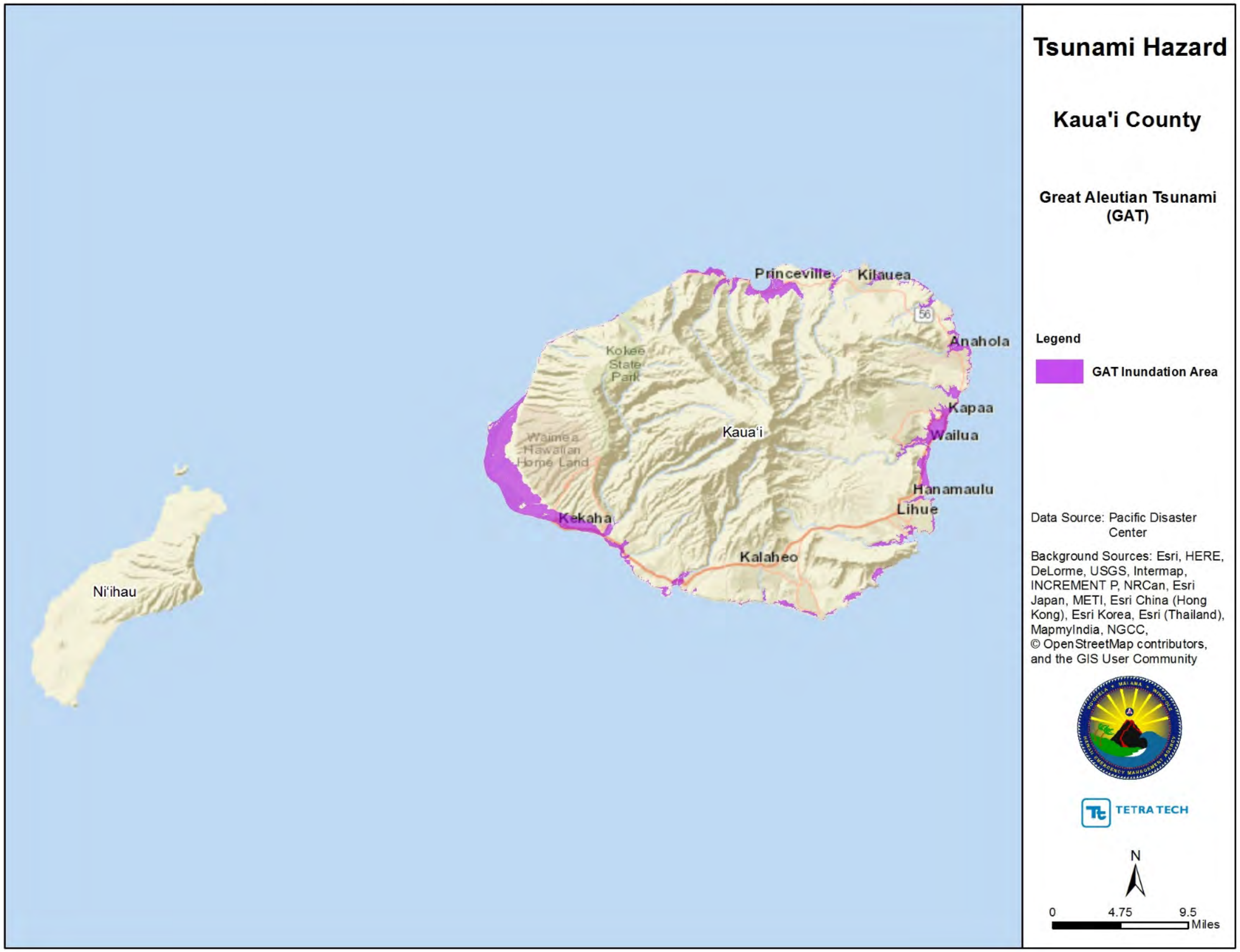


Figure 4.13-4. Great Aleutian Tsunami Inundation Area in the City and County of Honolulu

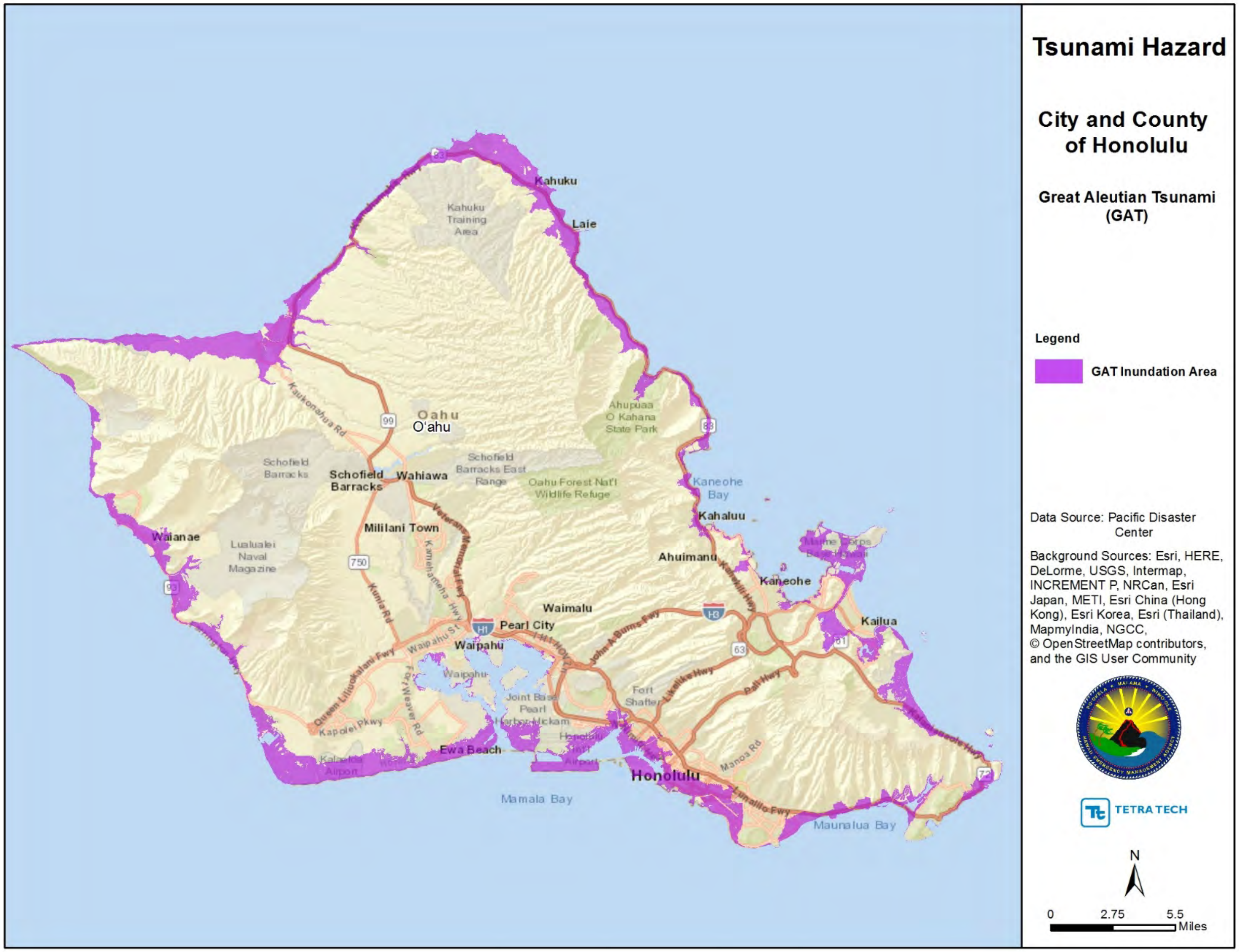


Figure 4.13-5. Great Aleutian Tsunami Inundation Area in the County of Maui

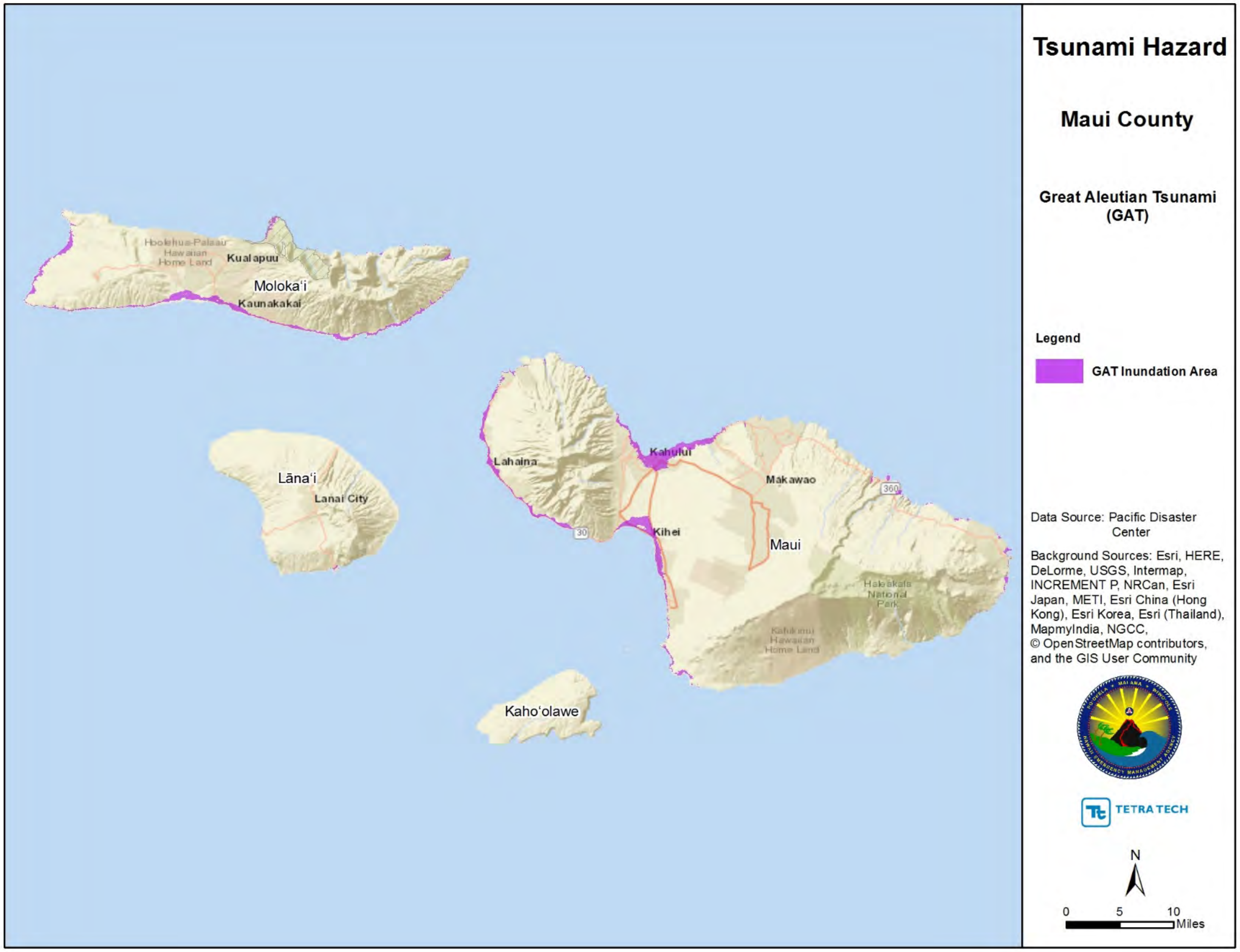
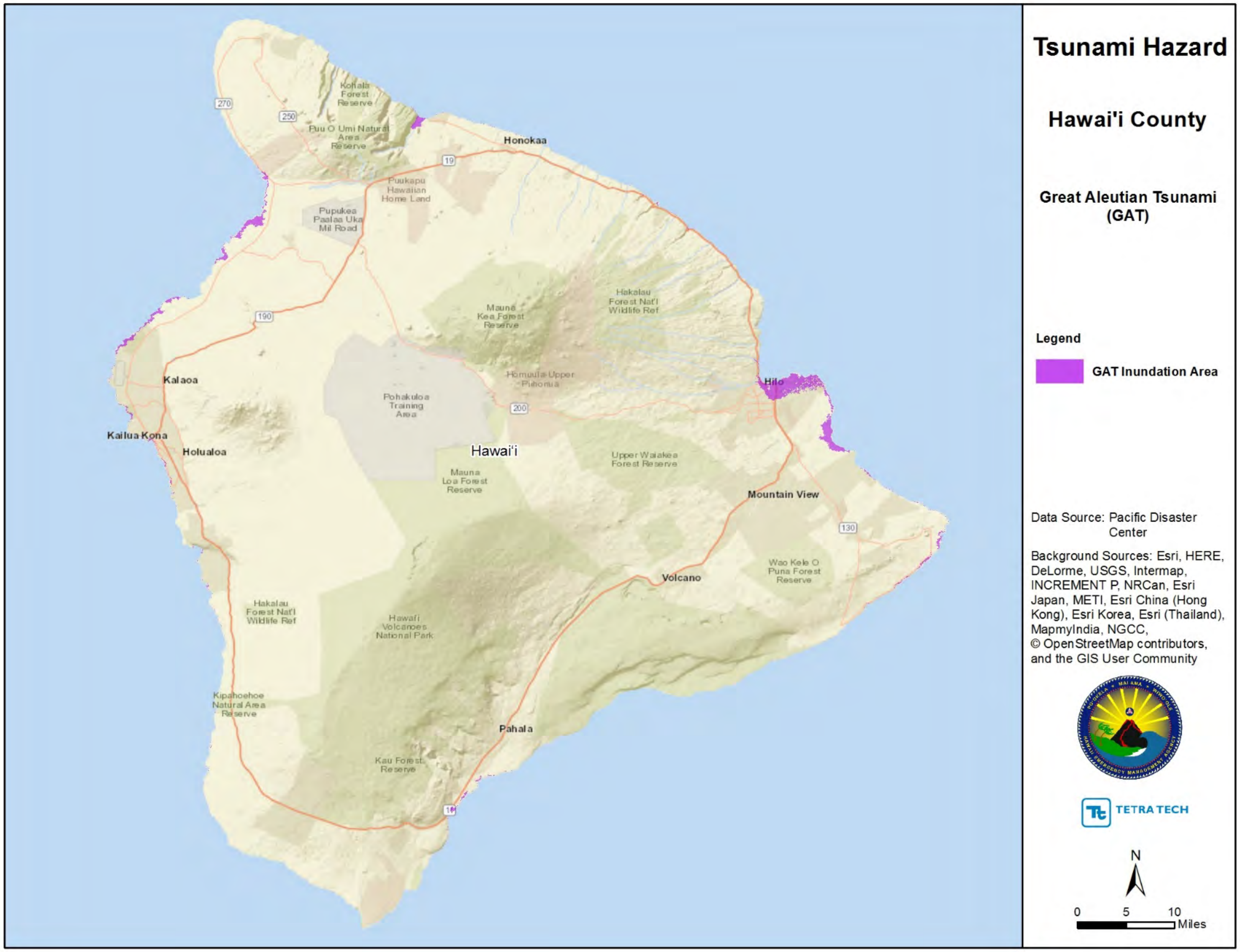


Figure 4.13-6. Great Aleutian Tsunami Inundation Area in the County of Hawaiʻi



EXTENT

A tsunami's effect at the shoreline is measured in terms of runup (the maximum elevation water reaches onshore, measured from sea level) height and inundation (the limit of flooding, measured horizontally from the shoreline; see Figure 4.12-2). Runup and inundation can vary considerably over short distances. Runup tends to be highest at steep shorelines, while inundation is greatest along low-lying coastal plains.

When a tsunami reaches the shore, the water level can rise many feet. In extreme cases, the water level can rise to more than 50 feet (15 meters) for tsunamis of distant origin, and over 100 feet (30 meters) for tsunamis generated near the earthquake's epicenter. The first wave may not be the largest in the series of waves. One coastal area may see no damaging wave activity, while in another area destructive waves can be large and violent (State of Hawaiʻi 2013).

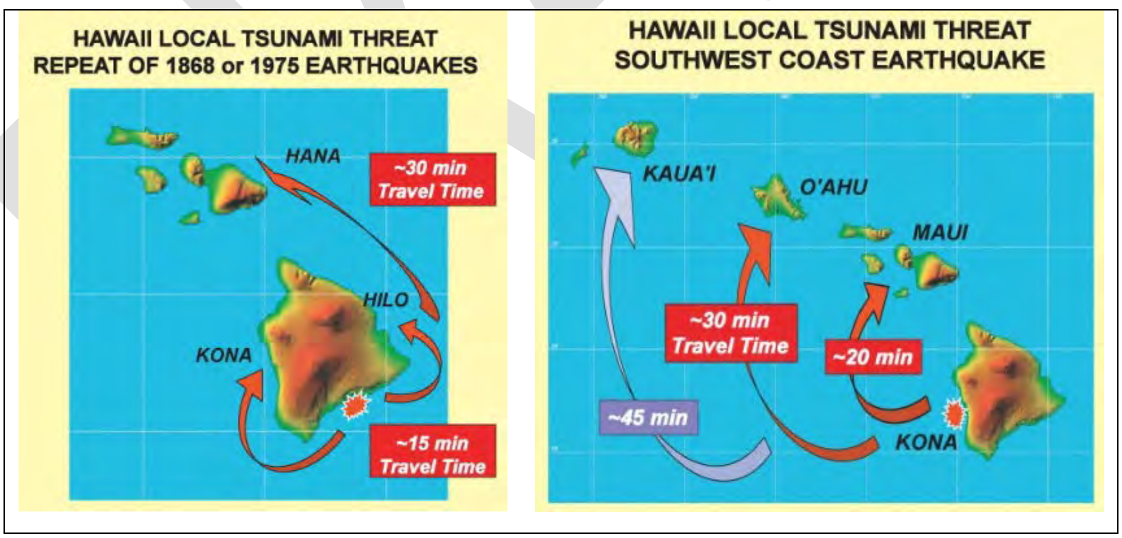
Warning Time

Tsunamis affecting the State of Hawaiʻi may be generated within the state (local-source tsunamis) or may come from across the ocean (distant-source tsunamis). Local tsunamis may be generated by volcanic eruptions, earthquakes, large-scale subsidence or sub-aerial and submarine landslides.

Local-Source Events

Local-source events are most likely to be generated near the County of Hawaiʻi, primarily from earthquakes and large-scale subsidence along the south flank of Kilauea. The local tsunami could reach the coastlines of most major Hawaiian Islands in less than one hour (Geist et al 2005). Figure 4.13-7 shows the travel times of tsunamis originated from earthquakes within the Hawaiian Islands.

Figure 4.13-7. Approximate Travel Time of Tsunamis Generated in Hawaiʻi



Source: International Tsunami Information Center 2018

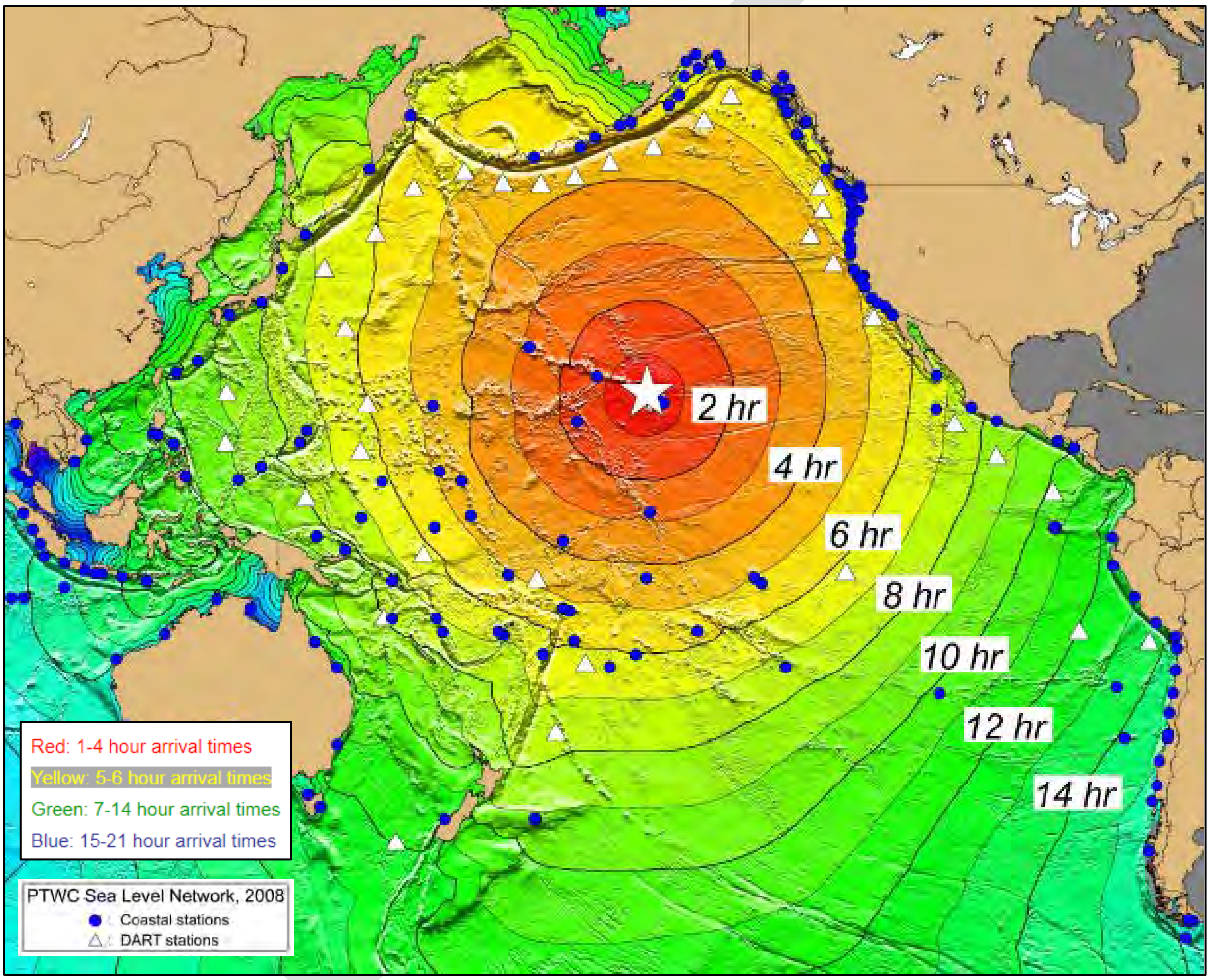
Distant-Source Events

Distant-source tsunamis originate from a faraway source, generally more than 600 miles or more than three hours tsunami travel time from its source. The State of Hawaiʻi is exposed to these types of tsunamis. In particular, areas with subduction fault lines such as the coasts of the State of Alaska's mainland and Aleutian

Islands, the States of Washington, Oregon, and California, the countries of Chile and Japan, and Russia's Kamchatka Peninsula, are common places of earthquakes that generate tsunamis that have affected Hawaiʻi in the past.

Although these tsunamis originate from earthquakes with epicenters far away from Hawaiʻi, they lose little energy on the open ocean and can, consequently, cause large devastation when they reach the Hawaiian Islands' coasts. For tsunamis from distant sources, the time for the waves to reach the islands is measured in hours. Figure 4.13-8 shows the travel times of tsunamis originated from earthquakes in the Pacific Rim.

Figure 4.13-8. Tsunami Travel Times to Hawaiʻi



Source: International Tsunami Information Center 2018

Evacuation Plans and Warning Systems

An effective early warning system is essential in protecting life and property (Intergovernmental Oceanographic Commission 2014). Tsunamis in the Hawaiian Archipelago have cumulatively killed the largest number of people of all natural hazards affecting the islands. Tsunamis reaching the Hawaiian Islands have exhibited tremendous variability in terms of their runup heights, inundation distances, and the damage they have inflicted (Hawaiʻi State HMP 2013).

About half a dozen tsunamis have crossed the Pacific Ocean in the last decade; those which required mandatory shoreline evacuations in Hawaiʻi occurred in February 2010, March 2011, and October 2012. Because of continually improving techniques and understanding, tsunami hazard, in particular identifying areas most likely to be flooded, is a continuous effort. The previous revision of the tsunami evacuation maps was completed in 2010. The 2011 Japan earthquake and tsunami, however, showed that the hazard had been underestimated. It became apparent that tsunamis could flood significantly farther inland than the limits of the evacuation zones published in the previous year. After a quick modeling study, it was clear that by far the greatest threat facing Hawaiʻi is a tsunami from the Aleutians. Therefore, a new effort was undertaken from 2012 to 2015 to consider the public safety implications of inundation from a Great Aleutian Tsunami, or as it was termed for the updated Hawaiʻi Evacuation Plan, an Extreme Tsunami (Chock 2016; Hawaiʻi State HMP 2013).

The GAT inundation area has been used by the County of Kauai, the City and County of Honolulu, and the County of Maui as the basis for new secondary evacuation zones (also known as Extreme Tsunami Evacuation Zones, or XETZ). The new set of tsunami evacuation zones do not replace the current tsunami evacuation zone; it adds a second zone for a potential extreme tsunami event.

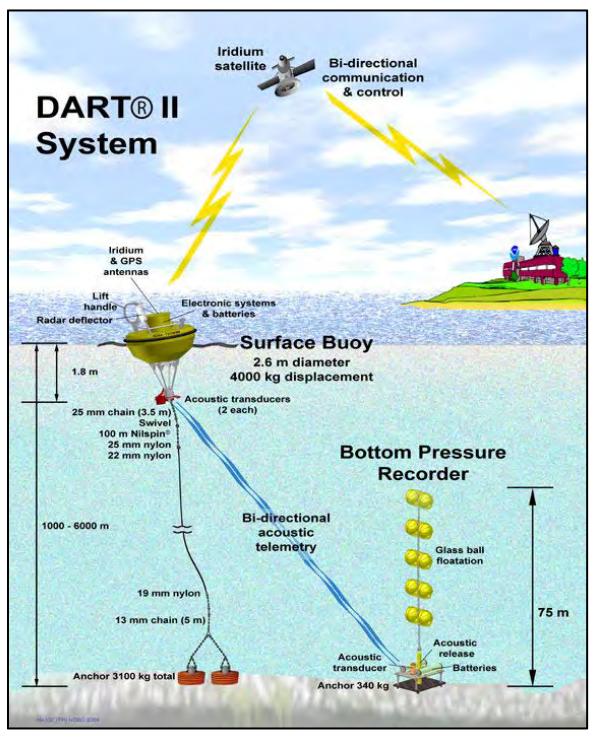
Tsunami Warning Centers

NOAA has two tsunami warning centers (TWC) that are staffed 24 hours a day, 7 days a week. Their mission is to provide early tsunami warnings on potentially destructive tsunamis and help protect life and property from them. The warning centers monitor for tsunamis and the earthquakes that may cause them, forecast tsunami impacts, issues tsunami messages, conduct public outreach, and coordinate with partners to continually improve warning operations (NWS 2018). The Pacific Tsunami Warning Center (PTWC) provides the official tsunami warnings for the State of Hawaiʻi. PTWC's products include: warnings, watches, advisories, information statements, seismic information statements, and warning cancellations. Operational warning sirens for these warnings exist on the most densely populated coastal areas of all islands (see additional discussion in Tsunami Warning Sirens section below). When the PTWC issues an urgent local tsunami warning (the warning product for a local-source tsunami), or a tsunami warning (the warning product for a distant-source tsunami), a steady three-minute siren tone is the attention alert signal.

- A **Tsunami Warning** is issued when a potential tsunami with significant widespread inundation is imminent or expected. Generally, this means that the tsunami is expected to run up more than one meter above sea level somewhere in the State. Warnings alert the public that widespread, dangerous coastal flooding accompanied by powerful currents is possible and may continue for several hours after arrival of the initial wave. Warnings also alert emergency management officials to take action for the entire tsunami hazard zone. Appropriate actions to be taken by local officials may include the evacuation of low-lying coastal areas, and the repositioning of ships to deep waters when there is time to safely do so. Warnings may be updated, adjusted geographically, downgraded, or canceled. To provide the earliest possible alert, initial warnings are normally based only on seismic information. The warning includes an estimate (usually good to within a few minutes) of when the first tsunami wave will arrive.

- A **Tsunami Advisory** is issued when the tsunami will be too small to require evacuation, but is expected to be large enough to make beaches and near shore waters dangerous. Generally, this means that tsunami runup is expected to exceed 0.3 meters somewhere in the State, but will not exceed 1.0 meters anywhere. A tsunami advisory means there is threat of a potential tsunami which may produce strong currents or waves dangerous to those in or near the water. Coastal regions historically prone to damage due to strong currents induced by tsunamis are at the greatest risk. The threat may continue for several hours after the arrival of the initial wave, but significant widespread inundation is not expected for areas under an advisory. Appropriate actions to be taken by local officials may include closing beaches, evacuating harbors and marinas, and the repositioning of ships to deep waters when there is time to safely do so. Advisories are normally updated to continue the advisory, expand/contract affected areas, upgrade to a warning, or cancel the advisory.
- A **Tsunami Watch** is issued to alert emergency management officials and the public of a tsunami which may later impact the watch area. A tsunami watch will always be either upgraded to a warning or advisory—or canceled—based on updated information and analysis. Therefore, emergency management officials and the public should prepare to take action. Watches are normally issued based on seismic information before confirmation that a destructive tsunami has been generated. A tsunami watch is only issued if any potential tsunami is more than three hours away; if the potential tsunami will arrive within three hours a tsunami warning is issued instead.
- A **Tsunami Information Statement** is issued to inform emergency management officials and the public that an earthquake has occurred, but there is no threat of a destructive tsunami in Hawaiʻi. For earthquakes within the state, information statements are issued to prevent unnecessary evacuations as the earthquake may have been felt. An information statement may, in appropriate situations, caution about the possibility of minor wave activity. Information statements may be re-issued with additional information, though normally these messages are not updated. However, a watch, advisory or warning may be issued for the area, if necessary, after analysis and/or updated information becomes available.
- A **Tsunami Warning Cancellation** is the final product indicating the end of the damaging tsunami threat. A cancellation is usually issued after an evaluation of sea level data confirms that a destructive tsunami will not impact the warned area (PTWC 2009). In the event of a damaging tsunami, the cancellation is issued after coastal tide gauges show that waves have fallen below the danger level and no further damaging waves are expected.

Figure 4.13-9. DART II System



Deep-ocean Assessment and Reporting of Tsunami (DART®)

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. For in-depth details on how the DART® system works, refer to: https://nctr.pmel.noaa.gov/Dart/about-dart.html. Figure 4.13-9 depicts the operation of the DART system.

The information collected by a network of DART® systems positioned at strategic locations throughout the ocean plays a critical role in tsunami forecasting. There are 51 systems located throughout the world, with a majority of them located in the Pacific Ocean. There is one DART® system located west of Kailua-Kona.

When a tsunami occurs, the first information available, from the worldwide network of seismometers, is about the earthquake source. That is enough to send out an initial warning message. As the tsunami wave propagates across the ocean and reaches coastal tide gauges or the DART® systems, sea level measurements are reported back to the Tsunami Warning Centers – National Tsunami Warning Center in Palmer, Alaska, and Pacific Tsunami Warning Center in Honolulu, Hawaiʻi. The information from the DART® systems are processed at the warning centers to produce a new and more refined estimated of the tsunami source. The result is an increasingly accurate forecast of the tsunami that can be used to issue refine watches and warnings (NOAA 2018).

Tsunami Warning Sirens

Each county in Hawaiʻi is responsible for tsunami evacuations and issuing the all-clear. For distant-source tsunamis, the State of Hawaiʻi Emergency Management Agency (HI-EMA) coordinates the statewide sounding of the first tsunami warning siren. Subsequent siren soundings are the responsibility of each county. If evacuation is necessary, the sirens will be activated. The sirens exist on most densely populated coastal areas of all Hawaiian Islands. They are tested monthly. When the Pacific Tsunami Warning Center (PTWC) issues a warning, a steady three-minute siren tone is the attention alert signal (Hawaiʻi State HMP 2013). For local-source events, PTWC uses HAWAS to instruct the counties directly to sound the sirens.

Figure 4.13-10. Tsunami Rushing Up Hakalau Stream, April 1946

Source: International Tsunami Information Center 2018

Runup Detector System

PTWC measures tsunamis within Hawaiʻi at nine tide gauges throughout the state as well as at the DART off Kailua-Kona. For a local-source tsunami, these data are not available fast enough to issue a useful warning, so in the early 2000s, a new runup detector system was installed close to potential sources on the Island of Hawaiʻi. Each sensor is a device on land, within 50 yards of the ocean, which sounds an alarm at PTWC if it gets wet. Six of these sensors are distributed along the southwest and southeast shorelines of Hawaiʻi Island. If two adjacent sensors are flooded within a few minutes of each other, regardless of whether or not there is an earthquake, PTWC will issue the appropriate local tsunami warning. In the event of an earthquake, PTWC will issue a warning within three minutes, several minutes before the tsunami reaches land. The runup detectors then serve simply to corroborate the warning, since the warning will already have been issued. But if there is no earthquake, as in the case of a tsunami generated by a spontaneous landslide, the runup sensors allow a warning to be issued for the adjacent coast. The runup sensors therefore serve as a "fail safe" system.

Previous Occurrences and Losses

The earliest historical account of a Hawaiʻi tsunami was from a 16th century Hawaiian chant that described a huge wave that struck the coast of Molokaʻi. The earliest confirmed tsunami in the state was on December 21, 1812 when a wave from southern California was observed at Hoʻokena on the west coast of the Island of Hawaiʻi. Since 1812, there have been more than 160 tsunamis (135 confirmed and 26 unconfirmed) in the state, resulting in over 2,000 runup observations. Nine of the confirmed tsunamis caused 294 deaths and damages totaling over $600 million (International Tsunami Information Center 2018).

From 1812 to December 2017, 27 tsunamis had runup heights greater than one meter have made landfall in the Hawaiian Islands. Seven had significant damaging effects (based on number of deaths, injuries, and damages) (NOAA National Geophysical Data Center/World Data Service [NGDC/WDS] 2018).

Many sources provided tsunami information regarding previous occurrences and losses associated with these events throughout the State of Hawaiʻi. The 2013 Plan discussed specific tsunami events that impacted Hawaiʻi through 2012. For this 2018 HMP Update, tsunami events and associated runups were summarized between January 1, 2012, and December 31, 2017. According to the NOAA National Centers for Environmental Information/World Data Service (NCEI/WDS) database, between 2012 and 2017, there have been no recorded tsunamis that originated in Hawaiʻi. However, Hawaiʻi has experienced impacts of recent tsunami events in the form of runups. Table 4.13-2 includes details of tsunami and runup events that occurred in the State between 2012 and 2017. For events prior to 2012, please refer to Appendix X.

FEMA Disaster Declarations

Between 1954 and 2017, FEMA included the State of Hawaiʻi in one tsunami-related major disaster (DR) declaration. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2018).

Based on all sources researched, the State of Hawaiʻi was not included in any FEMA tsunami-related declarations between 2012 and 2017. For details regarding all declared disasters, refer to Section 4.0 (Risk Assessment Overview).

Table 4.13-2. Tsunami Events in Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
October 28, 2012	Tsunami Runup	Honolulu, Maui, Kauaʻi, and Hawaiʻi	The source of the tsunami was in British Columbia, Canada. The maximum runup of this tsunami near the source was 13 meters. The Pacific Tsunami Warning Center issued a tsunami warning for Hawaiʻi. There were no reports of damage; however, one person died in a car crash on Oʻahu's north shore during the evacuation. From photographs, runup was inferred to have been about one meter at Honouliwai, Molokaʻi and at Kapalua, Maui. Runup was measured in all counties: • Waianea (Honolulu) had a maximum water height of 0.41 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.09 meters (tide-gauge measurement) • Lahaina (Maui) had a maximum water height of 0.28 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.79 meters (tide-gauge measurement) • Hanalei (Kauaʻi) had a maximum water height of 0.19 meters (tide-gauge measurement) • Nāwiliwili (Kauaʻi) had a maximum water height of 0.03 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.43 meters (tide-gauge measurement) • Mokuoloʻe-Coconut Island (Honolulu) had a maximum water height of 0.09 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.27 meters and 0.41 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.2 meters (tide-gauge measurement) • Kaumalapau (Maui) had a maximum water height of 0.18 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.56 meters (tide-gauge measurement) • Honokōhau (Hawaiʻi) had a maximum water height of 0.09 meters (tide-gauge measurement) • Honuʻapo (Hawaiʻi) had a maximum water height of 0.04 meters (tide-gauge measurement) • Kapoho (Hawaiʻi) had a maximum water height of 0.19 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.29 meters (tide-gauge measurement)
November 7, 2012	Tsunami Runup	Maui and Hawaiʻi	The source of the tsunami was in Guatemala. The maximum near-source runup of this tsunami was 0.35 meters. Runup was measured in the Counties of Maui and Hawaiʻi: • Kahului (Maui) had a maximum water height of 0.07 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.06 meters (tide-gauge measurement)
February 6, 2013	Tsunami Runup	Honolulu, Maui, Kauaʻi and Hawaiʻi	The source of the tsunami was in the Santa Cruz Islands, where runup reached 11 meters and there were numerous deaths. The tsunami was measured in all countiesi: • Waianea (Honolulu) had a maximum water height of 0.06 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.05 meters (tide-gauge measurement) • Lahaina (Maui) had a maximum water height of 0.12 meters (tide-gauge measurement)

Date(s) of Event	Event Type	Counties Affected	Description
			• Nāwiliwili (Kauaʻi) had a maximum water height of 0.01 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.19 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.08 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.06 meters (tide-gauge measurement) • Kaumalapau (Maui) had a maximum water height of 0.03 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.12 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.09 meters (tide-gauge measurement) • Honokōhau (Hawaiʻi) had a maximum water height of 0.07 meters (tide-gauge measurement)
April 1, 2014	Tsunami Runup	Honolulu, Kauaʻi, Hawaiʻi	The source of the tsunami was in Northern Chile, where runup reached 4.4 meters. Runup was measured in the Counties of Honolulu, Kauaʻi, and Hawaiʻi: • Waianea (Honolulu) had a maximum water height of 0.09 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.08 meters (tide-gauge measurement) • Nāwiliwili (Kauaʻi) had a maximum water height of 0.04 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.15 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.08 meters (tide-gauge measurement) • Waimānalo (Honolulu) had a maximum water height of 0.11 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.06 meters (tide-gauge measurement) • Kaumalapau (Maui) had a maximum water height of 0.02 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.53 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.22 meters (tide-gauge measurement) • Honokōhau (Hawaiʻi) had a maximum water height of 0.09 meters (tide-gauge measurement) • Honuʻapo (Hawaiʻi) had a maximum water height of 0.04 meters (tide-gauge measurement) • Kapoho (Hawaiʻi) had a maximum water height of 0.12 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.57 meters (tide-gauge measurement)
June 23, 2014	Tsunami Runup	Kauaʻi, Honolulu, and Maui	The source of the tsunami was in the Aleutian Islands in Alaska. The maximum measured runup in the Aleutians (though some distance from the source) was 0.17 meters. Runup was measured in the Counties of Kauaʻi, Honolulu, and Maui: • Hanalei (Kauaʻi) had a maximum water height of 0.05 meters (tide-gauge measurement) • Haleʻiwa (Honolulu) had a maximum water height of 0.04 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.03 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.1 meters (tide-gauge measurement)
September 16, 2015	Tsunami Runup	Honolulu, Kauaʻi, Hawaiʻi, and Maui	The source of the tsunami was in Central Chile, where runup reached 13.6 meters. A tsunami watch was issued for the State of Hawaiʻi, but was cancelled before the tsunami arrived. The tsunami was measured in all counties:

Date(s) of Event	Event Type	Counties Affected	Description
			• Waianea (Honolulu) had a maximum water height of 0.23 meters (tide-gauge measurement) • Barbers Point (Honolulu) had a maximum water height of 0.1 meters (tide-gauge measurement) • Nāwiliwili (Kauaʻi) had a maximum water height of 0.14 meters (tide-gauge measurement) • Hanalei (Kauaʻi) had a maximum water height of 0.03 meters (tide-gauge measurement) • Waimānalo (Hawaiʻi) had a maximum water height of 0.21 meters (tide-gauge measurement) • Mokuoloʻe-Coconut Island (Honolulu) had a maximum water height of 0.04 meters (tide-gauge measurement) • Makapuʻu Point (Honolulu) had a maximum water height of 0.01 meters (tide-gauge measurement) • Waimānalo (Honolulu) had a maximum water height of 0.21 meters (tide-gauge measurement) • Honolulu (Honolulu) had a maximum water height of 0.11 meters (tide-gauge measurement) • Kalaupapa (Maui) had a maximum water height of 0.08 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.65 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of 0.27 meters (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.91 meters (tide-gauge measurement)
November 21, 2016	Tsunami Runup	Hawaiʻi	The source of the tsunami was in Japan off the east coast of Honshu Island. The maximum water height from this tsunami is unknown. A runup from this event was observed at the Midway Islands in Hawaiʻi, with a maximum water height of 0.09 meters (tide-gauge measurement).
September 8, 2017	Tsunami Runup	Honolulu, Maui, and Hawaiʻi	The source of the tsunami was in Mexico, where runup reached 2.7 meters. The tsunami was measured in the Counties of Honolulu, Maui, and Hawaiʻi: • Mokuoloʻe-Coconut Island(Honolulu) had a maximum water height of 0.03 meters (tide-gauge measurement) • Kahului (Maui) had a maximum water height of 0.18 meters (tide-gauge measurement) • Kawaihae (Hawaiʻi) had a maximum water height of an unknown height (tide-gauge measurement) • Hilo (Hawaiʻi) had a maximum water height of 0.17 meters (tide-gauge measurement)

Source: NCEI Global Historical Tsunami Database 2018
Note: Please note that not all sources may have been identified in order to be researched for this 2018 HMP Update. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 4.13-2 may not include all events that have occurred in or impacted the State and the accuracy of monetary figures discussed is based only on the available information identified during research for this 2018 HMP Update.

Probability of Future Hazard Events

Tsunamis are caused by earthquakes, landslides, and volcanic eruptions, so the frequency of tsunamis depends on these other geological events. Generally, four to five tsunamis occur every year in the Pacific Basin, though these are usually hazardous only close to the source. Every five years or so a tsunami is generated which is large enough to threaten coastlines on the far side of the ocean from its source. Based on information from the National Centers for Environmental Information, since 1812, 59 tsunamis have produced a runup of greater than 0.3 meters (the threshold for issuing a tsunami advisory) somewhere in the State of Hawaiʻi. Of these, 34 produced a runup greater than one meter (the threshold for coastal flooding and therefore the threshold for issuing a tsunami warning). Based on these data, the State should expect a potentially damaging tsunami, one requiring coastal evacuation, approximately once every six years. The State of Hawaiʻi has roughly a 17 percent chance of a damaging tsunami occurring in any given year.

The probability of advisory-level tsunamis, those for which evacuation is unnecessary but which may create dangerous coastal currents, is at least double that of the larger, warning-level tsunamis (we have to be careful here, because the historical record for these smaller events is probably incomplete before about 1910). Very roughly, we should expect a tsunami advisory once every three years, or about a 34% chance of one in any year.

Climate Change Impacts

The warming of the atmosphere and the oceans and melting of ice sheets and glaciers is causing the global mean sea level to rise. Higher sea levels will exacerbate the extent of coastal inundation from a tsunami. The Intergovernmental Panel on Climate Change (IPCC) predicts up to 3.2 feet of global sea level rise by 2100; however, recent observations and projections suggest that this magnitude of sea level rise could occur as early as 2060. This projection would have devastating impacts on the State of Hawaiʻi. Rising sea levels will increase the extent of coastal flooding from tsunamis as they create waves that flood low-lying coastal areas (Hawaiʻi Climate Change Mitigation and Adaptation Commission 2017). Practically, what rising sea level means for tsunami preparedness is that the evacuation maps should be reassessed periodically, probably once a decade.

4.13.2 Vulnerability Assessment

A statewide tsunami analysis was conducted based on best available data for the State of Hawaiʻi. The GAT inundation area and Hazus reports were provided by the PDC including building damage and loss, displaced population and potential casualties for each county, for use in the 2018 HMP Update.

Tsunami Hazard Area Definition

Great Aleutian Tsunami (GAT) inundation area spatial data, provided by the Pacific Disaster Center, were used to assess exposure and potential loss to the tsunami hazard. The hazard area is called the GAT inundation area.

Assessment of State Vulnerability and Potential Losses

This section discusses statewide vulnerability of areas susceptible to the tsunami hazard and potential losses to state assets (state-owned or state-leased buildings), state roads and critical facilities.

State Assets

The spatial analysis determined there are 1,175 state buildings located in the GAT inundation area. Of these buildings, the greatest number are located in the City and County of Honolulu (760 buildings with a replacement cost value of $3.102 billion); the majority of these buildings are occupied by the Department of Education and University of Hawai'i. Table 4.13-3 and Table 4.13-4 summarize the state buildings located in the GAT inundation area by county and state agency, respectively.

Table 4.13-3. State Buildings Exposure to the GAT Inundation Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	State Buildings in the Tsunami Hazard Area			
			Number	Percent (%) of Total	Total Replacement Cost Value	Percent (%) of Total
County of Kaua'i	531	$957,679,537	130	24.5%	$239,699,568	25.0%
City and County of Honolulu	3,472	$16,750,785,426	760	21.9%	$3,102,858,820	18.5%
County of Maui	831	$2,862,316,819	153	18.4%	$559,044,781	19.5%
Count of Hawai'i	1,261	$4,209,774,236	132	10.5%	$543,574,970	12.9%
Total	**6,095**	**$24,780,556,017**	**1,175**	**19.3%**	**$4,445,178,139**	**17.9%**

Source: Hawai'i State Risk Management Office 2017; PDC 2017
Notes: PDC Pacific Disaster Center

Table 4.13-4. State Buildings Exposure to the GAT Inundation Area by State Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	17	25.8%	$224,412,549	23.7%
Dept of Agriculture	70	$133,065,375	25	35.7%	$44,264,540	33.3%
Dept of Attorney General	15	$95,151,863	6	40.0%	$30,214,798	31.8%
Dept of Budget & Finance	16	$26,624,294	6	37.5%	$20,647,179	77.6%
Dept of Business, Economic Development and Tourism	25	$612,574,032	6	24.0%	$529,204,718	86.4%
Dept of Commerce & Consumer Affairs	2	$35,611,360	1	50.0%	$31,638,545	88.8%
Dept of Defense	69	$246,099,477	12	17.4%	$34,899,610	14.2%
Dept of Education	4,090	$9,604,111,443	755	18.5%	$1,511,046,120	15.7%
Dept of Hawaiian Home Lands	12	$100,471,477	3	25.0%	$7,158,597	7.1%
Dept of Health	44	$387,068,440	7	15.9%	$11,154,835	2.9%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%
Dept of Human Services	130	$420,004,555	46	35.4%	$237,628,728	56.6%
Dept of Labor and Industrial Relations	22	$79,322,626	6	27.3%	$54,990,991	69.3%
Dept of Land and Natural	90	$98,666,185	36	40.0%	$19,584,394	19.8%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Resources						
Dept of Public Safety	154	$427,884,909	23	14.9%	$53,436,031	12.5%
Dept of Taxation	1	$6,864,408	1	100.0%	$6,864,408	100.0%
Dept of Transportation	68	$2,912,510,888	33	48.5%	$462,718,699	15.9%
Hawai'i State Ethics Commission	1	$891,212	1	100.0%	$891,212	100.0%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	1	0.9%	$829,553	0.1%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	16	18.6%	$153,919,201	46.1%
Hawaiʻi Public Housing Authority	273	$933,255,767	45	16.5%	$111,586,569	12.0%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%
Hawaiʻi State Public Library System	53	$525,584,082	17	32.1%	$46,999,631	8.9%
Judiciary	41	$511,093,204	12	29.3%	$163,124,526	31.9%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	8	72.7%	$49,715,963	92.1%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$3,977,640	0	0.0%	$0	0.0%
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawai'i	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawai'i	637	$5,000,692,783	92	14.4%	$638,246,741	12.8%
Total	**6,095**	**$24,780,556,017**	**1,175**	**19.3%**	**$4,445,178,139**	**17.9%**

Source: Hawaiʻi State Risk Management Office 2017; PDC 2017
Notes: PDC Pacific Disaster Center

State roads are vulnerable to tsunami inundation. Not only will these roads become flooded and may experience extensive damage, but the debris carried by the tsunami may be deposited on the roadway surfaces. Roads may take months to repair and reopen causing communities to become isolated. Table 4.13-5 shows the length of State roads in the GAT inundation area by county. The City and County of Honolulu has the greatest number of miles exposed (94.8 miles), followed by the County of Maui (54.2 miles). A complete list of State roads located in the GAT inundation area is included in Appendix X.

Table 4.13-5. State Road Exposure to the GAT Inundation Area by County

County	Length (in miles)		
	Total Length	Length of State Road in the GAT Inundation Area	Length as Percent (%) of Total Length
County of Kauaʻi	104.0	27.9	26.8%

County	Length (in miles)		
	Total Length	Length of State Road in the GAT Inundation Area	Length as Percent (%) of Total Length
City and County of Honolulu	375.3	94.8	25.3%
County of Maui	238.6	54.2	22.7%
County of Hawaiʻi	378.7	6.1	1.6%
Total	**1,096.5**	**183.0**	**16.7%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017; PDC 2017
Notes: GIS Geographic Information System
PDC Pacific Disaster Center
SDOT State Department of Transportation

Critical Facilities

Table 4.13-6 summarizes the total number of critical facilities located in the GAT inundation area by county and core category. The City and County of Honolulu has the greatest number of critical facilities (185) exposed, followed by the County of Maui (102 critical facilities). Table 4.13-7 summaries the number of facilities and replacement cost exposed by core category. The Energy core category has 51.5% of its facilities located in the tsunami hazard area, followed by Transportation Services (48.2%) and Water, Waste and Wastewater Systems (34.8%).

Table 4.13-6. Critical Facilities Located in the GAT Inundation Area by County

County	Core Category of Critical Facilities										Total in the Hazard Area
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	1	1	6	4	2	2	1	9	2	10	38
City and County of Honolulu	9	20	21	33	1	14	9	26	3	49	185
County of Maui	2	8	9	3	0	7	10	14	14	35	102
County of Hawaiʻi	3	8	4	6	12	2	4	4	8	12	63
Total	**15**	**37**	**40**	**46**	**15**	**25**	**24**	**53**	**27**	**106**	**388**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; PDC 2017
Notes: PDC Pacific Disaster Center

Table 4.13-7. Critical Facilities Located in the GAT Inundation Area by Core Category

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	15	25.0%	$95,637,385	46.2%
Communications	130	$523,848,060	37	28.5%	$123,390,205	23.6%
Emergency Services	149	$1,017,628,710	40	26.8%	$221,055,140	21.7%
Energy	90	$2,591,975,628	46	51.1%	$1,212,476,143	46.8%

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Food & Agriculture	39	$829,869,410	15	38.5%	$276,327,850	33.3%
Government Facilities	100	$399,781,575	25	25.0%	$97,717,895	24.4%
Healthcare & Public Health	193	$3,399,521,375	24	12.4%	$172,080,183	5.1%
Mass Care Support Services	353	$11,497,547,155	53	15.0%	$1,500,066,395	13.0%
Transportation Services	56	$1,739,256,960	27	48.2%	$837,469,440	48.2%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	106	34.8%	$3,300,771,840	34.8%
Total	**1,475**	**$31,687,768,838**	**388**	**26.3%**	**$7,836,992,475**	**24.7%**

Source: *Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; PDC 2017*
Notes: *PDC Pacific Disaster Center*

As summarized in Section 4.1 (Climate Change), the primary transportation arteries for the entry of people and goods to the State is the Daniel K. Inouye International Airport and Honolulu Harbor. In addition, each island has critical points of entry for people and goods located along the coast. Because of their geographic location, ports and harbors are especially vulnerable to the tsunami hazard; as well as airports located on the coast. Damages and closures to these critical facilities will likely be long-term have cascading economic impacts statewide.

The March 2011 tsunami that impacted Japan serves as a point of reference for potential losses to critical assets in the State of Hawaiʻi . As a result of the tsunami, cargo containers were floating in the flood waters; there is a similar concern that containers may fall into Honolulu Harbor not only losing the cargo itself but blocking ships from accessing the piers and the containers themselves becoming projectiles which can cause more damage. The Oahu Metropolitan Planning Organization 2011 *Transportation Asset Climate Change Risk Assessment* estimates the Daniel K. Inouye International Airport will experience one-to-three days of downtime for emergency response, and one-to-two weeks of downtime for commercial flights after a tsunami event (SSM International 2011).

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of vulnerability and potential losses to population, general building stock, and environmental resources and cultural assets by county.

Population

Table 4.13-8 displays the estimated population living in or near the GAT inundation area that could be impacted should a tsunami event occur. For the purposes of the 2018 HMP Update, the population vulnerable to possible tsunami inundation is considered the same as the exposed population. The degree of vulnerability of the population exposed 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?

Table 4.13-8. 2010 U.S. Census Population Located in the GAT Inundation Area by County

County	Population						
	Total Population	Population in Hazard Area	Population Exposed as % of Total Population	Population Over 65 in Hazard Area	Population Over 65 Exposed as % of Total Population	Income <$30K/yr in Hazard Area	Income <$30K/yr Exposed as Percent (%) of Total
County of Kauaʻi	67,091	9,961	14.8%	1,502	2.2%	3,519	5.2%
City and County of Honolulu	953,207	185,389	19.4%	25,964	2.7%	55,647	5.8%
County of Maui	154,924	32,595	21.0%	4,116	2.7%	8,598	5.5%
County of Hawaiʻi	185,079	8,412	4.5%	1,328	0.7%	4,887	2.6%
Total	**1,360,301**	**236,357**	**17.4%**	**32,910**	**2.4%**	**72,651**	**5.3%**

Source: U.S. Census 2010; PDC 2017
Notes: PDC Pacific Disaster Center
The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaiʻi. To convert households to residents, three people per household was used.

The analysis indicates that the City and County of Honolulu has the greatest number of people located in the GAT inundation area. This analysis does not include the number of tourists and visitors in the State; some may be located on the beach or in other recreational areas, or in lodgings that are located in GAT inundation area. Therefore, this estimate may be underestimating exposure and vulnerability. It is interesting to note that Hazus estimates a higher day population exposed to the GAT inundation area compared to the night population exposed which is the estimated 2010 U.S. Census population and displayed in Table 4-7. Therefore, the exposed population depends on the time of day the tsunami occurs.

The populations considered most vulnerable include children, elderly (persons over the age of 65), individuals with access and functional needs and visitors. Socially vulnerable populations are most susceptible based on many factors including their physical and financial ability to react or respond during a hazard. The population over 65 makes up about 2.4% of the total population residing in the hazard area. Visitors recreating in or around the inundation areas are vulnerable because they may not be as familiar on appropriate response and the best way to reach higher ground.

Tsunami events can cause injuries and fatalities if timely evacuation does not occur. Further, tsunami waves can carry debris and people out to sea when they retreat. Hazus estimates the number of casualties based on three community tsunami preparedness scenarios ranging from good to poor. ‘Good’ is intended for well-prepared communities such as Tsunami Ready communities. All counties and many communities throughout the state are Tsunami Ready. ‘Poor’ is considered for a community with little to no experience or education programs available. The guidance from Hazus is that areas with large visitor populations, such as the State, may incorporate more than one preparedness level into their planning. Table 4-8 summarizes the estimated casualties (fatalities and injuries) Hazus estimates as a result of the GAT.

Table 4.13-9. Estimated GAT Fatalities and Injuries by Community Preparedness Level

County	Community Preparedness Level								
	Good			Fair			Poor		
	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties	Fatalities	Injuries	Total Casualties
County of Kauaʻi	0	0	0	2,136	70	2,206	6,618	91	6,710
City and County of Honolulu	0	0	0	45,188	2,959	48,147	143,455	3,473	146,929
County of Maui	0	0	0	8,658	371	9,025	26,273	444	26,717
County of Hawaiʻi	0	0	0	3,422	131	3,553	10,336	159	10,495
Total	**0**	**0**	**0**	**59,404**	**3,531**	**62,931**	**186,682**	**4,167**	**190,851**

Source: PDC 2017
The estimated number of injuries and fatalities is based on the daytime population which is higher than the night population to provide a worse-case scenario for planning purposes.

According to the Centers for Disease Control and Prevention, the primary health concerns after a tsunami event include clean drinking water, food, shelter and medical care for injuries. Flood waters can pose health risks such as contaminated water and food supplies. The majority of deaths associated with tsunamis are related to drownings; however traumatic injuries are also a primary concern. Medical care is critical in areas impacted by a tsunami (CDC 2013).

After a tsunami, residents should not return home until after local officials indicate it is safe. It cannot be assumed that after one wave the danger is over; a tsunami is a series of waves that may continue for hours. Debris in the water may be a safety hazard to both people and pets. Residents should not enter their homes or other buildings when they have water in and around the structure; the floors may be cracked and the walls may collapse.

General Building Stock

All structures along the coast are vulnerable to a tsunami. The impact of the waves and the scouring associated with debris that may be carried in the water could damage or destroy structures in the tsunami's path. Similar to the analyses presented earlier, the general building stock data was overlaid with the tsunami hazard area to assess exposure; or buildings located in the GAT inundation area. The City and County of Honolulu has the greatest replacement cost value of buildings located in the GAT inundation area. Table 4.13-10 summarizes these values by county.

The PDC calculated estimated potential building damage as a result of the GAT. Total building loss includes structural damage cost, non-structural damage cost and content damage cost. Greater than $12.8 billion in building damages, or 5.3% of the state's total inventory, is estimated. The City and County of Honolulu is estimated to experience greatest loss (more than $6 billion in damages to over 17,000 buildings), followed by the County of Maui (more than $3.5 billion to over 6,000 buildings). The County of Hawaiʻi is estimated to experience more than $1.9 billion in building damages to over 2,000 buildings, and the County of Kauaʻi is estimated to experience more than $1.3 billion to nearly 4,000 buildings. According to Hazus, the majority of the building damage in all counties is to residential structures which are damaged beyond repair.

Table 4.13-10. General Building Stock Exposure and Potential Losses to the GAT by County

County	Total Value	Replacement Cost Value in Hazard Area	Replacement Cost Value Exposed as % of Total	Estimated Building Potential Loss	
				Replacement Cost Value	Percent (%) of Total
County of Kauaʻi	$13,287,882,000	$2,641,513,000	19.9%	$1,322,085,389	9.9%
City and County of Honolulu	$164,787,212,000	$43,010,342,000	26.1%	$6,082,130,961	3.7%
County of Maui	$31,320,693,000	$9,026,708,000	28.8%	$3,513,021,920	11.2%
County of Hawaiʻi	$33,326,392,000	$3,595,732,000	10.8%	$1,951,209,483	5.9%
Total	**$242,722,179,000**	**$58,274,295,000**	**24.0%**	**$12,868,447,753**	**5.3%**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; Hazus 4.2; PDC 2017
Notes: GIS Geographic Information System
PDC Pacific Disaster Center

Hazus estimates business interruption losses as a result of a tsunami event. Business interruption losses are the losses associated with the inability to operate a business because of the damage sustained from the tsunami. These losses also include temporary living expenses for those people displaced from their homes (relocation loss). Table 4.13-11 summarizes the business interruption losses that the State may incur, in addition to the direct building-related losses summarized in Table 4.13-10 above.

Table 4.13-11. Business Interruption Losses as a result of the GAT by County

County	Total Economic Loss	Relocation Loss	Capital-Related Loss	Wages Loss	Rental Income Loss
County of Kauaʻi	$293,086,000	$106,558,000	$49,702,000	$69,439,000	$67,387,000
City and County of Honolulu	$1,804,448,000	$565,135,000	$322,039,000	$544,205,000	$373,069,000
County of Maui	$1,001,682,000	$234,788,000	$241,543,000	$325,058,000	$200,293,000
County of Hawaiʻi	$601,671,000	$98,241,000	$117,593,000	$322,622,000	$63,215,000
Total	**$293,086,000**	**$106,558,000**	**$49,702,000**	**$69,439,000**	**$ 67,387,000**

Source: Hazus 4.2; PDC 2017
Notes: PDC Pacific Disaster Center

Land Use Districts

Table 4.13-12 shows the square miles of the tsunami hazard area in each State Land Use District statewide; refer to Appendix X for results for each county. More than 20% of Urban District lands statewide are exposed to the tsunami hazard, which is concerning due to the concentration of development in these areas. Although tsunami risk is considered to some extent in the delineation of special flood hazard areas (SFHA) in the State (areas where flood resistant construction standards apply), it is important to note that the inundation area from the GAT event includes more than double the amount of Urban District lands than are located in the SFHA. This means that development in these areas are unlikely to have been constructed within any considerations for flood damage reduction and that many of these structures will not be insured against flood losses. Although only less than 1% of the Conservation District lands are exposed to the tsunami hazard, there may be significant ecological consequences in these areas, particularly in the nearshore environment. Conservation District lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the discussion on environmental resources below.

Table 4.13-12. State Land Use Districts Located in the GAT Inundation Area

Land Use District	Total (square miles)	Square Miles in Tsunami Hazard Area	Percent (%) of Total Area
Agricultural	2,942.8	53.7	1.8%
Conservation	3,156.3	22.7	0.7%
Rural	16.1	1.7	10.6%
Urban	319.7	65.2	20.4%
Total	**6,434.9**	**143.3**	**2.2%**

Source: PDC 2017; State Land Use Commission, 2016
Notes: Total area was calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline were downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
GIS Geographic Information System

Environmental Resources

The loss of natural resources across the state is difficult to quantify. Not only do coral reefs benefit the environment, they provide protection from tsunamis. Coasts with offshore reefs receive less wave energy than unprotected coastlines lying in the path of an approaching tsunami. Islands in a group may “shadow” one another reducing the tsunami effect. Small islands may experience reduced runup as the tsunami waves may refract around them. Fringing and barrier reefs appear to have a mitigating influence on tsunamis by dispersing the wave energy (State of Hawaiʻi 2013).

Tsunami impacts range from loss of livelihood for fisherman, to damages to coral reefs, flora and fauna, and beach loss; all of which have cascading economic impacts statewide. An economic impact analysis was conducted for Wakīkī Beach to estimate the potential economic impact if the beach was completely eroded; whether the cause be a tsunami, flood event or climate change. The economic impact on total hotel revenues could be as much as $661.2 million annually with 6,352 lost jobs in the hotel industry. This is just one example of the potential economic impact to one sector due to the loss of one environmental resource (Wakīkī Improvement Association 2008).

As discussed above, there are 53.7 square miles of agricultural land located in the GAT inundation area. As a result of tsunami waves traveling potentially miles inland, salinization of the land may cause soil to be less fertile and increase vulnerability to erosion (World Wildlife Federation 2017).

Septic tanks, cesspools and other on-site sewage disposal systems are located along the coast. There is a concern that chronic flooding will impact these systems and release wastewater and hazardous materials and waste into nearshore waters and coastal habitats as discussed in the 2017 *Hawaiʻi Sea Level Rise and Vulnerability Assessment Report*. A tsunami may lead to the failure of these systems diminishing water quality, impacting natural aquatic systems and leading to human health exposure to these hazardous wastes.

Due to its geographic location and isolation, the state faces unique challenges in addressing disaster debris. With limited landfill capacity, advanced planning for large amounts of debris generated by a tsunami is critical. Hazardous materials may be mixed with the debris and need to be considered during staging and disposal.

A spatial analysis was conducted to estimate the square miles of environmental resources, including critical habitat (or habitats that are known to be essential for an endangered or threatened species), wetlands and parks and reserves located in the GAT inundation area. These results are summarized in Table 4.13-13.

Table 4.13-14. Environmental Resource Areas Located in the GAT Inundation Area

Environmental Resource	Statewide		
	Total Square Miles of Resources[b]	Square Miles in the GAT Inundation Area	Percent (%) of Total Resource Area
Critical Habitat[a]	915.2	3.0	0.3%
Wetlands	260.0	25.2	9.7%
Parks and Reserves	2,607.7	18.4	0.7%

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; HWMO 2013
Notes: GIS Geographic Information System
a. Critical habitat includes the habitats that are known to be essential for an endangered or threatened species. The area mileage includes the combined area of coverage of individual critical habitat areas.
b. Total square miles may be over reported as some environmental asset areas may overlap.
GIS Geographic Information System
HWMO Hawaiʻi Wildfire Management Organization

Cultural Assets

Many Native Hawaiian cultural and historical resources are located near the shore and are threatened by a tsunami event including fishing and cultural practices. The population, built and natural environment and cultural sites located on Hawaiian Home Lands are vulnerable to the tsunami hazard (see Table 4.13-14). The County of Hawaiʻi has the greatest number of square miles (2.3 square miles) located in the GAT inundation area; followed by the County of Maui (2.1 square miles).

Table 4.13-15. Hawaiian Home Lands Located in the GAT Inundation Area

County	Area (in square miles)		
	Total Area	Hawaiian Home Land in the GAT Inundation Area	Percent (%) of Total Area
County of Kauaʻi	32.0	0.9	2.8%
City and County of Honolulu	10.9	1.4	13.0%
County of Maui	92.6	2.1	2.3%
County of Hawaiʻi	190.3	2.3	1.2%
Total	**325.8**	**6.7**	**2.1%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System

FUTURE CHANGES THAT MAY IMPACT STATE VULNERABILITY

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population

- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Potential or Projected Development

The tsunami hazard area was overlain on areas that may experience significant changes in development or redevelopment in future years (see As sea levels rise inundation from tsunamis will reach further inland putting more people and property at risk.

Table 4.13-15 below; refer to Section 3 for more information on projected development areas). The results of this assessment indicate almost half (48%) of the HCDA Community Development Districts are located in tsunami hazard areas. None of these areas are located in the special flood hazard area, so it is unlikely that construction is to standards that would be able to withstand impacts from a tsunami event. Relatively small amounts of the Maui Development Project and Enterprise Zone areas are exposed to the tsunami hazard; however, the exposed area is also greater than the special flood hazard area in these areas.

Projected Changes in Population

As the population in the State ages, more of the State's residents may be unable to quickly evacuate in the event of a local-source tsunami and additional resources may be needed to support evacuation efforts in the event of a distant-source tsunami.

Other Factors of Change

As sea levels rise inundation from tsunamis will reach further inland putting more people and property at risk.

Table 4.13-16. HCDA Community Development Districts, Maui Development Projects, and Enterprise Zones Located in the GAT Inundation Area

	Area (in square miles)								
County	HCDA Community Development Districts (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area	Enterprise Zones (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	-	-	-	-	-	-	252.3	25.6	10.1%
City and County of Honolulu	-	-	-	-	-	-	288.3	36.4	12.6%
County of Maui	-	-	-	27.6	0.7	2.4%	1,016.7	25.9	2.6%
County of Hawaiʻi	7.4	3.6	48.4%	-	-	-	1,286.6	15.5	1.2%
Total	**7.4**	**3.6**	**48.4%**	**27.6**	**0.7**	**2.4%**	**2,843.9**	**103.5**	**3.6%**

Source: PDC 2017
Notes: Total area calculated from: (1) HCDA Community Development District GIS layer from Hawaiʻi Community Development Authority (2) Maui Development Projects GIS layer from Maui County Planning Department (3) Enterprise Zones from Community Economic Development Program, DBEDTS
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
HCDA Hawaiʻi Community Development Authority

SFHA	*Special Flood Hazard Area*

SECTION 4. RISK ASSESSMENT

4.14 Volcanic Hazards (Lava Flow and Vog)

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including how climate change may alter the dispersion and areas of impact of some of the volcanic hazards, e.g. vog).
- Volcanic hazard events that occurred in the State of Hawaiʻi from January 1, 2012, through December 31, 2017, were researched for this 2018 HMP Update. Due to the severity of recent events, the May 2018 event is discussed; however, details regarding the full range of impacts are not available at the time of this 2018 HMP Update.
- Maps of volcanoes and associated lava flows have been added.
- The high hazard lava flow zones for Hawaiʻi (Zones 1 through 4) and Maui (Zones 1 and 2) Counties were used as the hazard areas to assess vulnerability.

4.14.1 Hazard Profile

The main Hawaiian Islands are at the tops of giant undersea shield volcanoes, located at the southeastern end of a chain of volcanoes that began to form over 70 million years ago. Each island is made up of one or more volcanoes that first erupted on the ocean floor and emerged above the ocean's surface after countless eruptions over hundreds of thousands of years. Most of the volcanic activity in the last 200 years has occurred on the Island of Hawaiʻi. The Island of Hawaiʻi is known for frequent occurrence of lava flow eruptions on Kīlauea near its summit and along its East Rift Zone and, less frequently, its Southwest Rift Zone. Mauna Loa, the second most active volcano on the Island of Hawaiʻi, is undergoing a period of eruptive quiescence, having erupted only twice during the last 60 years; prior to this time, Mauna Loa was much more active, erupting, on average, about every five years.

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 (U.S. Geological Survey [USGS] 2017). Hualalai Volcano, although still considered active, has erupted most recently in 1801 whereas Mauna Kea is considered to be dormant, having erupted about 4,000 years ago. Both of these volcanoes are considered to pose comparatively minimal threats of eruptive impact to residents and infrastructure on the island.

Another volcano of note is Loihi, which is the youngest volcano associated with the Hawaiian chain and is located 15 miles (28 km) southeast of Kīlauea volcano underwater off the southern coast of the Island of Hawaiʻi. This volcano's activity has been consistently monitored since 1996. This emerging seamount may eventually break the surface, adding a new island to the Hawaiian chain, with some estimates ranging from

30,000 to 50,000 years. There are no estimated potential impacts to residents and infrastructure from Loihi at this time.

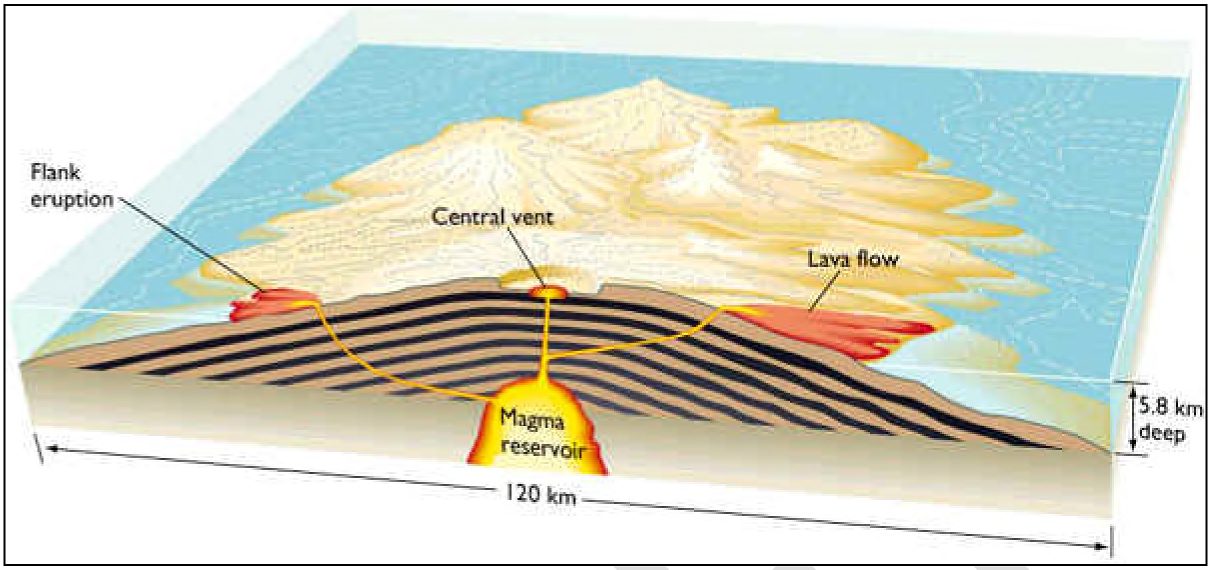
HAZARD DESCRIPTION

Hawaiian volcanoes are shield volcanoes, which, because they dominantly erupt fluid, lava flows form gently sloping, shield-like mountains. Shield volcanoes are the largest volcanoes on earth. Examples of shield volcano are Mauna Loa and Kīlauea, which are located in the County of Hawai`i. Hawaii's volcanic activity is distinct from that occurring at continental margins (e.g. Mt. Shasta, Mt. St. Helens, etc.) in that Hawaii's volcanoes produce more fluid basalt magmas that are typically less explosive. Hawaii's volcanoes are formed sequentially with the older volcanoes to the northwest and younger sister volcanoes to the southeast. Each volcano develops through a relatively consistent sequence of stages exemplified by: Loihi (the youngest), forming an intermittently active submarine volcano on the ocean floor; to Kīlauea, 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 its older sister volcano Mauna Loa. Mauna Loa, a less frequently active volcano, continues to discharge fluid basalts at much higher volume rates during its eruptive episodes; whereas Hualalai and Mauna Kea are less active but typically produce more viscous and more explosive lavas.

Mauna Loa last erupted in 1984, and Kīlauea has been continuously erupting since 1983, most recently with voluminous lava flows along its lower east rift zone and ash-rich explosions in the summit caldera. These simultaneous activities started in May of 2018 and have been on-going during the updating of this plan.

Shield volcanoes are gently sloping mountains produced from lava flows (e.g., Hawaiʻi Center for Volcanology 2013). Lava that flows from shield volcanoes is almost entirely of basalt composition. The gentle slopes of shield volcanoes are the result of basalt being very fluid (i.e., it has a low viscosity) and of the lava flows being so long. Basalt lava flows are characterized by two morphologies, known around the world by their Hawaiian names, `a`ā and pāhoehoe. Eruptions from shield volcanoes are not typically explosive unless water has entered the vent (Oregon State University 2018). The understanding of the eruptive process – explosive activity included – is incomplete since subject-matter experts have been able to observe and record only a small fraction of the life cycle of Hawaiian volcanoes and, hence, the frequency and intensity of the explosive events is not yet fully understood. Shield volcanoes erupt almost exclusively at their summits or along rift zones. For example, Puʻu ʻŌʻō, the vent associated with the current eruption from 1983 until April 2018, is on the east rift zone of Kīlauea Volcano (Rubin 2016).

Figure 4.14-1. Composition of a Shield Volcano



Source: Nelson 2017

Young Hawaiian volcanoes, such as Kīlauea and Mauna Loa, have summit calderas. In Hawaii's shield volcanoes calderas are depressions several miles in diameter that form as the result of a collapse when magma drains from beneath the summit. (Magma is the term used for molten rock that is still beneath the earth's surface; it is called lava when it reaches the surface). Summit eruptions of Kīlauea and Mauna Loa occur within or near their calderas. Flank eruptions usually take place along rift zones, which are highly fractured zones of weakness within the volcano that typically extend from the summit of a volcano toward the coastline and continue under the ocean (State of Hawaiʻi HMP 2013).

Volcanic Phenomena

Volcanic phenomena appear to be individually isolated and diversified. Some phenomena can pose great risk to people and property near these volcanoes, while others pose no risk to people and/or property (i.e., Loihi produces submarine pillow lavas that pose no measurable risk to residents or infrastructure). Those phenomena that would pose to most risk to people and/or property include:

- Lava flows at the summits and along the rift zones;
- Ground cracking/slumping/deformation;
- Earthquake activity associated with the intrusion of magma,
- Possible displacement of volcanic flank (i.e. larger earthquakes) associated with the intrusion of magma into the flanks (e.g. the recent 6.9 on Kīlauea's south flank or Mauna Loa's 1868 7.9 Ka'u event);
- The discharge of volcanic gases (sulfur dioxide, and sulfuric acid;
- The potential for explosive eruptions at the summit accompanying drain-out of the summit magma column;
- Pit crater formation on the rift zones – possibly accompanied by explosive interaction of groundwater with subsurface magma,
- Volcanic weather phenomena such as "fire clouds" or "volcanic tornadoes",

- Bench collapse along newly formed shoreline,
- Methane explosions from burning vegetation,
- Falling ejecta (ash), and
- Tsunami's induces by the earthquakes that trigger or are caused by volcanic activity

Volcanic hazards most prevalent in the State of Hawaiʻi are: lava flow, volcanic gases, bench collapse and methane explosions. These hazards are further discussed throughout this section.

Lava Flows

Lava flows typically erupt from a volcano's summit or along rift zones on its flanks. Lava flows present potential threats to homes, infrastructure, natural and historic resources and entire communities. The areas exposed to the highest risk from lava flows are those situated downslope and proximate to the active rift zones of the active Mauna Loa and Kīlauea volcanoes, the latter as is being seen with the 2018 eruption of Kīlauea. Lava flows travel downslope toward the ocean, burying everything along the way. Lava entering the ocean may build new land known as lava deltas, which are unstable and prone to sudden collapse. A collapsing lava delta can trigger explosive activity that hurls hot rocks hundreds of meters (yards) inland and/or seaward (USGS 2018). Steep slopes may allow lava flows to move quickly from the summit to the ocean in a matter of hours (State of Hawaiʻi HMP 2013).

Explosive volcanic eruptions can produce a variety of ejecta products including: tephra, fragments of rock formed when magma or rock is explosively ejected; large fragments (blocks, bombs) of rock from the volcanic conduit can be expelled with great force but are deposited near the eruptive vent; smaller fragments (lapilli) of ash can be carried upward within in a volcanic plume and downwind in a volcanic cloud; and very fine-grained material volcanic ash is both easily convected upward within the plume and carried downwind for very long distances; as it falls out of suspension it can potentially affect communities and farmland across hundreds, or even thousands, of miles.

Volcanic Gas

Volcanic gas emissions are composed mainly of water vapor (H_2O), carbon dioxide (CO_2), sulfur dioxide (SO_2), and sulfur trioxide (SO_3 – a precursor to sulfuric acid) gases, with trace amounts of several other gaseous compounds, including hydrogen sulfide (H_2S), hydrogen fluoride (HF), and carbon monoxide (CO). Volcanic air pollution (vog) is a hazy mixture of SO_2 gas and aerosols, the latter of which are primarily composed of sulfuric acid droplets 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 over periods of minutes to days. Vog particles grow by absorbing water vapor and other gases, so they can increase in size in a moist environment such as the human upper respiratory tract (nose, mouth, and throat) (USGS 2017).

When molten lava flows into the ocean, it creates localized air pollution known as laze (combination of the words lava and haze). This is a type of gas plume that results in hazy and noxious conditions downwind of an ocean entry. It forms through a series of chemical reactions as hot lava boils seawater to dryness. The plume is a mixture of hydrochloric acid gas (HCl), steam, and tiny volcanic gas particles. The entry point area and downwind should be avoided by humans, as laze can cause skin and eye irritation, and breathing difficulties (USGS 2017).

Bench Collapse

Unstable lava deltas along a newly formed shoreline following volcanic activity can result on what is often referred to as a "bench collapse". The collapses happen because the lava benches build up over unstable, underwater piles of rubble. Shifting or landslides in the rubble below erode the support for the surface outcropping, and finally the lava deltas collapse. In April 1993 a local native of the island of Hawaiʻi, a Kona photographer, died at Kīlauea's Eruption Site when a lava bench which appeared to be solid collapsed. He was attempting to photograph the entry site of lava into the ocean. He and several other onlookers had crossed a rope barrier set up by park rangers. When the bench collapsed, the others were able to scramble to safety, but the Photographer was swept into the sea (Sprowl 2014).

Methane Explosions

Methane gas explosions are caused by lava igniting the pockets of vegetation rotting due to vog. Decomposing vegetation produces methane gas that can travel subsurface beyond the lava front in different directions, accumulating in pockets that can ignite. The methane can seep through cracks several feet away from the lava. It can also cause explosions when it's ignited while trapped underground. These blasts can toss blocks several feet away. This methane gas can also be the source on the blue flame that is most recognizable at night during lava flow events.

Blue fire bursting from the ground on May 23 near the Kīlauea volcano in Hawaiʻi. AP/USGS

Location

This section discusses the best data available to define the locations of the four volcano hazards profiled above for the purpose assessing the risk from these hazards. To measure risk, assessments need a defined location to measure the vulnerability assets and populations exposed to the hazard. In some cases, for a hazard like vog, may potentially impact the entire planning area. In other cases, such as lava flows, there may be clearly define mapping that allows and assessment to determine exposure and potential impacts from the hazard.

There are six active volcanoes in the State of Hawaiʻi – five located in the County of Hawaiʻi and one located in the County of Maui. Table 4.14-1 summarizes the location of these volcanoes and the associated potential threat/areas at risk.

Table 4.14-1. Active Volcanoes in the State of Hawaiʻi

Name of Volcano	Location of Volcano	Date of Last Eruption	Threat Potential / Areas at Risk
Haleakalā	County of Maui	Late 1700s	Moderate threat potential; areas at risk include Hana, Keokea, Kula, Pukalani, and Wailea-Makena
Mauna Loa	County of Hawaiʻi	1984 and lasted 22 days	Very high threat potential; areas at risk include the districts of South Hilo, Puna, Kaʻu, South Kona, North Kona and South Kohala
Kīlauea	County of Hawaiʻi	May 2018 - ongoing	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 Hawaiʻi Volcanoes National Park and the district of Kaʻu
Hualālai	County of Hawaiʻi	1801	High threat potential; areas at risk include the land within the North Kona district
Mauna Kea	County of Hawaiʻi	between 6,000 and 4,000 years ago	Moderate threat potential
Lōʻihi (underwater volcano)	County of Hawaiʻi (located 22 miles southwest)	1996	Low to very low threat potential

Sources: USGS 2017; State of Hawaiʻi HMP 2013

Lava Flows Location

The USGS Hawaiian Volcanic Observatory (HVO) monitors six active volcanoes with delineated lava flow hazard areas on the Islands of Hawaiʻi and Maui (USGS 2017a) that may pose a hazard to communities in the State. The lava flow hazard areas are based on proximity to rift zones, frequency of lava coverage, and topography [i.e., downslope or not, and distance from rift zones (USGS 1992)]. The lava flow zones are designed to show the relative lava flow hazard across each island and are suitable for general planning purposes. The lower the number zone, the greater severity of the hazard (USGS 1992). The lava flow zones in each county are classified differently; meaning Zone 1 in the County of Hawaiʻi is not the equivalent of Zone 1 in the County of Maui. Figure 4.14-2 and Figure 4.14-3 illustrate the lava flow areas in the Counties of Hawaiʻi and Maui, respectively.

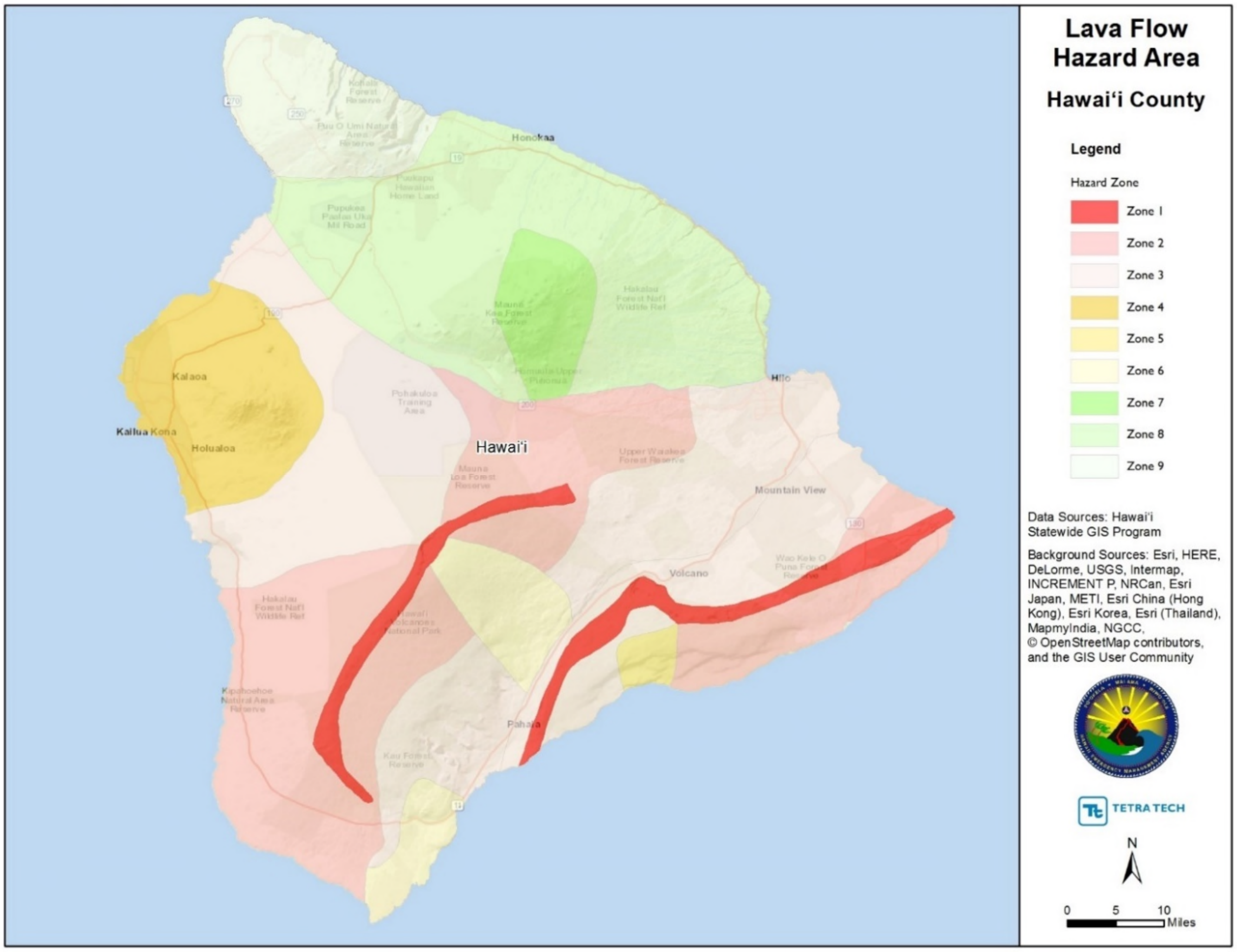
Dr. Donald Thomas, the volcano SME for the 2018 HMP Update, identified Zones 1 through 4 in the County of Hawaiʻi and Zones 1 and 2 in the County of Maui to assess risk from lava flows based on severity. Table 4.14-2 lists the square miles of these lava flow high risk zones, called the lava flow hazard areas, in each county. These zones were used to assess vulnerability discussed later in this section. The County of Hawaiʻi has the largest percent (65.7%) of the volcano lava flow hazard area (Zones 1 through 4) in the State. Table 4.14-2 and Figure 4.14-3 illustrate the hazard zone areas for the Counties of Hawaiʻi and Maui.

Table 4.14-2. Lava Flow Hazard Areas in the State of Hawaiʻi

County	Area (in square miles)		
	Total Area of the County	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total Area
Maui County	1,173.5	212.3	18.1%
Hawaiʻi County	4,028.4	2,644.8	65.7%
Total	**5,201.9**	**2,857**	**54.9%**

Source: Hawaiʻi Statewide GIS Programs Geoportal 2017; USGS 2006
Notes: County of Kauaʻi and City and County of Honolulu do not have USGS-produced lava flow maps.
The County of Hawaiʻi hazard area was calculated using zones 1 through 4. The County of Maui hazard area was calculated using zones 1 and 2.
GIS Geographic Information System
USGS U.S. Geological Survey

Figure 4.14-2. Lava Flow Hazard Areas in the County of Hawaiʻi



Source: USGS 1992

Zone 1 includes summits and rift zones of Kīlauea and Mauna Loa, where vents have been repeatedly active since written records have been kept (c.a. 1800 CE)

Zone 2 includes areas adjacent to, and downslope of, Zone 1. Fifteen to 25% of Zone 2 has been covered by lava since 1800, and 25 to 75% has been covered within the past 750 years. Lava flow hazard within Zone 2 decreases gradually as one moves away from Zone 1.

Zone 3 includes areas less hazardous than zone 2 because of greater distance from recently active vents and (or) because of topography. One to five percent of zone 3 has been covered since 1800, and 15 to 75 percent has been covered within the past 750 years.

Zone 4 includes all of Hualālai, where the frequency of eruptions is lower than that for Kīauea or Mauna Loa. Lava coverage is proportionally smaller, about 5 percent since 1800, and less than 15 percent within the past 750 years.

Zone 5 includes the area on Kīlauea currently protected by topography (the north-facing Koa`e fault system)

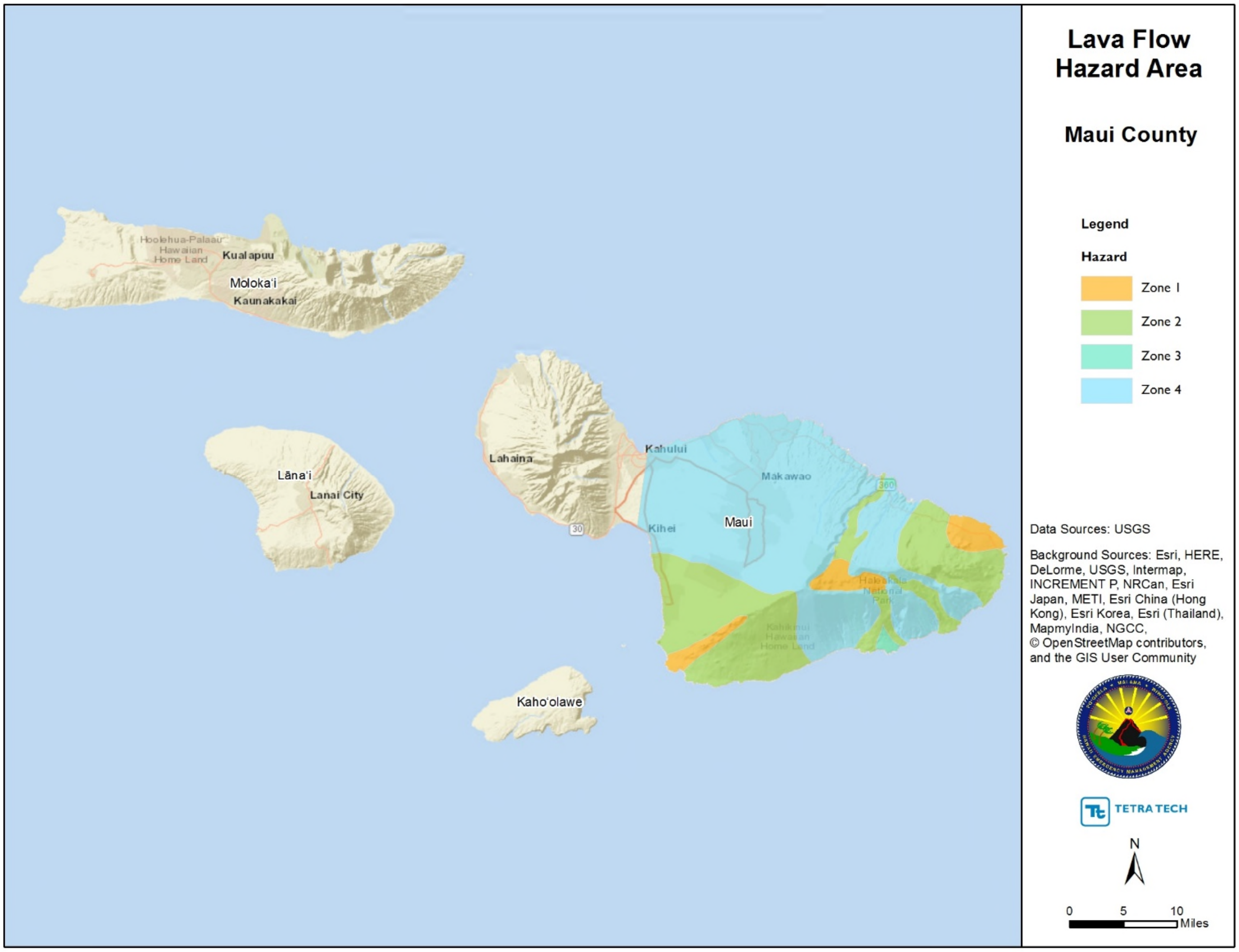
Zone 6 includes two areas on Mauna Loa, both protected by topography

Zone 7 includes the younger part of much-less-active volcano Mauna Kea; 20% of this area was covered by lava in the past 10,000 years

Zone 8 is the remaining part of Mauna Kea; only a small percentage of this area has been covered by lava in the past 10,000 years.

Zone 9 is Kohala Volcano, which last erupted over 60,000 years ago

Figure 4.14-3. Lava Flow Hazard Areas in the County of Maui



Source: USGS 1992

Zone 1 - Encompasses the lower- and middle-altitude reaches of the southwest and east rift zones, Haleakala Crater itself, and an area on the northern flank of the east rift zone; all areas where eruptions have occurred frequently in the past 1500 years.

Zone 2 - Encompasses the volcano's flanks downslope of the southwest and east rift zone axes, chiefly areas where lava has encroached at least once in the past 13,000 years.

Zone 3 - Demarcates downslope reaches centered low on the Kaupo and Koʻolau lava fans. These areas, although within potentially active lava sheds, have become sheltered by buildup of lava upslope during the past 40,000 years that now would deflect new lava toward only the margins of the fans.

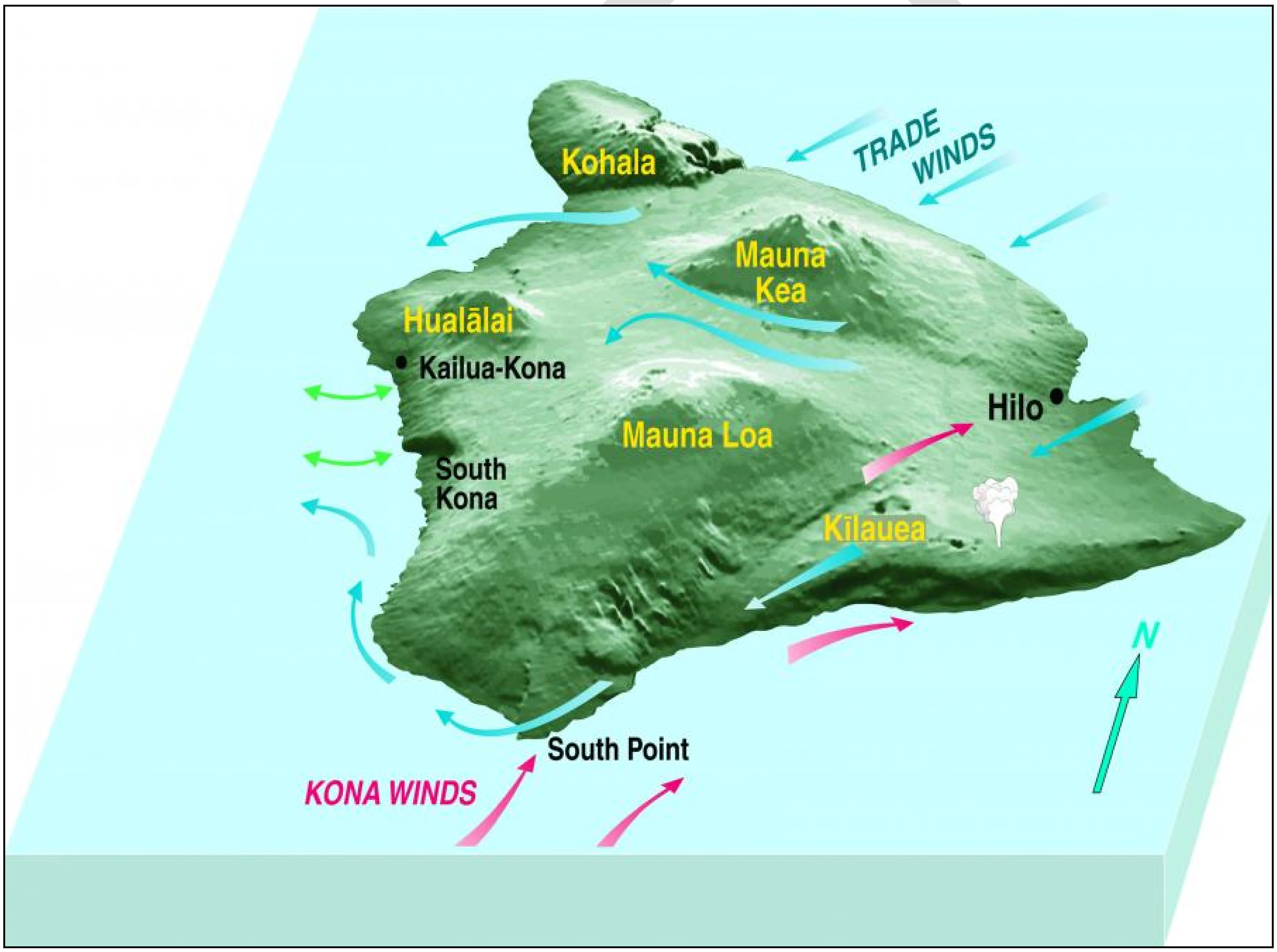
Zone 4 - Encompasses those flanks shielded from lava during the past 100,000 years or for which the sparse eruptive products found are the consequence of off-rift cinder cones from random, infrequent eruptive events. Corresponds to essentially no hazard under most lava inundation conditions.

Volcanic Gases and Vog

Whereas active volcanoes are located on the Counties of Hawaiʻi and Maui, the entire state can be impacted by volcanic gases and vog. Vog conditions in the County of Hawaiʻi vary depending on wind direction (northeasterly trade winds, southerly kona winds) and emission source. Looking at Figure 4.14-4, during prevailing trade winds, the nearly constant stream of vog produced by Kīlauea is blown to the southwest and west, where wind patterns send it up to the Kona coast. Once at the Kona coast, it 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 but can reach the Island of Oahu (City and County of Honolulu) which is more than 200 miles to the northwest of the County of Hawaiʻi (USGS 2017).

Vog risk is considered to be both source (spatially) dependent and time (weather) dependent. The vog Measurement and Prediction Project (VMAP) provides real-time vog forecasts (may be accessed at http://weather.hawaii.edu/vmap/index.cgi). Vog impacts the City and County of Honolulu when southerly Kona winds bring the vog plume to the north from the County of Hawaiʻi. However, the City and County of Honolulu is not expected to experience the elevated sulfur dioxide levels that may be experienced in the County of Hawaiʻi. It is important to note that Mauna Loa's magma – and magmatic gas – discharge rate can be ten times that of Kīlauea.

Figure 4.14-4. Wind Direction and Vog Conditions in the County of Hawaiʻi



Source: USGS 2017

Bench Collapse and Methane Gas Explosion

While no mapping has currently been produced specific to the bench collapse and methane case explosion hazards, their locations can be correlated to where there are likely to be lava flows, since both hazards are directly associated with a lava flow. For the purposes of this assessment, the location of the bench collapse and methane gas explosion hazards is associated with the lava flow data as discussed above.

EXTENT

The extent (the magnitude or severity) of volcanic hazards in the State of Hawaiʻi vary widely. Eruptions of volcanoes in the State range from almost imperceptible to major events that cover and/or create hundreds of acres of land, can destroy homes and businesses, block or destroy roadways and other infrastructure, and can impact the quality of life (particularly due to vog and other gases). The magnitude of (rare for Hawai`i) explosive eruptions is determined by the degree of interaction between magma and water, and ranges from harmless (such as steam blasts of pulverized rock when lava encounters the ocean) to catastrophic (such as those that produce pyroclastic surges that travel from the summit of a volcano several miles outward, killing people and destroying property) (State of Hawaiʻi HMP 2013).

In current times, most eruptions from Hawaiian volcanoes are forecasted due to weeks or months of precursory activity (e.g. seismicity, deformation, methane, littoral explosions, and laze). However, it is important to note that volcanic activity can also occur with little advanced warning. The 2018 eruption on the lower east rift zone was preceded by only a few hours of warning to at most a day. Officials were not seriously anticipating propagation of the Pu'u O'o rift into lower Puna weeks or months prior to the event. Volcano-alert notifications are produced by volcano observatory scientists and are based on analysis of data from monitoring networks, direct observations, and satellite sensors. They are issued for both increasing and decreasing volcanic activity and include text about the nature of the unrest or eruption and about potential or current hazards and likely outcomes. The USGS employs a nationwide volcano alert-level system for characterizing conditions (Normal, Advisory, Watch, Warning) at U.S. volcanoes. Notifications about the status of activity at U.S. volcanoes are issued through the five regional U.S. volcano observatories. The USGS alert-level system for volcanic activity has two parts: 1) ranked terms to inform people on the ground about a volcano's status and 2) ranked colors to inform the aviation sector about airborne ash hazards.

Table 4.14-3. USGS Volcano Alert-Level Terms

Alert Level	Details
Normal	Volcano is in typical background, non-eruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to non-eruptive 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 underway, imminent, , or suspected.

Source: USGS 2018
Note: When the volcano alert-level is changed, a Volcano Activity Notice (VAN) is issued
USGS U.S. Geological Survey

Table 4.14-4. USGS Volcano Aviation Color Codes

Alert Color	Details
Green	Volcano is in typical background, non-eruptive state or, after a change from a higher level, volcanic activity has ceased and volcano has returned to non-eruptive background state.
Yellow	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	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	Eruption is ongoing or 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 2018
Note: When the volcano color code changes, a Volcano Observatory Notification for Aviation (VONA) is issued.
USGS U.S. Geological Survey

Lava Flows

The advance of lava flows is governed by the chemical composition and temperature of the lava, the steepness of the terrain, the volume of lava erupted, the eruption rate, and the duration of the eruption. Hawaiian lava flows generally advance slowly and can be easily avoided by people. But they can destroy or bury pretty much everything in their paths. Future lava flows are likely to interfere with human activity and infrastructure as communities and other development encroach on active volcanoes (USGS 2017).

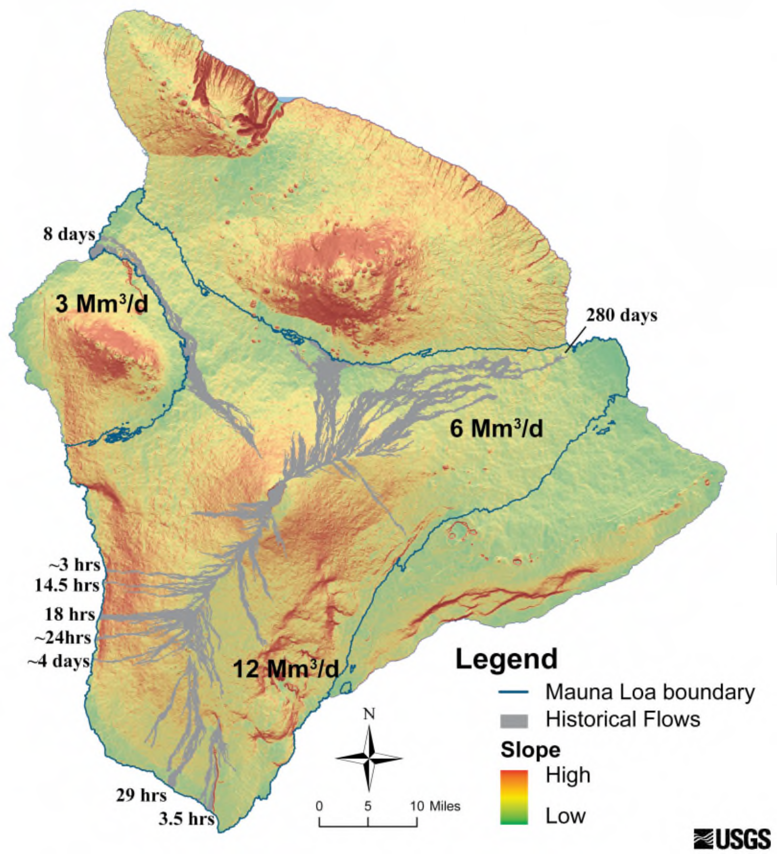
Geologists monitor active vents and lava flows to observe and document newly created volcanic features and to sample lava or tephra for chemical and mineral analyses. This helps in understanding what a volcano is doing and how the activity might impact adjacent communities. Measuring the effusion rate (the volume of lava flow per unit of time) is used to characterize the vigor of an eruption (USGS 2017). During ongoing eruptions, lava flows are monitored for changes such as increases in eruption rate and overflows from established channels because these may result in changing hazards downslope.

Warning Time

The speed of a lava flow is determined not only by the steepness of the terrain, but also by the effusion rate of lava that is erupted, with higher effusion rates producing faster (and usually larger) flows. The distance that a flow travels ultimately depends either on the eruption rate (for channel-fed ʻaʻā flows) and on the duration of the eruption (for tube-fed pāhoehoe flows; State of Hawaiʻi HMP 2013).

During an eruption, advance rates of lava flow fronts are based on any available observations of the flow front itself and, if known, the overall advance rate of similar, earlier lava flows that passed through the same location. However, this method is highly uncertain because factors that control flows are always changing [i.e. eruption rate, ground slope the flow is moving over, and the complex interaction of a'a and pahoehoe flows with the local (micro)terrain over which the flow is moving]. ʻAʻā is a term for lava flows that have a rough rubbly surface composed of broken lava blocks. Pāhoehoe flows consist of lava that has a smooth, hummocky, or ropy surface. This type of flow usually advances as a series of small lobes and toes that continually break out from a cooled crust (USGS 2015). Figure 4.14-5 illustrates the historical lava flows for eruptions at Mauna Loa (USGS 2017).

Figure 4.14-5. Lava Flows of Mauna Loa

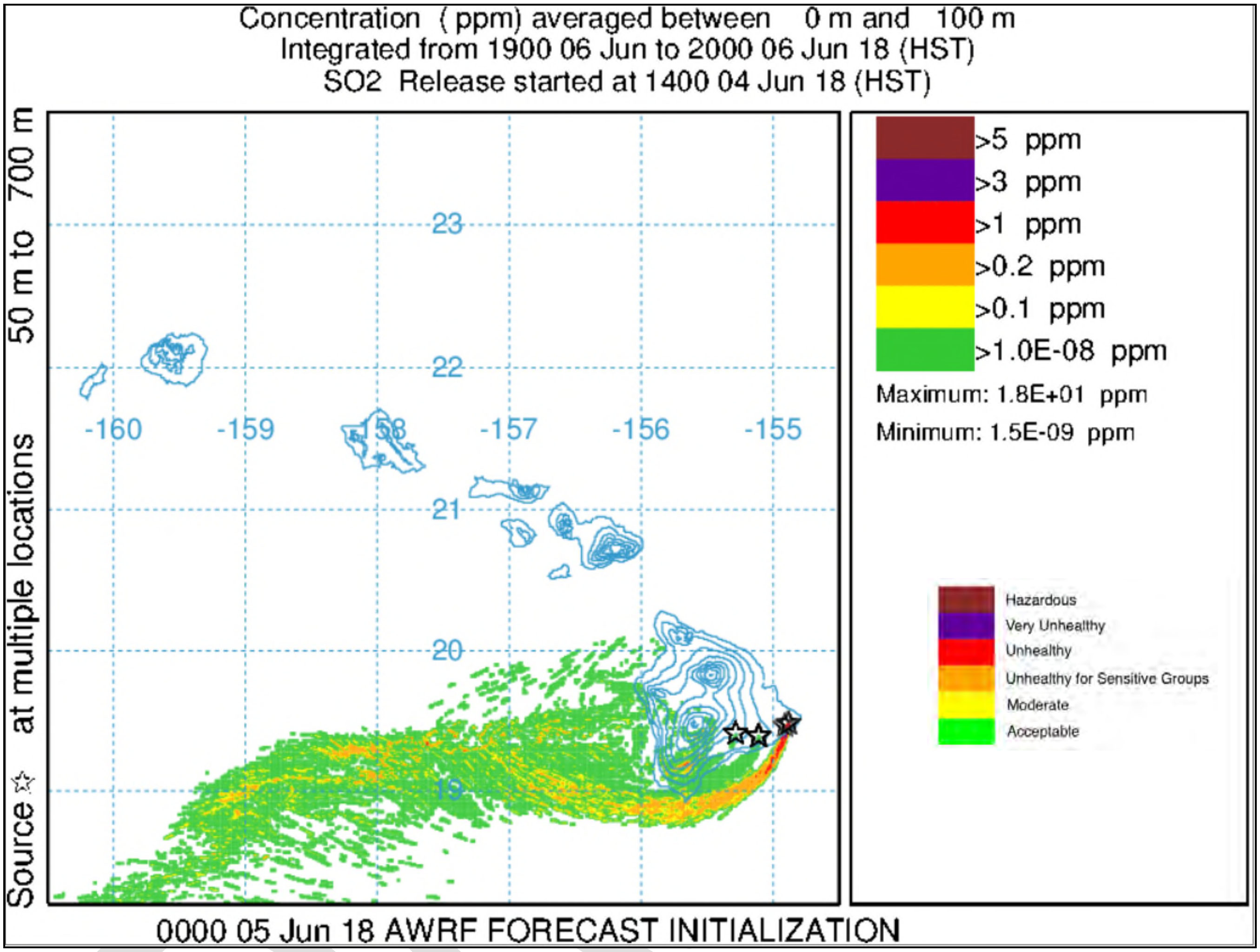


Source: USGS 2017
Notes: Mm3/d Million cubic meters per day
USGS U.S. Geological Survey

Volcanic Gases and Vog

The extent of the hazard posed by volcanic gases and vog depends on the amount of magma being erupted and the concentration of gas in that magma. The Vog Measurement and Prediction Project (VMAP) provides real-time vog forecasts of vog trajectories and vog concentrations for the state when the emission rate is known. Each day, VMAP provides a summary and forecast for the Island of Hawaiʻi and statewide, and is online here: ihttp://weather.Hawaiʻi.edu/vmap/fcst/index.cg Figure 4.14-6 illustrates an example of the SO_2 concentration for the entire state. This particular emission rate is for a period of time when multiple vents were discharging sulfur dioxide gas at the summit and the East Rift of Kīlauea.

Figure 4.14-6. SO_2 Concentration Map, Statewide



Source: VMAP 2018

Warning Time

The HVO conducts gas monitoring to determine changes in emission rates of certain gases, chiefly sulfur dioxide (SO_2) and carbon dioxide (CO_2). Changes are compared with other monitoring information to assess magma supply and eruption rates, issue eruption warnings, improve gas-hazard assessments and vog forecasts, and better understand how Hawaiian volcanoes work. Additionally, the Hawaiʻi State Department of Health (HDOH) monitors the air quality for the state, including vog and its effects on people. Stationary air quality monitors that measure particulate levels are located in Hilo, Mountain View, Pāhala, Hawaiian Ocean View Estates, and Kailua on Hawaiʻi Island, and on Maui, O`ahu, and Kaua`i. HDOH also has air monitoring stations for SO_2 on the islands of Hawaiʻi, Oʻahu, and Kauaʻi (USGS 2017). The Hawai`i Interagency Vog Information Dashboard (HIVID) is an excellent source of background information and up-to-date measurements and observations: https://vog.ivhhn.org/.

PREVIOUS OCCURRENCES AND LOSSES

All eruptions since 1778 have been at Mauna Loa and Kīlauea, except for the 1800–1801 eruption of Hualālai on the west coast of the Island of Hawaiʻi. In an exception to the overall northwest-southeast shift of volcanic activity, a series of minor submarine eruptions may have occurred in 1955–56 between the islands of Oʻahu and Kauaʻi and near Necker Island, about 350 miles northwest of Kauaʻi, although there is considerable uncertainty about these (USGS 2010).

Many sources provide information regarding previous occurrences and losses associated with volcanic hazard events throughout the State of Hawaiʻi. The 2013 Plan discussed specific volcanic events that occurred in Hawaiʻi through 2012. For this 2018 HMP Update, volcanic ~~hazard~~ events were summarized between January 1, 2012, and December 31, 2017 (Table 4.14-5). Major events include those that resulted in losses or fatalities, events that resulted in the activation of the State and/or County Emergency Operations Center (EOC), and/or events that led to a FEMA disaster declaration. It should be noted that it is recognized that the Kīlauea Volcano entered a new and very damaging phase of its long-running eruption at the end of April of 2018 and this activity continues as this plan is updated. Data regarding those impacts are in the development stage. More complete analysis regarding the eruptions and impacts will be analyzed in the future Hawaiʻi County Hazard Mitigation Plan Update as well as the State's 2023 Update. For events prior to 2012, please refer to Appendix F.

Table 4.14-5. Volcanic Hazard Events in Hawaiʻi, 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
September 4, 2014 to June 27, 2015	Puʻu ʻŌʻō Volcanic Eruption and Lava Flow	Hawaiʻi	Lava erupted from the northeast flank of Kīlauea's Puʻu ʻŌʻō cone. Hawaiʻi Electric Light Company staff worked to insulate utility poles from encroaching lava flows. Staff were deployed to monitor the lava flow. Crews worked to build new roads around Pahoa in case the lava cut off access to Highway 130. One residence was destroyed and a solid waste transfer station was temporarily out of commission.
June 8, 2017	South Flank Kīlauea Volcanic Eruption and Earthquake	Hawaiʻi	A 5.3 magnitude earthquake occurred on the south flank of Kīlauea, due to southward spreading of the volcano. The earthquake was reported felt by about 800 people within an hour. The Hawaiʻi County EOC was fully activated.
May – June 2018*	Kīlauea Volcanic Eruption and Earthquakes (DR-4366)	Hawaiʻi	▪ On May 1, the USGS HVO issued a report that a migration of seismicity and deformation downrift (east) of Puʻu ʻŌʻō indicated that a large area along the East Rift Zone was potentially at risk of new outbreak, possibly in the Lower Puna area. ▪ On May 11, FEMA issued a major disaster declaration for the State of Hawaiʻi due to the eruption of Kīlauea. The County of Hawaiʻi was included in this declaration. ▪ On May 16, heavy de-gassing was occurring at each vent within the Leilani Estates neighborhood and the lower East Rift. The Hawaiʻi Fire Department reported air quality condition RED (immediate danger to health) in areas around Lanipuna Gardens and surrounding farm lots on Pohoiki Road. ▪ On May 17, HVO indicated an explosive eruption at Kīlauea summit occurred at 4:17am. By the afternoon, HVO reported a new fissure 21 down rift of Makamae Street in Leilani Estates neighborhood. Several fissures reactivated, and flows have been generated. The HVO reported lava was pahoehoe. Residents were issued masks for ash protection and shelters were open for residents. Eruptions continued to occur and fissures reactivated. Lava destroyed homes, led to road closures, caused brush fires, and residents were evacuated. ▪ On May 20, white plumes of acid and extremely fine shards of glass billowed over the Island of Hawaiʻi as molten rock from Kīlauea poured into the ocean. The rate of sulfur dioxide gas shooting from the ground fissures tripled, leading Hawaiʻi County to repeat warnings about air quality. At the volcano's summit, two explosive eruptions unleashed clouds of ash. Winds carried much of it toward the southwest. Since May 3, Kīlauea burned some 40 structures, including two dozen homes, since it began erupting in the Leilani Estates neighborhood. About 2,000 people were evacuated from their homes, including 300 who were staying in shelters. ▪ May 31, 2018, Mandatory Evacuation Order in Effect for Leilani Estates Hawaiian Volcano Observatory reports that vigorous lava eruptions continue from the lower east rift zone fissure system in the area of Leilani Estates and Lanipuna Gardens.

Sources: Cave and Kearns 2014; Taylor 2014; Osher 2017; Thomas 2017

EOC	*Emergency Operations Center*	*FEMA*	*Federal Emergency Management Agency*
HVO	*Hawaiian Volcano Observatory*	*USGS*	*U.S. Geological Survey*

The Kīlauea Volcanic Eruption is an ongoing event; not all impacts have been captured to date.

FEMA Disaster Declarations

Between 1954 and 2018, FEMA included Hawaiʻi in six volcanic hazard-related disasters (DR) or emergencies (EM) classified as one or a combination of volcano or earthquake with volcanic disturbances. These disasters have only affected the County of Hawaiʻi (FEMA 2018).

Based on all sources researched, two known volcanic hazard events that have affected the State of Hawaiʻi and were declared a FEMA disaster between 2012 and 2018. These are identified in Table 4.14-6. This table provides information on the disaster declarations for volcanic hazard events, including date of event, federal disaster declaration and disaster number, and counties affected. For details regarding all declared disasters, refer to Section 4.0 (Risk Assessment Overview). Appendix E (Map Atlas) illustrates the number of FEMA-declared volcanic hazard-related disasters by county.

Table 4.14-6. Volcanic Hazard-Related State and Federal Declarations, 2012 to 2018*

Year	Event Type	Date Declared	Federal Declaration Number	Counties Affected
September 4, 2014 to March 26, 2015	Pu'u ʻŌʻō Volcanic Eruption and Lava Flow	November 13, 2014	DR-4201	Hawaiʻi
May 2018	Hawaiʻi Kīlauea Volcanic Eruption and Earthquakes	May 11, 2018	DR-4366	Hawaiʻi

Source: FEMA 2018
Notes: DR Major Disaster Declaration
FEMA Federal Emergency Management Agency
** As of June 1, 2018*

Probability of Future Hazard Events

Explosive eruptions of any size take place infrequently in the State of Hawaiʻi. It should be noted that eruptions are often preceded with some warning. The HVO rates the potential threat, based in part on the probability of future eruptions, from each of the volcanoes it monitors as follows (USGS 2017a):

- Kīlauea—Very High. This volcano has been erupting continuously since 1983.
- Mauna Loa—Very High. It last erupted in 1984, and is considered certain to erupt again.
- Hualālai—High. It is likely to erupt again.
- Mauna Kea—Moderate.
- Haleakalā—Moderate.

Overall, volcanic hazard events will continue to occur in the State of Hawaiʻi. As noted earlier, there are six active volcanoes in the State with Kīlauea currently erupting at the time of this plan update. Based on historical record, the State has experienced six FEMA declarations associated with volcanic hazards since 1954. Based on the historic FEMA disaster declaration record, the State may experience a major event that leads to a FEMA declaration roughly once every 10 years. Looking at volcanic hazard events that occurred in the State of Hawaiʻi since 1823, there have been 92 volcanic eruptions; with varying severity and impacts. Based on this data, the

State of Hawaiʻi may experience one volcanic eruption every two years and has a 47% chance of an eruption occurring in any given year.

Potential Impacts of Climate Change on Probability of Future Events

Changing future conditions may impact the dispersion and areas of impact of the volcanic hazard. As discussed in other hazard sections in this plan, projections indicate potential changes in wind and rainfall activity in the State. Any changes in wind and rainfall frequency and intensity may alter the dispersion of volcanic gas emissions thus adversely impacting human health. For details regarding climate change as a distinct hazard and its unique impacts to the State of Hawaiʻi, refer to Section 4.1 (Climate Change).

It should be noted that the types of volcanic activity that could impact climate, are not those typically associated with Hawaiian Volcanos. The massive outpouring of gases and ash can influence climate patterns for years following a volcanic eruption. The conversion of sulfur dioxide to sulfuric acid is the most significant climate impact from a volcano. The Pinatubo eruption in the Philippines in 1991 was one of the largest volcanic events in the 20th century, injecting 20 million tons of sulfur dioxide into the stratosphere. It ultimately cooled the Earth's surface by as much as 1.3°F for 3 years after its eruption. In contrast, the carbon dioxide released in recent eruptions has not been shown to lead to a detectable increase in global warming (USGS 2017c).

4.14.2 Vulnerability Assessment

To assess the State's risk from volcanic hazards, the spatially-delineated lava flow zones for the Counties of Hawaiʻi and Maui were used. Therefore, the Counties of Kauaʻi and City and County of Honolulu do not appear in the tables below.

In collaboration with the volcanic SME, the following zones were selected to define the lava flow hazard areas: Zones 1 through 4 for the County of Hawaiʻi; and Zones 1 and 2 for the County of Maui. Overall, an asset is considered exposed if it is located in a lava flow hazard area. During an active lava flow event, total loss of exposed assets is assumed. A qualitative discussion regarding potential vog impacts is also presented below.

Lava Flow Hazard Area Definition

To assess vulnerability to lava flow, the following datasets were used:

- ✓ ***County of Hawaiʻi –*** *Lava flow zones 1 through 4 in the spatial layer available on the Hawaiʻi Statewide GIS Programs Geoportal (originally prepared by USGS HVO 1991).*
- ✓ ***County of Maui*** *– Lava flow zones 1 and 2 in the spatial layer provided by USGS.*

Assessment of State Vulnerability and Potential Losses

This section discusses the state asset exposure and potential losses due to lava flows; state assets include state buildings, state roads and critical facilities.

State Assets

The spatial analysis determined that there are 95 state buildings in the County of Maui and 1,021 state buildings in the County of Hawaiʻi located in the lava flow hazard areas (see Once the lava flow reaches the buildings, it is assumed the entire structure will be burned and the land will be buried. Only replacement cost value was available for state buildings; however, a more accurate reflection of loss to the lava flow hazard would be the combined value of the land and structure using tax-assessed data.

Table 4.14-7 through 4.14-9). Greater than 80% of the state buildings located in the County of Hawai'i are located in the lava flow hazard area. The majority of these buildings are occupied by the Department of Education, University of Hawai'i and Hawai'i Health Systems Corporation. Once the lava flow reaches the buildings, it is assumed the entire structure will be burned and the land will be buried. Only replacement cost value was available for state buildings; however, a more accurate reflection of loss to the lava flow hazard would be the combined value of the land and structure using tax-assessed data.

Table 4.14-7. State Buildings Located in the Lava Flow Hazard Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	State Buildings in the Lava Flow Hazard Area			
			Number	Percent (%) of Total	Total Replacement Cost Value	Percent (%) of Total
County of Maui	831	$2,862,316,819	95	11.4%	$210,900,497	7.4%
County of Hawai'i	1,261	$4,209,774,236	1,021	81.0%%	$2,851,738,537	67.7%
Total	**2,092**	**$7,072,091,055**	**1,116**	**53%**	**$3,062,639,034**	**43.31%**

Source: Hawai'i State Risk Management Office 2017; Hawai'i Statewide GIS Programs Geoportal 2017; USGS 2006
Notes: County of Kaua'i and City and County of Honolulu do not have USGS-produced lava flow maps.
GIS Geographic Information System
USGS U.S. Geological Survey

Table 4.14-8. State Buildings in the County of Hawai'i Located in the Lava Flow Hazard Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	23	$49,197,127	9	39.1%	$42,488,950	86.4%
Dept of Agriculture	14	$12,981,586	8	57.1%	$8,661,919	66.7%
Dept of Attorney General	5	$7,005,694	5	100.0%	$7,005,694	100.0%
Dept of Budget & Finance	4	$963,863	4	100.0%	$963,863	100.0%
Dept of Business, Economic Development and Tourism	1	$21,930,055	1	100.0%	$21,930,055	100.0%
Dept of Commerce & Consumer Affairs	0	$0	0	0.0%	$0	0.0%
Dept of Defense	7	$20,990,069	7	100.0%	$20,990,069	100.0%
Dept of Education	806	$2,640,531,838	621	77.0%	$1,382,525,079	52.4%
Dept of Hawaiian Home Lands	4	$4,426,065	2	50.0%	$2,156,000	48.7%
Dept of Health	6	$16,433,860	6	100.0%	$16,433,860	100.0%
Dept of Human Resources Development	0	$0	0	0.0%	$0	0.0%
Dept of Human Services	18	$23,694,724	15	83.3%	$16,740,733	70.7%
Dept of Labor and Industrial Relations	8	$12,439,257	8	100.0%	$12,439,257	100.0%
Dept of Land and Natural Resources	2	$4,295,538	2	100.0%	$4,295,538	100.0%
Dept of Public Safety	52	$58,352,205	52	100.0%	$58,352,205	100.0%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Taxation	0	$0	0	0.0%	$0	0.0%
Dept of Transportation	7	$145,908,345	5	71.4%	$144,544,745	99.1%
Hawai'i State Ethics Commission	0	$0	0	0.0%	$0	0.0%
Hawai'i Health Systems Corporation	34	$267,489,341	23	67.6%	$241,774,312	90.4%
Hawai'i Housing Finance & Development Corporation	29	$74,931,443	29	100.0%	$74,931,443	100.0%
Hawai'i Public Housing Authority	63	$214,946,736	55	87.3%	$188,297,816	87.6%
Hawai'i State Legislature	0	$0	0	0.0%	$0	0.0%
Hawai'i State Public Library System	11	$42,426,683	6	54.5%	$19,817,400	46.7%
Judiciary	13	$103,967,864	11	84.6%	$103,016,093	99.1%
Legislative Reference Bureau	0	$0	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	2	$479,656	2	100.0%	$479,656	100.0%
Office of the Auditor	0	$0	0	0.0%	$0	0.0%
Office of the Governor	0	$0	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	0	$0	0	0.0%	$0	0.0%
Office of the Ombudsman	0	$0	0	0.0%	$0	0.0%
Research Corporation of the University of Hawai'i	0	$0	0	0.0%	$0	0.0%
University of Hawai'i	152	$486,382,287	150	98.7%	$483,893,850	99.5%
Total	**1,261**	**$4,209,774,236**	**1,021**	**81.0%**	**$2,851,738,537**	**67.7%**

Source: Hawai'i State Risk Management Office 2017

Table 4.14-9. State Buildings in the County of Maui Located in the Lava Flow Hazard Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	5	$11,155,000	0	0.0%	$0	0.0%
Dept of Agriculture	6	$13,702,507	0	0.0%	$0	0.0%
Dept of Attorney General	2	$3,993,357	0	0.0%	$0	0.0%
Dept of Budget & Finance	3	$809,916	0	0.0%	$0	0.0%
Dept of Business, Economic Development and Tourism	1	$9,978,917	1	100.0%	$9,978,917	100.0%
Dept of Commerce & Consumer Affairs	0	$0	0	0.0%	$0	0.0%
Dept of Defense	3	$15,307,089	0	0.0%	$0	0.0%
Dept of Education	563	$1,443,495,782	70	12.4%	$116,936,292	8.1%
Dept of Hawaiian Home Lands	2	$689,000	0	0.0%	$0	0.0%
Dept of Health	3	$4,843,533	0	0.0%	$0	0.0%
Dept of Human Resources Development	0	$0	0	0.0%	$0	0.0%
Dept of Human Services	15	$34,878,132	0	0.0%	$0	0.0%
Dept of Labor and Industrial Relations	6	$6,940,947	0	0.0%	$0	0.0%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Value in the Hazard Area	Percent (%) of Total Value
Dept of Land and Natural Resources	15	$7,246,459	1	6.7%	$552,425	7.6%
Dept of Public Safety	24	$66,087,940	0	0.0%	$0	0.0%
Dept of Taxation	0	$0	0	0.0%	$0	0.0%
Dept of Transportation	28	$214,582,180	1	3.6%	$191,500	0.1%
Hawai'i State Ethics Commission	0	$0	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	36	$658,565,946	21	58.3%	$79,315,317	12.0%
Hawaiʻi Housing Finance & Development Corporation	28	$67,636,635	0	0.0%	$0	0.0%
Hawaiʻi Public Housing Authority	4	$15,058,800	0	0.0%	$0	0.0%
Hawaiʻi State Legislature	0	$0	0	0.0%	$0	0.0%
Hawaiʻi State Public Library System	7	$20,774,018	1	14.3%	$3,926,046	18.9%
Judiciary	9	$45,106,735	0	0.0%	$0	0.0%
Legislative Reference Bureau	0	$0	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	2	$292,187	0	0.0%	$0	0.0%
Office of the Auditor	0	$0	0	0.0%	$0	0.0%
Office of the Governor	0	$0	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	1	$1,956,330	0	0.0%	$0	0.0%
Office of the Ombudsman	0	$0	0	0.0%	$0	0.0%
Research Corporation of the University of Hawai'i	0	$0	0	0.0%	$0	0.0%
University of Hawai'i	68	$219,215,409	0	0.0%	$0	0.0%
Total	**831**	**$2,862,316,819**	**95**	**11.4%**	**$210,900,497**	**7.4%**

Source: Hawaiʻi State Risk Management Office 2017

Lava flows can close and ultimately destroy roads. This may result in the isolation of areas and larger regional issues such as loss of commerce and increased traffic on other roadways. Utilities that commonly follow roads, including those underground, will be buried and probably burned or rendered useless by excess heat resulting in disruption of services. Table 4.14-10 shows the length of state roads exposed to lava flow hazard (zones) by county. The County of Hawaiʻi has the greatest number of miles (218.4 miles) exposed which makes up 57.7% of all state roads in the county. A complete list of state roads located in the lava flow hazard zones is included in Appendix G (State Profile and Risk Assessment Supplement).

Table 4.14-10. State Roads Located in the Lava Flow Hazard Area by County

County	Length (in miles)		
	Total Length	Length of State Road in Hazard Area	Percent (%) of Total Length
County of Maui	238.6	22.1	9.3%
County of Hawaiʻi	378.7	218.4	57.7%
Total	**617.3**	**240.5**	**38.9%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017; Hawaiʻi Statewide GIS Programs Geoportal 2017; USGS 2006
Notes: County of Kauaʻi and City and County of Honolulu do not have USGS-produced lava flow maps.

GIS Geographic Information System
SDOT State Department of Transportation
USGS U.S. Geological Survey
There are no lava flow zones available in the County of Kauaʻi and City and County of Honolulu; therefore no results are reported.

Critical Facilities

Table 4.14-11 summarizes the total number of critical facilities by core category located in the lava flow hazard area in the Counties of Hawaiʻi and Maui. The County of Hawaiʻi has 201 critical facilities located in the lava flow hazard area. The County of Maui has 38 critical facilities located in the lava flow hazard area. Table 4.14-12 and Table 4.14-13 summarize the number and percentage of exposed critical facilities by category in the Counties of Hawaiʻi and Maui, respectively. Food and agriculture have the largest percentage (61.5%) of their facilities within the County of Hawaiʻi lava flow hazard area. Transportation Services and Water, Waste, & Wastewater Systems both have the largest percentage (3.6%) of their facilities within the County of Maui lava flow hazard area.

Similar to state buildings, only replacement cost value was available for critical facilities; however, a more accurate reflection of loss to the lava flow hazard would be the combine value of the land and structure using tax-assessed data. Additionally, the loss of service of provided by each destroyed critical facility would increase the total loss from the hazard.

Table 4.14-11. Critical Facilities Located in the Lava Flow Hazard Area in Counties of Hawaiʻi and Maui

County	Core Category of Critical Facilities										Total in the Hazard Area
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Maui	0	4	4	1	1	0	6	9	2	11	38
County of Hawaiʻi	9	15	20	8	24	7	27	38	15	38	201
Total	**9**	**19**	**24**	**9**	**25**	**7**	**33**	**47**	**17**	**49**	**239**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Hawaiʻi Statewide GIS Programs Geoportal 2017; USGS 2006
Notes: GIS Geographic Information System
USGS U.S. Geological Survey
There are no lava flow zones available in the County of Kauaʻi and City and County of Honolulu; therefore no results are reported.

Table 4.14-12. Critical Facilities by Core Category Located in the Lava Flow Hazard Area in the County of Hawai'i

Core Category	Total Number of Critical Facilities in the County of Hawai'i	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	RCV in the Hazard Area	Percent (%) of Total RCV
Commercial Facilities	11	$26,963,666	9	81.8%	$22,061,182	81.8%
Communications	20	$52,908,180	15	75.0%	$41,177,680	77.8%
Emergency Services	26	$164,280,230	20	76.9%	$132,987,140	81.0%
Energy	9	$170,320,480	8	88.9%	$161,157,640	94.6%
Food & Agriculture	30	$741,388,480	24	80.0%	$574,065,440	77.4%
Government Facilities	8	$31,081,435	7	87.5%	$27,108,620	87.2%
Healthcare & Public Health	36	$338,688,960	27	75.0%	$207,699,670	61.3%
Mass Care Support Services	60	$1,272,598,340	38	63.3%	$1,094,601,660	86.0%
Transportation Services	17	$526,287,360	15	88.2%	$464,371,200	88.2%
Water, Waste, & Wastewater Systems	53	$1,642,379,520	38	71.7%	$1,178,008,320	71.7%
Total	**270**	**$4,966,896,651**	**201**	**74.4%**	**$3,903,238,552**	**78.6%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Hawai'i Statewide GIS Programs Geoportal 2017; USGS 2006

Notes: GIS Geographic Information System
RCV Replacement cost value
USGS U.S. Geological Survey

Table 4.14-13. Critical Facilities by Core Category Located in the Lava Flow Hazard Area in the County of Maui

Core Category	Total Number of Critical Facilities in the County of Maui	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	RCV in the Hazard Area	Percent (%) of Total Value
Commercial Facilities	2	$63,264,080	0	0.0%	$0	0.0%
Communications	22	$129,434,540	4	18.2%	$21,356,760	16.5%
Emergency Services	24	$299,309,640	4	16.7%	$39,319,560	13.1%
Energy	4	$98,094,820	1	25.0%	$30,958,080	31.6%
Food & Agriculture	4	$72,495,070	1	25.0%	$31,632,040	43.6%
Government Facilities	21	$81,325,860	0	0.0%	$0	0.0%
Healthcare & Public Health	50	$717,287,448	6	12.0%	$236,533,590	33.0%
Mass Care Support Services	75	$1,477,495,075	9	12.0%	$186,730,340	12.6%
Transportation Services	23	$712,035,840	2	8.7%	$61,916,160	8.7%
Water, Waste, & Wastewater Systems	59	$1,826,526,720	11	18.6%	$340,538,880	18.6%
Total	**284**	**$5,477,269,093**	**38**	**13.4%**	**$948,985,410**	**17.3%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; Hawaiʻi Statewide GIS Programs Geoportal 2017; USGS 2006

Notes: GIS Geographic Information System
RCV Replacement cost value
USGS U.S. Geological Survey

Assessment of Local Vulnerability and Potential Losses

This section provides a summary of statewide exposure and potential losses to population, general building stock, environmental resources and cultural assets by county.

Population

Lava Flows

Lava flows endangers people's property, livelihood, and peace of mind, but less commonly, their lives. The leading edge of Hawaiian lava flows generally move more slowly than the speed at which people walk, although the lava in the channel behind the front may be flowing much faster. On steep slopes a large flow could travel rapidly enough to endanger persons in its path. During the 1950 eruption of Mauna Loa, a flow front advanced at an average speed of almost 6 mph for over 2 hours (State of Hawaiʻi HMP 2013).

The chief threat of lava flows to property owners is that the flows may burn structures and bury land as well as everything in its pathway. There are other effects, however, that may be almost as disruptive. For instance, the residents of the Kalapana community saw their daily commutes increase by nearly 100 miles after lava flows covered almost 2 miles of the coastal highway. Some residents were forced to move. Many others were faced with financial losses as land values dropped and insurance companies refused to issue new homeowners policies (State of Hawaiʻi HMP 2013).

For the County of Hawaiʻi, Table 4.14-14 shows that an estimated 77.5% of the county population is living in the lava flow hazard area. For the County of Maui, Table 4.14-14 shows that an estimated 11.4% of the county population is living in the lava flow hazard area. This analysis does not include the number of tourists and visitors in the state whose lodgings are located in the lava flow hazard area. Therefore, this estimate may be underestimating exposure and vulnerability.

The populations considered most vulnerable to hazards in general include the elderly (persons over the age of 65) and individuals living below the U.S. Census poverty threshold. These socially vulnerable populations are most susceptible based on many factors including their physical and financial ability to react or respond during a hazard. The population over 65 located in the lava flow hazard area makes up approximately 11.1% of the population in the County of Hawaiʻi and only 1.7% in the County of Maui. The population with less than $30,000 per year annual household income located in the lava flow hazard area makes up about 26.2% of the population in the County of Hawaiʻi and 2.6% in the County of Maui.

Table 4.14-14. 2010 U.S. Census Population Located in the Lava Flow Hazard Area by County

County	Population

	Total Population	Population in Hazard Area	Population Exposed as Percent (%) of Total	Population Over 65 in Hazard Area	Population Over 65 Exposed as Percent (%) of Total	Income <$30K/yr in Hazard Area	Income <$30K/yr Exposed as Percent (%) of Total
Maui County	154,924	17,654	11.4%	2,617	1.7%	3,975	2.6%
Hawaiʻi County	185,079	143,370	77.5%	20,620	11.1%	48,408	26.2%
Total	**340,003**	**161,024**	**47.4%**	**23,237**	**6.8%**	**52,383**	**15.4%**

Source: U.S. Census 2010; Hawaiʻi Statewide GIS Programs Geoportal 2017; USGS 2006
Notes: GIS Geographic Information System
USGS U.S. Geological Survey
$30K $30,000
yr Year
There are no lava flow zones available in the County of Kauaʻi and City and County of Honolulu; therefore no results are reported.
The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaiʻi. To convert households to residents, three people per household was used.

Volcanic Gases and Vog

Toxic gasses emitted from a volcano can travel great distances and cause respiratory distress. Sulfur dioxide is irritating to the eyes, nose, throat and respiratory tract. It is important to note that SO_2 is considered to be a volcanic gas, and not a principle component of vog. The most vulnerable populations to vog include children and individuals with pre-existing respiratory conditions such as asthma, emphysema, bronchitis, and chronic lung or heart disease. Vulnerable populations may respond to very low levels of sulfur dioxide in the air. Prolonged or repeated exposure to higher levels may increase the danger.

The acute health threats posed by the gas discharges are largely associated with the acid gases; sulfur dioxide being the greatest threat because it is discharged at the highest rates and is also accompanied by sulfuric acid aerosols. The acute threats (to human health) typically fall off rapidly with distance from the vent. Although epidemiological data demonstrating the adverse impacts of gas exposure have been difficult to develop, anecdotal reports of families and individuals moving out of the exposed communities to avoid the effects of the gases are quite common. Future threats from these gases will also be dependent on the location of future eruptions.

As with the acute effects, documentation of the human health impacts of lower level chronic exposure to the volcanic gases in downwind communities has proven difficult: epidemiological studies have documented only relatively minor impacts from sulfur dioxide exposure, but anecdotal reports of respiratory discomfort and eye irritation are extremely common and extend beyond the County of Hawaiʻi to the City and County of Honolulu during weather conditions conducive to transport of the plume along the island chain.

Of more concern is the presence of fluoride ion in the gas discharges. Because the use of roof-catchment of rainfall for domestic water consumption is a common practice in communities in the County of Hawaiʻi around and downwind of Kīlauea, there is the potential for accumulation of fluoride in these systems. More recent studies by Donald Thomas and Trisha Macomber on public health hazards associated with rainfall catchment systems exposed to vog emitted from Kīlauea's Halemaʻumaʻu Crater have shown that there is a clear influence on the emissions of vog on rainfall catchment systems located downwind from the source (Thomas and Macomber 2010). Thomas and Macomber's study indicates that an increase in fluoride and sulfate concentrations arise from dry deposition of vog plumes. The study found that levels of these compounds did not exceed the World Health Organization standards for drinking water. However, this finding precludes possible exceedance in the levels of the compounds in the catchment systems due to variations in the levels of the compounds in the plume of vog or exceedance in the levels of the compounds in catchment systems not sampled in the study.

In late 1980s, studies conducted on private rainfall catchment systems in the South Kona area revealed higher than average acidity in several water samples. Drinking the acidic water does not pose a health hazard, but such water can leach lead from the lead roof flashings, lead-headed nails, and solder connections found in many plumbing systems, resulting in unsafe levels of lead in the drinking water. Extensive testing in 1988 determined that many rainfall catchment systems in the County of Hawaiʻi, particularly those in the districts adjacent to or downwind of the active vent, contained elevated levels of lead.

Other recent studies and tests on rainfall catchment systems suggest that although fluoride levels were not found to be above the EPA Maximum Contaminant Level (MCL) for fluoride, several systems showed levels that were quite near the recommended drinking water limits and suggest that relatively small changes in gas discharge rates, in wind trajectories, or decreases in rainfall rates in the downwind communities could bring about fluoride levels that exceed drinking water standards. It is also noteworthy that the testing showed pH levels as low as 3 were present that could enhance heavy metal leaching from the catchment system and domestic plumbing. Older homes, which may contain lead-based paint, lead-based solder or lead-gasketed roofing nails are at particularly high risk of mobilization of lead into the domestic water supply by the acidic rainwater (State of Hawaiʻi HMP 2013).

General Building Stock

Lava Flows

Man-made structures that escape other damage from an eruption can be damaged or destroyed by cracking, tilting, or settling of the ground beneath them. Ground cracks will remain after the eruption is over and can pose a threat to unwary people and animals if the cracks are obscured by heavy vegetation (State of Hawaiʻi HMP 2013).

Similar to the analyses presented earlier, the general building stock data were overlaid with the lava flow hazard area to assess exposure. Table 4.14-15 summarizes the replacement costs and percentages for the Counties of Hawaiʻi and Maui. The County of Hawaiʻi has the greatest estimated potential losses (78.7%) to general building stock. As stated earlier, once lava flow reaches a building, it is assumed that both the structure and land are lost.

Table 4.14-15. General Building Stock Located in the Lava Flow Hazard Area by County

County	Total Replacement Cost Value	Replacement Cost within the Lava Flow Hazard Area	Percent (%) of Total
County of Maui	$31,320,693,000	$5,378,580,000	17.2%
County of Hawaiʻi	$33,326,392,000	$26,223,254,000	78.7%
Total	**$64,647,085,000**	**$32,601,834,000**	**50.4%**

Source: Hazus v4.2, Hawaiʻi Statewide GIS Programs Geoportal 2017; USGS 2006
Notes: GIS Geographic Information System

USGS U.S. Geological Survey
There are no lava flow zones available in the County of Kauaʻi and City and County of Honolulu; therefore no results are reported.

A hazard event can have great impacts on the local and statewide economy. In the far downwind community, on the western side of the Island of Hawaiʻi, weather conditions tend to accumulate the vog discharge into a thick haze that results in persistently overcast skies. The economy in the communities on the western side of the island is heavily dependent on tourism; the primary attraction is balmy weather, blue skies, and access to ocean activities. Current discussion in the State's tourism industry express concern that the adverse air quality associated with the ongoing eruption is reducing the attractiveness of this area as a vacation spot resulting in a loss of income to all the businesses that rely on tourism for their success (2013 State HMP).

It is too soon to estimate economic impacts of the ongoing 2018 Kīlauea volcanic event. According to the University of Hawaiʻi Economic Research Organization, bookings for travel to the County of Hawaiʻi are down due to the eruption. The current eruption has closed Hawaiʻi Volcanoes National Park, the County of Hawaii's biggest tourist attraction (University of Hawaiʻi 2018). Tourists may be apprehensive to visit resulting in decreased or canceled bookings that can equate to a direct economic loss potentially in the millions. As discussed later in the 'Environmental Resources' subsection below, agriculture in the State have experienced loss due to the volcanic gases.

Land Use Districts

Table 4.14-16 shows the square miles of the lava flow hazard area in each State Land Use District statewide; refer to Appendix G for results for the County of Hawaiʻi and the County of Maui. More than half of the Conservation District lands, statewide, are located in lava flow zones. Conservation District lands contain valuable environmental and ecological resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the Environmental Resources

Besides respiratory tract health effects similar to those in humans, vog can also cause the death of wildlife and livestock because of contaminated food consumption. Wildlife and livestock that graze, for example, can die after ingesting water or grass that has been heavily contaminated by falling ash and other volcanic particles. Another effect of vog on wildlife that has been noted particularly in the County Hawaiʻi is the interruption of pollination by bees during heavy vog concentrations (Big Island Weekly News Update 2009).

Also of great concern to wildlife and livestock is the deposition of fluoride salts carried by vog onto forage crops. The scientific literature has documented a number of events where sheep, cattle, and horses have suffered significant losses as a result of acute exposure as well as chronic exposure and accumulation of fluoride salts by grazing animals (2013 State HMP).

In 2010, Donald Thomas from the Center for the Study of Active Volcanoes and Trisha Macomber from the University of Hawaii's College of Tropical Agriculture (CTAHR) produce a study on the effects of fluoride and sulfates on forage lands downwind of Kīlauea's Halemaʻumaʻu Crater (Thomas and Macomber 2010). The study shows that forage samples contained fluoride and sulfate values higher than recommended by the World Health Organization. The study also indicates that although elevated concentrations of fluoride and sulfate do induce adverse health/nutritional effects on grazing animals, the high levels of these compounds do not impact the quality of meat from those animals that would be used for public consumption.

The general effects of sulfur dioxide exposure to plants varies between plant species, age, and the sulfur dioxide dosage; these effects may include:

- reduced seed germination
- enhanced susceptibility to other diseases
- foliar necrosis (spots, blight)
- epicuticular wax erosion
- rupture of epidermis, plasmolysis
- reduced chlorophyll content
- increased membrane permeability of plant leaves
- decreased plant growth (root length, shoot length, leaf numbers)
- plant organ or entire plant death

Downwind of Kīlauea, farmers growing food crops, foliage crops, and cut flowers have all experienced immediate and severe losses due to damage arising from exposure to high concentrations of sulfur dioxide and sulfuric acid aerosols. Although downwind ranches did not experience immediate impacts, over time, they have found that horses, cattle, and goats have developed serious adverse health impairment consistent with chronic fluoride exposure as well as severe mineral deficiencies. At the present time, the mediating factors in these health impacts are not well understood, although excess bone fluoride has been measured and therefore chronic exposure to and intake of fluoride is clearly one aspect of the problem. A secondary economic issue has been greatly accelerated corrosion of fencing, pipelines, and deterioration of ranching equipment. Anecdotal reports of service life losses of 60% to 70% suggest that the economic impacts of these losses could be severe.

It should be noted, finally, that the impacts resulting from gas discharge detailed above are based on existing rates of discharge from more or less fixed locations of emissions. In the event of significant increases in the discharge rate from Kīlauea, or an eruption by Mauna Loa with ten or more times the gas production rate of Kīlauea, the impacts from the gas can be expected to increase correspondingly.

Table 4.14-17 summarizes the environmental resources located in lava flow hazard areas. Coastal features, reefs and other marine habitats, although not located in the lava flow hazard areas, may be impacted once the lava reaches the ocean.

Table 4.14-17. Environmental Resources Located the in Lava Flow Hazard Area

Environmental Asset	Area (in square miles)					
	County of Hawaiʻi			County of Maui		
	Total Asset Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total	Total Asset Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total Area
Critical Habitat[a]	440.4	227.8	51.7%	263.2	91.4	34.7%
Wetlands	88.2	1.6	1.8%	109.7	38.5	35.1%
Parks and Reserves	1,985.4	1,466.6	73.9%	311.3	0.0	0.0%
Reefs[b]	8.6	0.0	0.0%	25.8	0.0	0.0%
Total[c]	**2,522.6**	**1,696**	**67.2%**	**710.1**	**130**	**18.3%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System
a. Critical habitat area mileage includes the combined area of coverage of individual critical habitat areas
b. Reefs include artificial and coral reefs. Reefs are offshore and may be impacted once lava reaches the ocean.
c. Total square miles may be over reported as some environmental asset areas may overlap.

Cultural Assets sections below. Almost a quarter of Urban District lands statewide, are located in lava flow zones, including more than 76% of Urban Districts in the County of Hawaiʻi.

Table 4.14-16. State Land Use Districts Located in the Lava Flow Hazard Area

Land Use District	Total (square miles)	Square Miles in Volcano Lava Flow Zones	Percent (%) of Total Area
Agricultural	2,942.8	1,119.8	38.1%
Conservation	3,156.3	1,659.9	52.6%
Rural	16.1	3.0	18.4%
Urban	319.7	75.5	23.6%
Total	**6,434.9**	**2,858.2**	**44.4%**

Source: USGS 2006; State Land Use Commission, 2016
Notes: Total area was calculated from the State of Hawaiʻi State Land Use District GIS layer
There are no lava flow zones in the County of Kauaʻi or the City and County of Honolulu.
Hazard area clipped to coastline were downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
GIS Geographic Information System

Environmental Resources

Besides respiratory tract health effects similar to those in humans, vog can also cause the death of wildlife and livestock because of contaminated food consumption. Wildlife and livestock that graze, for example, can die after ingesting water or grass that has been heavily contaminated by falling ash and other volcanic particles. Another effect of vog on wildlife that has been noted particularly in the County Hawaiʻi is the interruption of pollination by bees during heavy vog concentrations (Big Island Weekly News Update 2009).

Also of great concern to wildlife and livestock is the deposition of fluoride salts carried by vog onto forage crops. The scientific literature has documented a number of events where sheep, cattle, and horses have suffered significant losses as a result of acute exposure as well as chronic exposure and accumulation of fluoride salts by grazing animals (2013 State HMP).

In 2010, Donald Thomas from the Center for the Study of Active Volcanoes and Trisha Macomber from the University of Hawaii's College of Tropical Agriculture (CTAHR) produce a study on the effects of fluoride and sulfates on forage lands downwind of Kīlauea's Halemaʻumaʻu Crater (Thomas and Macomber 2010). The study shows that forage samples contained fluoride and sulfate values higher than recommended by the World Health Organization. The study also indicates that although elevated concentrations of fluoride and sulfate do induce adverse health/nutritional effects on grazing animals, the high levels of these compounds do not impact the quality of meat from those animals that would be used for public consumption.

The general effects of sulfur dioxide exposure to plants varies between plant species, age, and the sulfur dioxide dosage; these effects may include:

- reduced seed germination
- enhanced susceptibility to other diseases
- foliar necrosis (spots, blight)
- epicuticular wax erosion
- rupture of epidermis, plasmolysis
- reduced chlorophyll content
- increased membrane permeability of plant leaves
- decreased plant growth (root length, shoot length, leaf numbers)
- plant organ or entire plant death

Downwind of Kīlauea, farmers growing food crops, foliage crops, and cut flowers have all experienced immediate and severe losses due to damage arising from exposure to high concentrations of sulfur dioxide and sulfuric acid aerosols. Although downwind ranches did not experience immediate impacts, over time, they have found that horses, cattle, and goats have developed serious adverse health impairment consistent with chronic fluoride exposure as well as severe mineral deficiencies. At the present time, the mediating factors in these health impacts are not well understood, although excess bone fluoride has been measured and therefore chronic exposure to and intake of fluoride is clearly one aspect of the problem. A secondary economic issue has been greatly accelerated corrosion of fencing, pipelines, and deterioration of ranching equipment. Anecdotal reports of service life losses of 60% to 70% suggest that the economic impacts of these losses could be severe.

It should be noted, finally, that the impacts resulting from gas discharge detailed above are based on existing rates of discharge from more or less fixed locations of emissions. In the event of significant increases in the discharge rate from Kīlauea, or an eruption by Mauna Loa with ten or more times the gas production rate of Kīlauea, the impacts from the gas can be expected to increase correspondingly.

Table 4.14-17 summarizes the environmental resources located in lava flow hazard areas. Coastal features, reefs and other marine habitats, although not located in the lava flow hazard areas, may be impacted once the lava reaches the ocean.

Table 4.14-17. Environmental Resources Located the in Lava Flow Hazard Area

Environmental Asset	Area (in square miles)					
	County of Hawaiʻi			County of Maui		
	Total Asset Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total	Total Asset Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total Area
Critical Habitat[a]	440.4	227.8	51.7%	263.2	91.4	34.7%
Wetlands	88.2	1.6	1.8%	109.7	38.5	35.1%
Parks and Reserves	1,985.4	1,466.6	73.9%	311.3	0.0	0.0%
Reefs[b]	8.6	0.0	0.0%	25.8	0.0	0.0%
Total[c]	**2,522.6**	**1,696**	**67.2%**	**710.1**	**130**	**18.3%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System
a. Critical habitat area mileage includes the combined area of coverage of individual critical habitat areas
b. Reefs include artificial and coral reefs. Reefs are offshore and may be impacted once lava reaches the ocean.
c. Total square miles may be over reported as some environmental asset areas may overlap.

Cultural Assets

Cultural sites are non-renewable resources. Lava flows can cut off or cover cultural sites and native land. A large percentage of the Hawaiian Home Lands are located in lava flow hazard areas; 34.9 square miles in the County of Maui or nearly 38% of the county total; and 35.3 square miles in the County Hawaiʻi or 18.5% of the county total (see Table 4.14-18.).

Table 4.14-18. Hawaiian Home Lands Located in Lava Flow Hazard Area

County	Area (in square miles)		
	Total Area	Lava Flow Hazard Area	Hazard Area as Percent (%) of Total
County of Maui	92.6	34.9	37.7%
County of Hawaiʻi	190.3	35.3	18.5%
Total	**282.9**	**70.2**	**25.8%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal
Notes: GIS Geographic Information System

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Potential of Projected Development

Lava flow hazard areas were overlain on areas that may experience significant changes in development or redevelopment in future years (see Table 4.14-19 below; refer to Section 3 for more information on projected development areas). The results of this assessment indicate that 42% of the Maui Development Project areas and 39% of the Enterprise Zones in the County of Maui and the County of Hawaiʻi are located in lava flow hazard areas. County governments may wish to limit the density of development in these areas to prevent increasing exposure of life and property to the lava flow hazard.

Projected Changes in Population

As the age distribution of the population changes resulting in an increase in the number of elderly and young persons in the State, vulnerability to the impacts of volcanic gases and vog may increase as these populations tend to be more susceptible to negative impacts.

Table 4.14-19. Maui Development Projects and Enterprise Zones Located in Lava Flow Hazard Areas

County	Area (in square miles)					
	Maui Development Projects (Total Area)	Total Area Exposed to Hazard	Hazard Area as Percent (%) of Total	Enterprise Zones (Total Area)	Total Area Exposed	Hazard Area as Percent (%) of Total
County of Maui	27.6	11.7	42.2%	1,016.70	176.7	17.4%
County of Hawaiʻi	-	-	-	1,286.60	726.1	56.4%
Total	**27.6**	**11.7**	**42.2%**	**2,303.4**	**902.8**	**39.2%**

Note: There are no lava flow zones in the County of Kauaʻi or in the City and County of Honolulu
Total area calculated from: (1) Maui Development Projects GIS layer from Maui County Planning Department (2) Enterprise Zones from Community Economic Development Program, DBEDT
Hazard area clipped to coastline downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal

SECTION 4. RISK ASSESSMENT

4.15 Wildfire

2018 HMP Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, and probability of future occurrence (including how climate change may impact the hazard). New and updated figures from federal and state agencies are incorporated.
- Wildfire events that occurred in the State of Hawaiʻi from January 1, 2012 through December 31, 2017 were researched for this 2018 HMP Update.
- The high wildfire risk areas provided by the Hawaiʻi Wildfire Management Organization were used to assess vulnerability (HWMO 2013).

4.15.1 Hazard Profile

Wildfires in the State of Hawaiʻi destroy native forests, alter soil composition, and threaten human safety and infrastructure. The State of Hawaii's native ecosystems are not fire adapted. In many cases, once an area burns, it is replaced by fire-prone non-native species, permanently changing the State of Hawaii's landscape. Over 25% of the State contains non-native, fire-prone grasses and shrubs which fuels the fires that occur in the State. This percentage grows each time fire burns into native forest because the forest is then further invaded by fire prone non-native species (Hawaiʻi Wildfire Management Organization [HWMO] 2016a).

Each year, approximately 0.5% of the State of Hawaii's total land area burns, which is equal to or greater than the proportion burned of any other state. Over 98% of the total wildfires are human-caused. In the last 10 years, nearly 1,000 wildfires burned an average of 20,000 acres per year statewide. On the Hawaiian Islands, damages spread mauka to makai (from the mountain to the ocean) quickly, leading to catastrophic impacts to natural resources (Trauernicht et al. 2015).

Hazard Description

"Wildfire" is the term applied to any unwanted and unplanned fire burning in undeveloped land regardless of whether it is naturally or human-induced (State of Hawaiʻi HMP 2013). While sometimes caused by lightning, nine out of ten wildfires are estimated to be human-caused in the State.

Fire hazards present a considerable risk to native ecosystems and biodiversity, including threatened and endangered plant and animal species. As a consequence of wildfire, vulnerability to flooding increases due to the reduction or elimination of plant materials and root systems to stabilize soils resulting in negative impacts including potential destruction of watersheds affecting water quality and availability. Wildfire near coastal areas and increased erosion is a key threat to coral reef ecosystems. While wildfire damages terrestrial and aquatic systems, losses to cultural and economic resources and community infrastructure also occur.

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. Across the mainland U.S. the WUI is roughly defined as the zone where natural areas and development meet. In Hawaiʻi, this definition has been expanded. Steep slopes create linkages between upland wildland fires and downslope impacts on communities, coastal areas, and municipal resources. Conversely, wildfires ignited near developed areas quickly spread into forested areas because of invasive grasses, putting threatened and endangered plant and animal species at risk (DLNR 2016).

The State of Hawaiʻi is also unique in that the vegetation surrounding communities is rapidly undergoing changes that yield higher wildfire risk, in large part due to increased invasion by fire-prone species from changes in land uses (such as active agriculture become unmanaged fallow land). In 2013, HWMO updated the Communities at Risk From Wildfire (CAR) map (discussed in the Location section of this profile). All developed areas across the State were assessed for risk and rated from Low to High based on 36 hazard characteristics that contribute to wildfire risk.

The wildfire urban interface (WUI) is the approximate area where the natural environment and development meet. According to the 2016 Hawaiʻi Forest Action Plan, the wildland areas in the WUI are made up of vast tracts of land that were once used and maintained for agricultural purposes, but are now fallow and dominated by highly fire-prone invasive grasses. Wildfires in the WUI move quickly into forested areas because of the invasive grasses, putting threatened and endangered plant and animal species at risk (DLNR 2016).

Overall, WUI fires can be as damaging or even potentially more damaging than urban structural fires. This is due to the fact that wildland 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. Current home and structure building standards allow structures to be built and maintained in a manner that leaves them and their occupants vulnerable (USDA 2013). Thus, wildfires becomes a significant threat to both humans and natural resources and often result in ecological losses to the State of Hawaiʻi.

According to NOAA, there are four specific types of wildfires: ground wildfires, surface wildfires, crown wildfires, and spotting wildfires.

- **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. Brush fires are a type of surface fire, which the State of Hawaiʻi is quite vulnerable to during

periods of prolonged drought and high winds. Brush fires burn vegetation that is less than six feet tall, such as grasses, grains, brush, and saplings.

- **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 the spread of this type of wildfire.
- **Spotting Wildfires**— These wildfires can also be started by surface fires – basically any fuel type with a significant woody component – shrubs or trees – has potential to spot. A characteristic of spotting wildfires is that large burning embers are thrown ahead of the main fire. Once spotting begins, the wildfire will be very difficult to control (NOAA 2018).

Location

Steep slopes, rough terrain, strong winds, and a large percentage of highly ignitable invasive grasses characterize the landscape for much of the State of Hawaiʻi. Coupled with warm weather, recurring drought conditions, changes in land use and maintenance, and a history of human-caused fires put the State at increased risk to wildfire (HWMO 2016b).

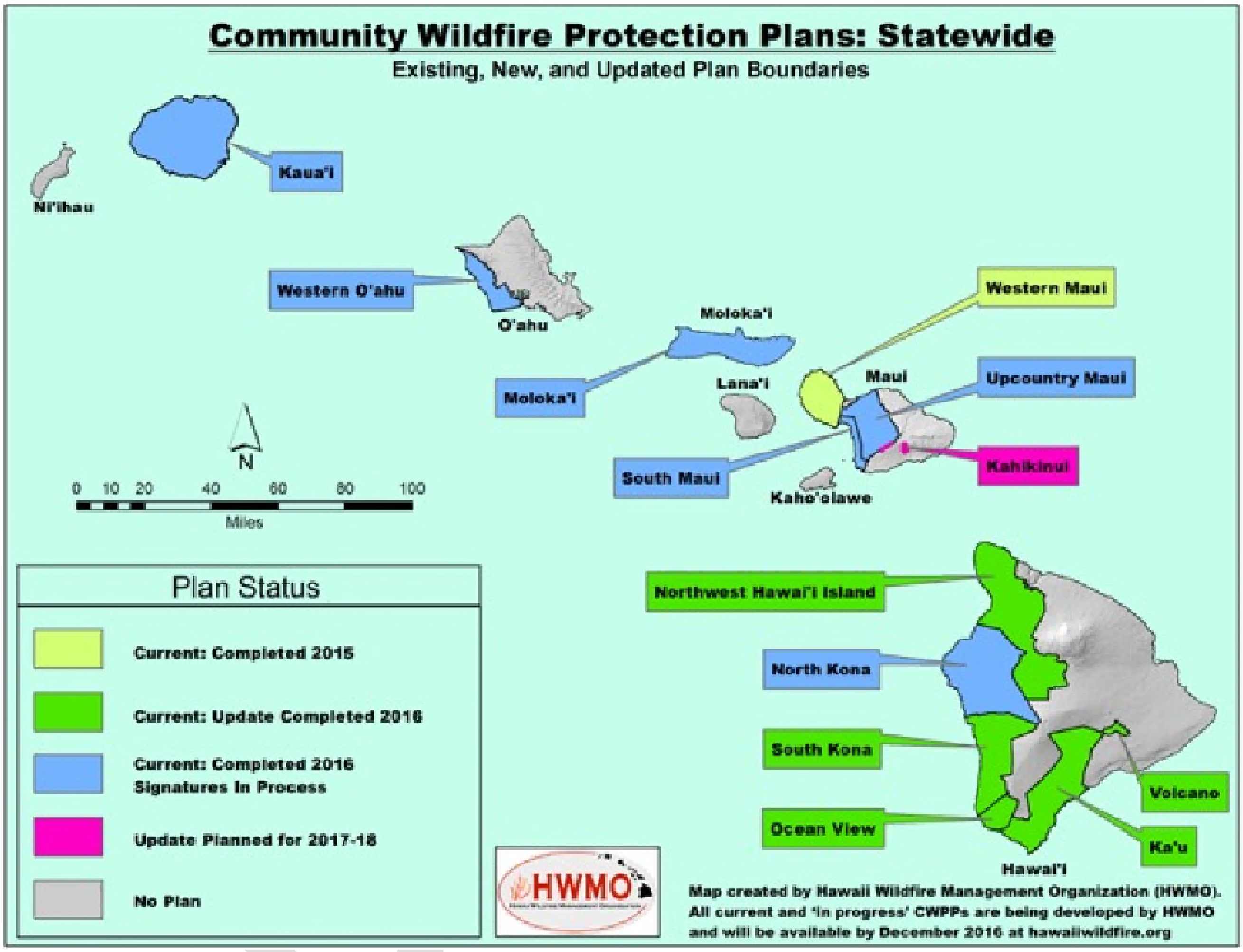
In the State of Hawaiʻi, most wildfire ignitions occur in the WUI which impacts the State's population, infrastructure, and environmental resources. The WUI areas often experience significant risk of losses to property and life, and to natural resource function. As stated earlier, a majority of wildfires in the State of Hawaiʻi are human caused. These fires typically occur near developments, power line right-of-ways, and along roadways. Additionally, sprawling dry, nonnative grasslands surround many of the communities. Once ignited along the WUI, wildfire can spread quickly through residential areas, threatening both property and life. Wildfires can also spread from the interface to higher elevations, threatening natural areas and protected species (HWMO 2016b through 2016h). Nationally, CAR maps delineate communities that share similar environmental conditions, land use characteristics, fuel types, hazards, and general wildfire issues, and provide ratings to characterize generalized hazards in each area. The State of Hawaiʻi Department of Land and Natural Resources (DLNR)-Division of Forestry and Wildlife (DOFAW) has been developing the State of Hawaiʻi CAR maps for more than a decade, and has developed streamlined community boundaries for the purposes of the Hawaiʻi CAR map. In 2013, HWMO partnered with DLNR-DOFAW and the county fire departments across the State of Hawaiʻi to update the Hawaiʻi CAR maps. The original community boundaries were replicated in the 2013 map update, with changes made to reflect current hazards and subdivision expansions. The CAR for the entire State of Hawaiʻi is shown in Figure 4.14-1. Table 4.14-1 summarizes the square miles of high wildfire risk areas as defined by the CAR maps in each County. The table indicates the City and County of Honolulu has the largest wildfire high risk areas and the County of Hawaiʻi has the smallest wildfire high risk areas.

Many communities in the State of Hawaiʻi are located in high risk areas due to a variety of factors including: one point of ingress/egress into neighborhoods; narrow streets; few fire truck turnaround options; unmanaged/untended fire fuels interspersed within developed areas; very limited firefighting access and water resources; and under addressed pre- and post-fire planning and preparedness. These characteristics make fire suppression difficult and can promote fire spread, thus endangering communities (HWMO 2016a).

The HWMO is in the process of developing Community Wildfire Protection Plans (CWPPs) in partnership with local agencies to address the intent and requirements of the Healthy Forests Restoration Act (HFRA) of 2003 – HR1904, which describes the CWPP as a fire mitigation and planning tool for an 'at risk' community. The CWPPs provide a community level overview of the fire environment, to include climatic, topographic, and vegetative influences on wildfire. These locally administered plans serve to provide an indication of risk throughout the State, focusing on developed areas.

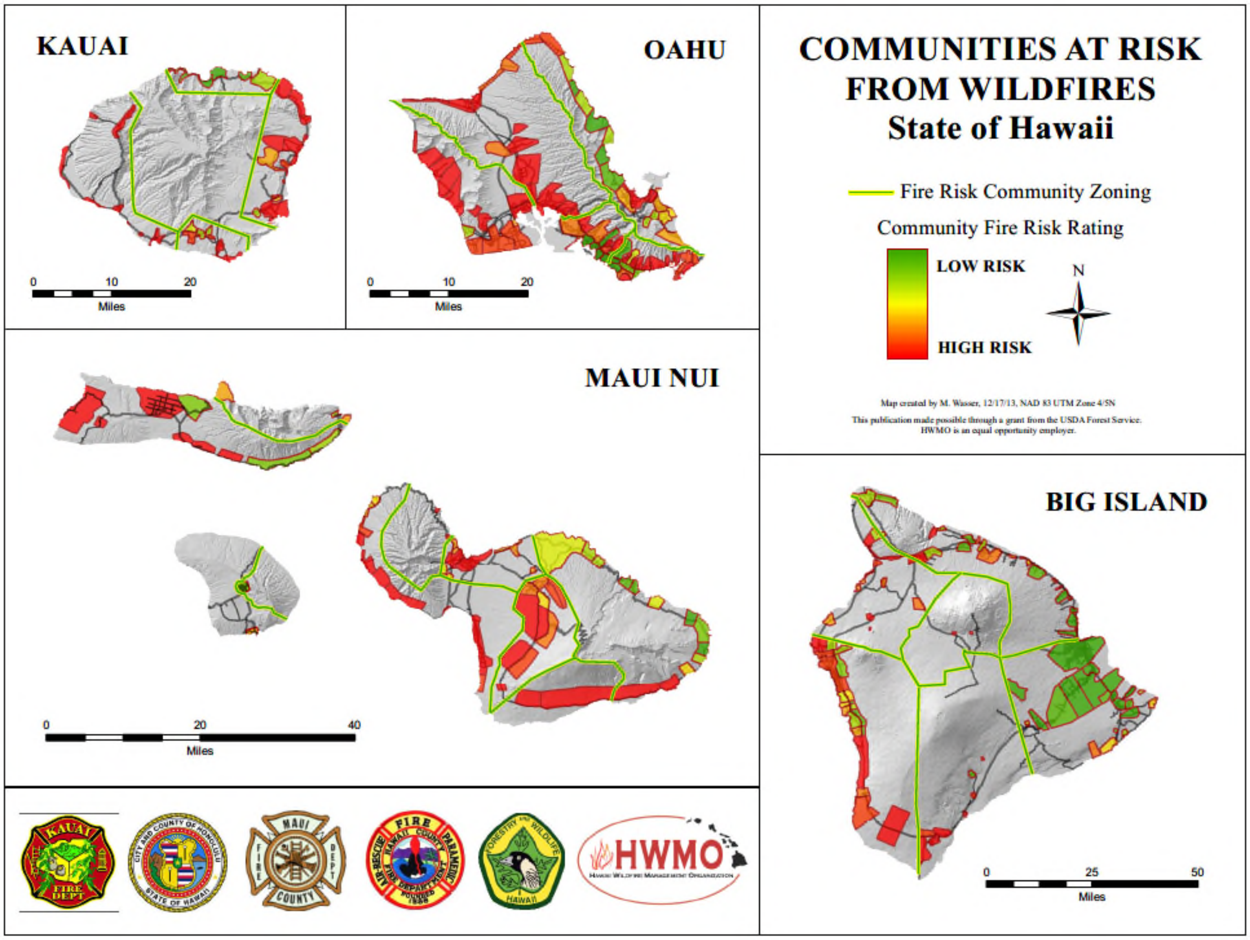
The statewide status of CWPPs is shown in the map below and are available through contacting the HWMO. Selected plans are available on line at http://www.hawaiiwildfire.org/home.

Figure 4.15-1. Community Wildfire Protection Plans – State of Hawaiʻi



A comprehensive assessment of statewide wildfire risk, including undeveloped areas, is not available at this time. Information related to developed areas has been used to inform this plan. Figure 4.15-2 illustrates all developed areas in the State of Hawaiʻi that have been assessed with a gradient color scale used to indicate the overall risk rating for each area (from low to high risk). Gray areas represent undeveloped wildland areas; these areas were not assessed or rated for the purpose of the CAR map. Table 4.15-1 lists the area of high wildfire risk areas by county. The high wildfire risk areas were used to assess vulnerability for the purposes of the 2018 HMP Update (discussed later in the vulnerability assessment subsection).

Figure 4.15-2. Communities at Risk from Wildfires – State of Hawaiʻi



Source: HWMO 2013

Table 4.15-1. High Wildfire Risk Hazard Area by County

County	Total Area (Square Miles)	Square Miles in the High Wildfire Risk Hazard Area	Percent (%) of Total Area
County of Kauaʻi	620.0	37.5	6.0%
City and County of Honolulu	600.7	138.7	23.1%
County of Maui	1,173.5	163.1	13.9%
County of Hawaiʻi	4,028.4	192.0	4.8%
Total	**6,422.6**	**531**	**8.3%**

Source: HWMO 2013
Note: Total area for each County calculated using coastline spatial layer downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal. The calculated area is based on the high wildfire risk areas delineated to date.

The following provides the context to the high wildfire risk hazard areas identified to date in each county. For further details of each, as well as mapping of the high risk areas amongst communities, please refer to the CWPP.

County of Kauaʻi

Steep slopes, rough terrain, difficult access, and a large percentage of highly ignitable invasive grasses, and numerous threatened and endangered native species characterize the County of Kauaʻi landscape. This, coupled with warm weather, recurring drought conditions, changes in land use, and a history of human-caused fires puts the area at increased risk of wildfire. The proximity of development to fire-prone wildlands present hazardous conditions that now threaten Kaua'i communities and natural resources. Overgrown vegetation close to homes, pockets of open space within subdivisions, and an increase of nonnative high fire-intensity plants around developed areas and native forests pose increasing threats to commercial, community, environmental, and residential resources. Together, these factors create the fire environment that puts the County of Kaua'i at risk of wildfire (HWMO 2016d).

City and County of Honolulu

Available information is provided for Western O'ahu where wildfire occurrence is tied to broad climate patterns, in that more and larger fires typically occur in drier leeward areas. Rainfall in Western O'ahu is highly variable over space and time and can greatly influence fire risk.

The widespread establishment of nonnative grasslands and shrublands, especially in lower elevation areas, is a leading cause of increased fire risk in Western O'ahu. Recurrent fires in these lower elevation grasslands and shrublands effectively 'erode' the edges of upland forested areas, which become replaced by grasses and increase the risk of future fires over time. Upper elevation forests in the Wai'anae mountains contain some of the few remaining tracts of native mesic forest. Lower elevation nonnative forests are more exposed to loss from wildfire due to the proximity of fire-prone grasslands and shrublands (HWMO 2106g).

Typical of many areas, larger fires tend to occur during droughts and drier seasons, but wet periods may increase the quantity of available vegetative fuels, leading to an increase both in fire risk and in the frequency that mitigation measures such as firebreaks and fuels reduction need to be applied. Drier conditions tend to persist at lower elevations, making neighborhoods and lands near the coast particularly vulnerable to wildfire starts. Rainfall is typically greater in mauka (upland) areas, which may result in lower fire risk on average in these areas. However, due to more abundant vegetation in the higher elevations, mauka areas frequently experience moderate to high wildfire risk during periods of drought. Daily weather patterns including diurnal thermal winds also influence fire risk (HWMO 2016g).

County of Maui

The County of Maui is comprised of distinct regions with differing risk to wildfire due to climate, topography, vegetation and natural resources. Brief overviews of the Upcountry Maui, South Maui, and Molokaʻi areas are provided below. A CWPP addressing Lanai is not available at this time.

The majority of wildfires in the County of Maui are caused by human error or arson, especially near developments, power line right of ways, and along roadsides. Additionally, sprawling dry, invasive, fire-prone grasslands surround many communities. Once ignited along the interface, wildfire can spread rapidly through residential areas, threatening both property and life. In coastal areas, increased erosion after fire degrades nearshore resource quality through increased sedimentation that damages coral reef ecosystems. Wildfires in the higher elevations threaten natural areas and watershed forests, creating changes to soil that affect groundwater infiltration and drinking water. Upland fires also threaten numerous protected species (HWMO 2014b).

Both the shoreline and upland areas have access roads (multiple ignition points) and include older settlement areas, historical buildings, and irreplaceable cultural and natural resources. Many of these roads are unpaved. Unmanaged fire fuels (primarily grasses and shrubs) in these areas create a significant hazard, as vehicles are common sources of fire ignition. Once ignited, these fires spread rapidly and threaten nearby community infrastructure, neighborhoods, grazing lands, and valuable native flora and fauna (HWMO 2014b).

Upcountry Maui

Upcountry Maui sits entirely on the western slopes of Haleakalā, a 10,023-foot shield volcano, which makes up more than 75% of the County of Maui and spans from the island's eastern coast to its central plains. It is characterized by a combination of residential and agricultural areas, and rugged, often inaccessible, terrain. The communities of Waiakoa, Lower Kula, Ulupaiakua, and Kula Hawaiian Homesteads have the highest risk from wildfires in Upcountry Maui (HWMO 2016e).

Western Maui

Steep slopes, rough terrain, strong trade winds, and a large percentage of highly ignitable invasive grasses characterize the Western Maui landscape. This, coupled with warm weather, recurring drought conditions, and a history of human-caused fire starts puts the area at increased risk of wildfire. The proximity of development to fire-prone wildlands present hazardous conditions that now threaten every Western Maui suburban and rural community.

Abundant fire fuels and heavy winds in the lowland coastal areas promote rapid spread of fires, quickly endangering historical sites, recreational areas, forested watersheds, grazing lands, homes, and community infrastructure. Overgrown vegetation close to homes, pockets of open space within subdivisions, fallow agricultural fields, and an increase of non-native high fire-intensity plants around developed areas pose increasing threats to commercial, community, environmental, and residential resources (HWMO 2014b).

South Maui

The South Maui landscape is characterized by residential areas surrounded by highly ignitable fire-prone grasses on its upland side and the Pacific Ocean on its coastal boundary. South Maui stretches along a coastal region of the downslope edge of two volcanic mountain areas and the saddle between them: Haleakalā, the West Maui Mountains to the northwest, and the central plains connecting the two. The South Maui CWPP planning area is characterized by a combination of residential, agricultural, and wildland areas. It stretches along a coastal region of the downslope edge of two volcanic mountain areas and the saddle between them: Haleakalā, the 10,023-foot shield volcano that comprises much of the Island of Maui, the West Maui Mountains to the northwest, and the central plains connecting the two.

Topography plays a key role in wildfire behavior and post-fire impacts in South Maui and its surrounding (and contributing) environs. Wildfires spread more quickly as they progress upslope and burn at higher intensity. Following wildfires, surface water from rain quickly travels downslope and increases soil erosion, causing downslope flooding and adding sediment to nearshore waters. These post-fire impacts can affect traffic and transportation routes, tourism and economic activities, and harm natural resources by way of runoff that smothers coral reefs and reduces water quality (HWMO 2016c).

Molokaʻi

Molokaʻi is characterized by a combination of residential, commercial, and agricultural areas, as well as rugged, often inaccessible terrain. A majority of Molokaʻi is dominated by non-native vegetation such as Christmas berry, kiawe, and several fire-promoting shrubs and grasses. These non-native, fire-prone grass, shrub, and tree species provide abundant fine fuels that cure quickly in dry conditions, and are easily ignitable even in humid conditions. This allows fires to spread rapidly, creating dangerous conditions for communities and fire responders. These conditions are the leading cause of increased fire risk in the area. The communities of Kaluakoʻi, Maunaloa, Hoʻolehua, Kalamaʻula, Kaunakakai, and Kaweia have the highest risk from wildfires in Molokaʻi (HWMO 2016b).

Lanaʻi

No CWPP exists for Lanaʻi.

County of Hawaiʻi

The County of Hawaiʻi is prone to wildfire conditions. On the leeward side, conditions are affected by a greater number of days with dry conditions expansive grasslands. The windward side of the island has significant grassland cover and, although has less number or dry days, becomes just as vulnerable to wildfire impacts during a drought. In addition, windward areas including Puna and Hawaiʻi Volcanoes National Park, deal with lava-ignited wildfires (Trauernicht, 2018).

Available information is provided for the communities of Kau, Northwest Hawaiʻi Island, Ocean View, and Volcano.

Kau

The Kaʻu CWPP area is situated within the larger Hawaiʻi County district of Kaʻu. Formed from Mauna Loa and Kīlauea volcanoes and the prehistoric Ninole Volcano, the region is characterized by areas of barren lava, rocky substrate, and soil areas derived from volcanic ash. Elevations range from sea level to over 13,000 feet at the top of Mauna Loa. The Kaʻu region has a wide range of climatic conditions in a relatively small distance, providing diverse physical environments from the coastline to high elevations. Hazardous conditions exist throughout the Kaʻu area. Steep slopes, rough terrain, strong trade winds, and a prevalence of fire-promoting fuels characterize the Kaʻu landscape. This, coupled with warm weather, recurring drought conditions, and a history of human-caused fire starts puts the area at risk of wildfire. Both the shoreline and upland areas have access roads (multiple ignition points) and include older settlement areas, historical buildings, and irreplaceable cultural and natural resources. Many of these roads are unpaved. Unmanaged fire fuels (primarily grasses) in these areas create a significant hazard, as vehicles are common sources of fire ignition. Once ignited, these fires spread rapidly and threaten nearby community infrastructure, neighborhoods, grazing lands, and valuable native flora and fauna. Kaʻu is extremely isolated and the closest water source can be many miles away. Catchment systems and hauled water are the only source of water for those residents not serviced by the two small municipal systems. The distances to water resources and the high cost of hauled water are problematic for residents, business owners, and farmers, and hinder fire suppression capabilities in the area (HWMO 2010; 2015a).

South Kona

South Kona stretches for approximately 30 miles between Kailua-Kona and Ka'u, on the leeward side of island. The South Kona area includes Kealakekua, Captain Cook, Honaunau, Napo'opo'o, Ke'ei, Miloli'i, Ho'okena, Papa Bay, Kona Paradise, and other smaller communities and farm areas. Steep slopes and rough terrain dominate most of South Kona, with residential areas, businesses, community infrastructure, cultural resources, and farms spread throughout the district and ranging from sea level to upland areas. The region is primarily rural with low-density development. Over half of these residents depend on rain catchment and hauling or delivery of potable water.

Differences in climate, topography, and soils have resulted in unique natural ecosystems. In the past several hundred years of human habitation, pristine native ecosystems have diminished. Human activity and introduction of non-native plants and animals have displaced many of the historic plant and animal communities. Today, invasive grasses and shrubs and human-caused fire contribute to a cycle of hazardous wildfire conditions and increased post-burn conversion to non-native fire-promoting species. Despite the widespread alteration of native ecosystems, a few areas in South Kona remain as habitat for rare and endangered species and are protected. Upland areas are less disturbed and contain abundant 'ohia and koa forests (HWMO 2010; 2015b).

Northwest Hawai'i Island

Within Northwest Hawai'i there are several communities, including, from north to south, Kawaihae, Waimea, Puako, Pu'uanahulu, and Waikoloa. Communities covered by this CWPP vary in size from 100 single-family home subdivisions to more than 2,700 dwellings with single-family homes, condominiums, retail outlets, schools, historical sites, recreational areas, and commercial facilities. Some of the subdivisions in the coverage area are: Waiki'i, Puakea Ranch, Kohala by the Sea, Kohala Ranch, Kohala Estates, Kawaihae Village, Pu'u Kapu, Pu'u Lani Ranch Estates, Kona Palisades, Kealakehe, and Hina Lani Estates. In addition, there are several internationally known world-class resorts that draw thousands of visitors from around the world.

The WUI areas in Northwest Hawai'i communities have a high risk of wildfire based on a wildfire hazard assessment. Wildland fires occur frequently throughout Northwest Hawai'i, threatening area residents. The largest wildfire in State history was in Northwest Hawai'i in 1969 and burned more than 47,000 acres. In 2005 a wildfire event burned 25,000 acres forcing the evacuation of thousands of people. The continued invasion of non-native plant species, which are considered high-intensity burning fuels, increases the wildfire risk. Grazing of animals traditionally assisted in reducing fuel loads and wildfire risk. However, due to a variety of circumstances, grazing has been reduced or eliminated in many areas, which has contributed to the accelerated wildfire risk in areas that were previously less prone to wildfire. The lack of reliable water resources for both ground and helicopter fire suppression crews have also compromised the rapid response to these disasters and have contributed to the increased fire spread. Communities vary in their access of water, with some communities relying on private water systems or catchment water basins, with others accessing county water (HWMO 2007).

Ocean View

The community of Ocean View in the County of Hawai'i abuts Hawai'i Volcanoes National Park (HAVO) and is in a WUI environment. Covering a swath from sea level to a 13,000-foot mountaintop, the 377-square miles (333,000 acres) of Hawai'i Volcanoes National Park encompasses Mauna Loa, the world's largest volcano, as well as Kīlauea, the world's most active volcano. The Park's ecological zones include coastal strand, dry lowland, mesic and wet rain forest, seasonally dry montane, sub-alpine, and alpine. It is home to more than 50 federally-listed endangered, threatened, and candidate endangered species, as well as numerous rare species. Kīlauea has made HAVO the State's largest tourist attraction with more than 2.5 million visitors annually. In addition, Ocean View has experienced tremendous development in recent years. Many new residents are from other parts of the United States and unfamiliar with the wildfire risks of the community (HWMO 2006; 2015a).

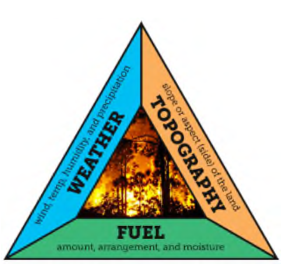
Volcano

The community of Volcano in the County of Hawai'i also abuts HAVO and is in a WUI environment. Due to its location in proximity to HAVO, the community is impacted by lava flows within the Park which have caused several wildfires, some as large as 5,000 acres. Wildland fires originating within the Park have threatened the community of Volcano, which encompasses Volcano Village, the Volcano Golf Course Community, including the Golf Course Subdivision, Mauna Loa Estates, and Ohia Estates. Conversely, wildland fires caused by human error in neighboring towns, such as Volcano, could impact the Park. The Kīlauea Forest Reserve separates Volcano Village and the Golf Course Subdivision. To the east of Volcano Village is the Ola'a Forest Reserve, a land tract of Native Hawaiian forest largely untouched by invasive species. Volcano has experienced tremendous development in recent years. Volcano Fairway Estates is a new subdivision (HWMO 2006; 2015b).

EXTENT

Heat, fuel, and oxygen are all required for the creation and maintenance of any fire as depicted in the wildfire triangle as shown in the adjacent image. When not enough heat is generated or when water is used to reduce the heat level; when the fuel is exhausted, removed, or isolated; or when the oxygen supply is limited, then a side of the triangle is broken and the fire is extinguished.

- **Heat**—A heat source is needed for the initial ignition of wildfires. Heat is also generated by the fire. For a fire to grow, heat must be transferred to the initial and surrounding fuel. It allows fire to spread by removing the moisture from the nearby fuel, enabling it to ignite or travel more easily.
- **Fuel**—The fuel side of the triangle (as shown in the image above) refers to both the external and internal properties of the fuel. External properties refer to the type and the characteristics of the fuel material. Internal properties of fuel address aspects of fuel chemistry. Fuel is characterized by its moisture content, size and shape, quantity, and the location of the fuel type (ground, surface, ladder, or aerial).
- **Oxygen**—Air contains about 21% oxygen. Most fires require air with at least 16% oxygen content to burn under most conditions. Oxygen supports the chemical processes that occur during a wildland fire. When fuel burns, it reacts with oxygen from the surrounding air, releasing heat and generating combustion products (National Interagency of Fire Center [NIFC] 2018).



Fire Behavior Triangle

All wildfires begin with an ignition source. Fire behavior describes the manner in which fuels ignite, flames develop, and fire spreads. The "fire behavior triangle" illustrates how the three primary factors influence wildfire behavior: fuel, topography, and weather. Each point of the triangle represents one of the three factors; the sides represent the interplay between the factors. For example, drier and warmer weather combined with dense fuel loads and steeper slopes will cause more hazardous fires than light fuels on flat ground (NIFC 2018).

Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. However, there are tools used to identify the possibility of fire weather in an area. Fire weather watches and red flag warnings are used to convey the possibility of severe fire weather to wildland fire agencies.

The National Weather Service (NWS) issues Fire Weather Watches and Red Flag Warnings to alert fire departments and residents of the onset, or possible onset, of critical weather and dry conditions that could lead to rapid or dramatic increases in wildfire activity. The watches, warnings, and evacuation notices are science-based predictions that are intended to provide adequate time for evacuation (NWS 2018). Fire weather forecasts are available on the NWS website accessed at https://www.weather.gov/fire/ and provides a hazard/overview map, the NWS Fire Wx Forecast Map, Today's SPC Outlook, the Latest Wildland Fire Outlook, and Current Large Incidents.

A fire weather watch is issued by the NWS when the potential for severe fire weather exists in the near future. A watch is used when there is a relatively low probability of occurrence and less chance of verifying. The fire danger rating is usually in the high to extreme category. It is normally issued 12 to 24 hours in advance of the expected onset of severe fire weather conditions and typically in conjunction with the routine forecasts. The area affected, onset time, and a statement describing the conditions are included in the forecast. A Red Flag Warning is issued by the NWS to indicate the imminent danger of severe fire weather combined with a relatively high probability of occurrence. At issuance, the fire danger is usually in the high to extreme category. A Red Flag Warning may or may not be preceded by a Fire Weather Watch.

Previous Occurrences and Losses

The first reported disastrous wildfire in the State of Hawaiʻi was in 1901 on the Hāmākua Coast of the Island of Hawaiʻi. Over 30,000 acres of agricultural and forested lands burned during this fire, over a period of three months (Trauernicht 2015). This event led to the establishment of Hawaiʻi's Forest Reserve System and the integration of wildfire management into government forest management policy (DLNR 2016).

A plethora of wildfire information and specifically previous occurrences and losses associated with wildfire events exists throughout the State of Hawaiʻi. The 2013 HMP discussed specific wildfire events that occurred in the State of Hawaiʻi through 2012 (see Appendix F for events prior to 2012). For the 2018 HMP Update, only wildfire events that burned over 100 acres between January 1, 2012, and December 31, 2017 were summarized. However, to provide a context for the overall frequency of wildfires, regardless of size, it is noted that the State average number of wildland fires is 1,000 and burning 16,945 acres annually (PFX 2017). Table 4.15-2 provides the numbers of wildfires by year (from 2012 to 2016) and ignition source. This table includes data through 2016 as 2017 information was not available at the time of this 2018 HMP Update. During the reporting period, on average there were 7 fires per year burning an average of 9,000 acres per year though it should be noted that averages are not truly beneficial as wildfire incidents vary widely due to contributing factors. Table 4.15-3 lists the major wildfire events from 2012 to 2017.

Table 4.15-2. Summary of Wildfires from 2012 to 2016

Year	Miscellaneous	
	Number	Acres
2012	11	13,065
2013	2	700
2014	2	554
2015	9	5,691
2016	13	25,514

Sources: Dible 2016; Epping 2015; Hawaiʻi 24/7 Staff 2017, 2014, 2012; Hawaiʻi DLNR 2012; Hawaiʻi Tribute Herald 2017; HNN Staff 2015; Jansen 2012; Kakesako 2012; MauiNow 2016; Osher 2016; Pacheco 2016; Star Advertiser Staff 2012a, 2012b; State of Hawaiʻi 2017; The Associated Press 2013; The OANRP 2012; West Hawaiʻi Today 2012; Inefuku 2016

Table 4.15-3. Wildfire Events in the State of Hawaiʻi – 2012 to 2017

Date(s) of Event	Event Type	Counties Affected	Description
February 18, 2012	Wildfire	Hawaiʻi	Approximately 80 acres burned near the Waikoloa Elementary School. No structures were threatened, and no roads were closed. A nearby car show was evacuated as a precaution. Waikoloa Emergency Operations Center (EOC) was activated.
May 28 to June 5, 2012	Wildfire (Miloliʻi Hikimoe Fire)	Kauaʻi	Approximately 220 acres burned
June 4 to 11, 2012	Wildfire (Kukahi Fire)	Honolulu	Fire burned approximately 1,200 acres, starting in the Lualualei Naval Magazine and burning through the Lualualei Valley into the Waiʻanae Kai Valley Forest Reserve. By June 5, nearly half of the Honolulu Fire Department's assets were dedicated to battling the fire. Many farms were evacuated and roads were closed.
June 6 to 7, 2012	Wildfire	Honolulu	Approximately 1,000 acres burned in the Waiʻanae Valley, unrelated to the fire burning from June 4 to 11, 2012. Sixty firefighters responded, and prevented the fire from threatening structures. The County of Oʻahu EOC was partially activated.
June 18, 2012	Brush Fires	Hawaiʻi	The Hawaiʻi EOC was partially activated in response to two wildfires burning in the Pāhala area. One wildfire burned approximately 5,200 acres, the other burned 400 acres.
June 25 to July 4, 2012	Wildfire (Hikimoe Ridge)	Kauaʻi	The Hikimoe Ridge Fire burned 765 acres of a eucalyptus tree plantation. A voluntary evacuation order was put in place as a precaution. The fire cost the State $375,000, mostly for the cost of hiring fire suppression helicopters.
July 4, 2012	Wildfire	Honolulu	A fire flared along the north side of the Kaloko New Industrial Area road. Smoke was visible in Kailua Village.
July 14 to 15, 2012	Wildfire (Yokahama Cecily fire)	Honolulu	Approximately 500 acres burned
August 17 to 22, 2012	Wildfire (Pōkiʻi Ridge Fire)	Kauaʻi	Approximately 3,000 acres above Kekaha burned. It started on the Pōkiʻi Ridge, and spread to the Paua and Waiaka Ridges. The fire approached a high voltage power line, which was shut down. The fire damaged power, radio, and fiber optic lines. Residents and businesses in Kekaha and Waimea were asked to limit water consumption to essential uses only. The fire chief issued a voluntary evacuation order of Kōkeʻe. The County of Kauaʻi EOC was activated.
November 10, 2012	Wildfire (Iroquois Point Fire)	Honolulu	ʻEwa Beach experienced its largest wildfire between 2001 and 2012 on November 10, 2012. The fire started near the intersection of Hoʻomaka Street and Iroquois Road in an area of dry grass and brush. One hundred acres of brush and grasses burned along Iroquois Point Road in western Oʻahu.
November 15, 2012	Wildfire (PTA Training Area 22 Fire)	Hawaiʻi	Approximately 1,000 acres burned
August 18, 2013	Wildfire (Makua Keaʻau Keolu Fire)	Honolulu	Approximately 100 acres burned

Date(s) of Event	Event Type	Counties Affected	Description
November 25 to 26, 2013	Wildfire (Puʻu Anahulu Fire Complex)	Hawaiʻi	Nearly 600 acres on the Island of Hawaiʻi burned. Three fires made up this incident. No structures were damaged. The Hawaiʻi County EOC was activated.
April 24, 2014	Wildfire	Hawaiʻi	Four acres burned near Mile Marker 29 of Highway 190 in Kona. Traffic was limited to one lane on the highway. No injuries or structure damage were reported. The County of Hawaiʻi EOC was partially activated.
August 22, 2014	Wildfire (Makakilo First Goal Fire)	Honolulu	Approximately 550 acres burned.
January 20 to February 17, 2015	Wildfire (Lau Strike Kīpapa Fire)	Honolulu	Approximately 460 acres burned.
March 23, 2015	Wildfire (Waimea Canyon Drive Fire)	Kauaʻi	Approximately 130 acres burned.
May 4, 2015	Brush Fire	Hawaiʻi	Over 20 acres within the Nīnole Loop on the southeast side of Highway 11 burned. Highway 11 was closed for several hours due to low visibility. The fire burned through vacant pasture land. The County of Hawaiʻi EOC was partially activated.
May 11, 2015	Brush Fire	Hawaiʻi	A runaway brush fire consumed 20 acres and one home in the Green Sands and Mark Twain Estates subdivision in Kaʻū. No injuries were reported. The County of Hawaiʻi EOC was partially activated.
June 5 to 9, 2015	Wildfire (Pōkiʻi Ridge 2015 Fire)	Kauaʻi	Approximately 365 acres burned.
August 1 to 11, 2015	Wildfire (Malevolence Poamoho Fire)	Honolulu	Approximately 500 acres burned.
August 8, 2015	Wildfire (Kawaihae Fire)	Hawaiʻi	Approximately 3,300 acres burned.
August 14, 2015	Wildfire (Puʻukoliʻi Fire 2015)	Maui	Approximately 356 acres burned.
August 22, 2015	Wildfire	Honolulu	The Makakilo Fire was human-caused and one of the largest wildfires in Makakilo's history. The fire burned 1,000 acres near homes along ʻUmena Street and up toward Honouliuli Forest Reserve. Dozens of homes and cabins were evacuated, including Camp Timberline visitors and occupants. Red Cross established an emergency shelter at Makakilo Community Park, where they hosted approximately residents.
January 16, 2016	Wildfire	Hawaiʻi	Palamanui Campus fire burned 200 acres near Queen Kaʻahumanu Highway.

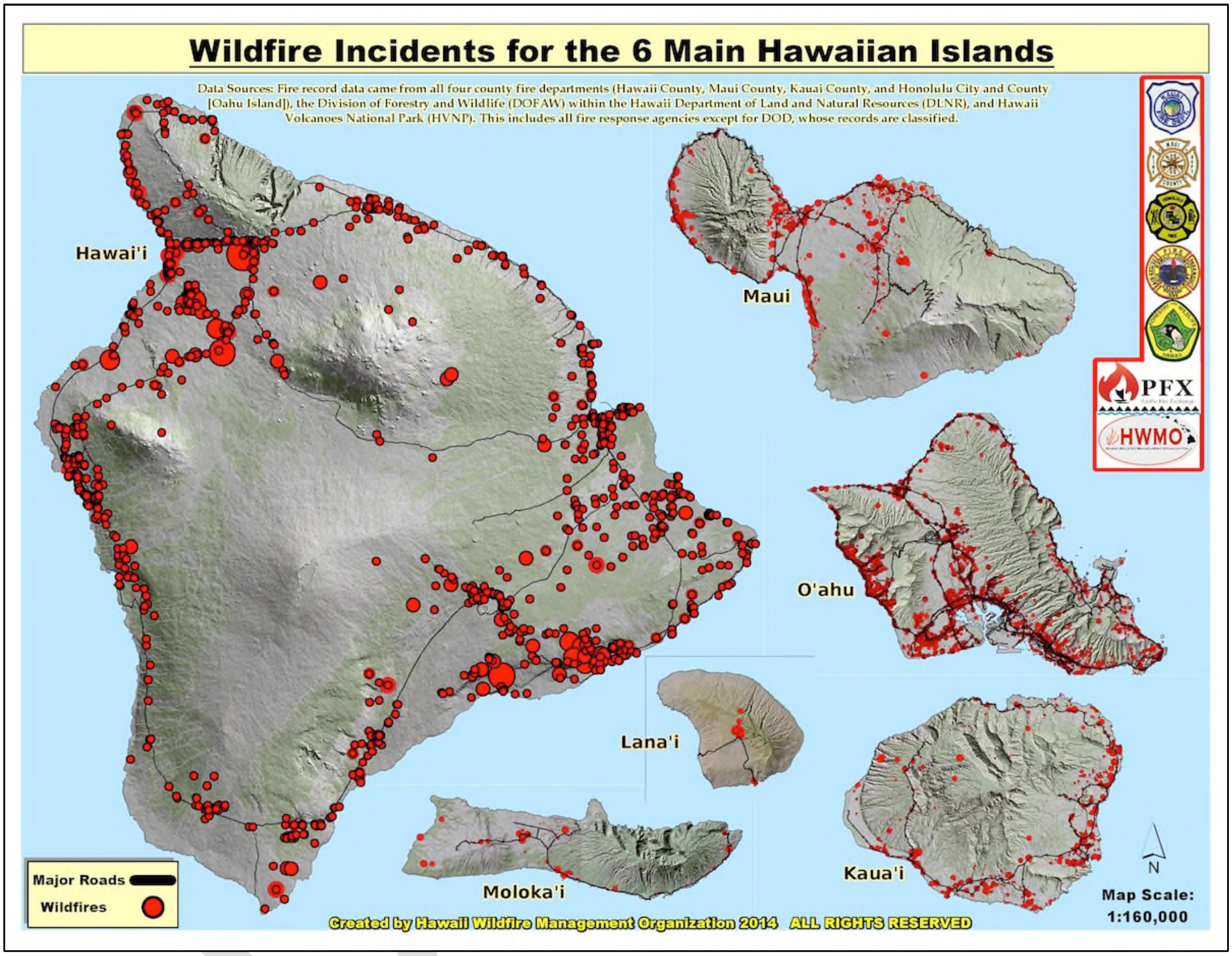
Date(s) of Event	Event Type	Counties Affected	Description
February 10 to 11, 2016	Wildfire	Hawaiʻi	A string of Puʻu Anahulu fires burned 1,150 acres in total in North Kona. These included a fire mauka of intersection of Daniel K. Inouye Hwy (Mile Marker 50) and Highway 190; a fire at Highway 190 at Mile Marker 16; and a fire at Highway 190 near Mile Marker 17 on the mauka side of the highway.
February 15 to 24, 2016	Brush Fire	Maui	Approximately 5,300 acres of the southern slopes of Haleakalā burned between February 15 and 24, 2016. The Kahikinui Homesteads area was evacuated. Shelters for displaced residents were opened at Kēōkea Park in Kula. The County of Maui EOC was activated.
March 5, 2016	Wildfire	Maui	The Kahikinui Fire, caused by arson, burned 5,800 acres and threatened 15 residences and 3 other structures. No structures were destroyed.
March 17, 2016	Wildfire	Honolulu	The Nānākuli Valley Fire was one of the largest wildfires in Western Oʻahu's history, burning 2,500 acres. The wildfire began atop a steep cliff on the southeastern edge of the valley and moved downslope toward homes along Pikaiolena Street, Waiea Place, and Huikala Place. The fire burned right to the edge of homes, prompting voluntary evacuations. Westbound lanes of Farrington Highway at Ko ʻOlina were shut down by police.
March 23 to 24, 2016	Wildfire	Hawaiʻi	A wildfire burned 2,500 acres of brush and grass mixture along Highway 190 between Mākālei and Daniel K. Inouye Highway.
March 28, 2016	Brush Fire	Hawaiʻi	A runaway brush fire that started in a residential area burned 125 acres on the mauka side of Waimea. The fire destroyed a ranch shed, but no homes or businesses. The County of Hawaiʻi EOC was activated.
March 29, 2016	Brush Fire	Honolulu	Due to drought conditions, the slopes of Diamond Head on Oʻahu were impacted by a brush fire. The fire was moving quickly upslope and spreading due to strong winds. Roads were closed and 12 fire companies responded. The brush fire burned approximately two acres.
July 2, 2016	Wildfire (Māʻalaea Nui Fire)	Maui	Approximately 4,700 acres burned after equipment caused the Māʻalaea Nui wildfire.
July 8 to 10, 2016	Wildfire (Ukumehame Fire)	Maui	Approximately 1,242 acres burned
November 18 to 22, 2016	Wildfire	Honolulu	Approximately 1,235 acres burned
March 22 to 23, 2017	Bush Fire	Hawaiʻi	Approximately 10 acres of brush makai of the Queen Kaʻahumanu Highway shut down southbound lanes of the highway and other roads. The County of Hawaiʻi EOC was partially activated.
May 4 to 18, 2017	Wildfire	Kauaʻi	The Kapalawai Wildfire resulted in the County of Kauaʻi EOC being partially activated. Approximately 750 acres burned. Total costs in equipment and personnel to suppress the fire reached over $80,000.
July 7, 2017	Brush Fire	Hawaiʻi	Approximately 2,176 acres burned near the Puukapu Farm Lots and Parker ranch area over two days. No injuries were reported. The County of Hawaiʻi EOC was partially activated.

Sources: Dible 2016; Epping 2015; Hawai‘i 24/7 Staff 2017, 2014, 2012; Hawai‘i DLNR 2012; Hawai‘i Tribute Herald 2017; HNN Staff 2015; Jansen 2012; Kakesako 2012; MauiNow 2016; Osher 2016; Pacheco 2016; Star Advertiser Staff 2012a, 2012b; State of Hawai‘i 2017; The Associated Press 2013; The OANRP 2012; West Hawai‘i Today 2012; Inefuku 2016

EOC Emergency Operations Center

Figure 4.15-3 illustrates wildfire incidents that have been reported throughout the State. The location of these wildfires corresponds to the CARs previously discussed. A majority of these incidents occurred in the medium and high-risk areas previously documented.

Figure 4.15-3. Wildfire Incidents for the State of Hawai'i



Source: HWMO 2018
Note: HWMO Hawai'i Wildfire Management Organization

FEMA Disaster Declarations

During the years of 1954 through 2017, no wildfire-related disasters (DR) or emergencies (EM) were designated in the State by FEMA. However, FEMA did provide Fire Management Declaration Assistance to the State 18 times during that time period. They are summarized in Table 4.15-4.

Table 4.15-4. Fire Management Declarations (1954 to 2017)

Incident Date	Declaration Number	County Affected	Name	Date Declared
March 4, 1993	FM-2044	--	Hawaiʻi Kīlauea	March 4, 1993
February 16, 1998	FM-2195	--	Hawaiian Beaches Subdivision Fire	February 18, 1998
March 14, 1998	FM-2196	--	Hawaiʻi Puna District Wildfire	March 16, 1998
August 25, 1998	FM-2236	--	Hawaiʻi Molokaʻi Fire 98	August 25, 1998
March 20 to 23, 2000	FS-2293	Hawaiʻi	Hawaiʻi County Fire Complex	March 20, 2000
May 18 to 21, 2003	FM-2468	Hawaiʻi	Hawaiʻi Waikoloa Village Fire	May 18, 2003
September 12 to 16, 2004	FM-2556	Hawaiʻi	Hawaiʻi Kawaihae Road Fire	September 14, 2004
August 1 to 6, 2005	FM-2573	Hawaiʻi	Hawaiʻi Lālāmilo Fire	August 2, 2005
August 2 to 6, 2005	FM-2574	Hawaiʻi	Hawaiʻi Akoni Pule Highway Fire	August 4, 2005
August 14 to 20, 2005	FM-2576	Honolulu	Hawaiʻi Nānākuli Brush Fire	August 15, 2005
August 17 to 20, 2005	FM-2577	Honolulu	Hawaiʻi Waikele Fire	August 19, 2005
September 1-6, 2006	FM-2673	Maui	Hawaiʻi Māʻalaea Fire	September 2, 2006
June 27 to July 4, 2007	FM-2701	Maui	Hawaiʻi Olowalu Fire	June 28, 2007
August 14 to 21, 2007	FM-2720	Honolulu	Hawaiʻi Waialua Fire	August 14, 2007
August 16 to 22, 2007	FM-2722	Hawaiʻi	Hawaiʻi Kohala Mountain Road Fire	August 17, 2007
October 28 to November 7, 2007	FM-2740	Hawaiʻi	Hawaiʻi Puakō Fire	October 28, 2007
August 29 to September 7, 2009	FM-2834	Maui	Hawaiʻi Kaunakakai Fire	August 31, 2009
June 8 to 13, 2010	FM-2844	Maui	Hawaiʻi Māʻalaea Fire	June 9, 2010

Source: FEMA 2018

Probability of Future Hazard Events

In the State of Hawaiʻi, although wildfires can occur year-round, the fire season typically runs from the dry months of April through October during which occur the majority of ignitions. However, dry periods or periods of drought can extend the season. With drought and dry seasons, there is increased likelihood of wildland fires. See Section 4.4 for a discussion of the drought hazard.

For the 2018 HMP Update, the best available information was collected to calculate the probability of future occurrence of wildfire events, of all magnitudes, for the State of Hawaiʻi. Information from the 2013 State HMP, HWMO, DLNR and HI-EMA were used to identify the number of wildfire events of 100 acres or greater, that occurred between 1953 and 2017. Based on these statistics, the State of Hawaiʻi has a 100% chance of a wildfire occurring in any given year and can experience approximately 12 wildfire events each year.

It should be noted that there are additional factors which may increase the future occurrence of wildfires in the State of Hawaiʻi. Changing environmental conditions can lead to larger and more intense wildfires in the future. During an El Niño year, the Hawaiian Islands experience more rainfall than normal in the summer months, and less rainfall than average during the winter months (Pacific Fire Exchange 2015). The El Niño rainfall patterns have important consequences for the Pacific Islands:

- Wetter summer/fall increases fuel loads, particularly in typically dry areas which are then more susceptible to increased wildfire activity during dry conditions
- Drier winters increase the potential for wildfire occurrence and spread (Trauernicht 2015).

Wildfire records from the State of Hawaiʻi show an increase in annual area burned during El Niño events. These patterns show that the State can anticipate late, onset drought during the winter months following El Niño development and a higher fire danger throughout the winter (Trauernicht 2015).

Additionally, the number of CARs has increased over time due to changing land use patterns with increased commercial and residential development and more people living proximate to wildland areas. Also, some CARs that had a lower risk designation in the past are now at higher risk (DLNR 2016).

All of the factors listed above increase the risk of wildfires across the State and increase the probability of future occurrences each year.

Climate Change Impacts on Future Probability of Events

Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, frequency of ignition and ignition points, fire management practices, and vegetation fuels and fuel loading. By the middle of the 21st century, it is anticipated that there will be a 35% increase in days with high fire danger across the world (Trauernicht, 2015).

The projected annual surface air temperature for the State of Hawaiʻi is estimated to increase in a range from 1.5˚F to 3.5˚F (U.S. Global Change Research Program 2017). 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.

Wildfire is tied to rainfall patterns in the State of Hawaiʻi much more than temperature. Fires are more frequent in the dry leeward areas and larger fires occur under drought conditions. In the past 30 years, the State has experienced longer droughts, an increase in consecutive dry days, and decrease in the days of intense rainfall. All of which lead to perfect conditions for wildfires throughout the State (HWMO 2018). Additionally, a warming, drying climate, as well as increased frequency and strengths of El Niño events have led to drought conditions that are greatly increasing the risk of wildfires across the State.

4.15.2 Vulnerability Assessment

Wildfire Hazard Area Definition

To assess vulnerability to wildfire, the high-risk communities delineated by the Communities at Risk from Wildfire (CAR) data was used.

A spatial analysis was conducted utilizing the CAR data. For the purposes of this risk assessment, an asset is considered potentially vulnerable to the wildfire hazard if it is located in a high-risk community (noted as a high wildfire risk hazard area above). It is important to note that the wildfire risk data used for this analysis focuses on communities or developed areas. Therefore, the wildfire risk to state assets located outside of these communities could not be determined. Refer to Appendix G (State Profile and Risk Assessment Supplement) which provides more detailed results for the high wildfire risk hazard area analysis, and the exposure analysis results for the assets located in the moderate wildfire risk areas.

Assessment of State Vulnerability and Potential Losses

To assess wildfire vulnerability and potential losses, a spatial analysis was conducted to review the state assets located in the high wildfire risk hazard area. This section discusses the vulnerability of state assets (state-owned or state-leased buildings and state roads) and critical facilities.

State Assets

The spatial analysis for the wildfire hazard determined there are 2,895 state buildings located in the high wildfire risk hazard area with the greatest number of state buildings located in the City and County of Honolulu (1,645 buildings with a replacement cost value of $3.548 billion). The majority of these buildings are occupied by the Department of Education and University of Hawaiʻi. Table 4.15-5 and Table 4.15-6 summarize the state buildings located in the high wildfire risk hazard area by county and agency, respectively.

Table 4.15-5. State Buildings Located in the High Wildfire Risk Hazard Area by County

County	Total Number of State Buildings	Total Replacement Cost Value	High Wildfire Risk Area			
			Number of State Buildings in Hazard Area	Percent (%) of Total	Total Value of State Buildings in Hazard Area	Percent (%) of Total
County of Kauaʻi	531	$957,679,537	377	71.00%	$690,290,935	72.08%
City and County of Honolulu	3,472	$16,750,785,426	1,645	47.38%	$3,548,483,643	21.18%
County of Maui	831	$2,862,316,819	626	75.33%	$2,047,144,499	71.52%
County of Hawaiʻi	1,261	$4,209,774,236	247	19.59%	$662,854,284	15.75%
Total[a]	**6,095**	**$24,780,556,017**	**2,895**	**47.50%**	**$6,948,773,361**	**28.04%**

Source: *Hawaiʻi State Risk Management Office 2017; HWMO 2013*
Notes: *Totals do not include assets that were not able to be geocoded. Please see Section 4.0 for further discussion.*
HWMO Hawaiʻi Wildfire Management Organization

Table 4.15-6. State Buildings Located in the High Wildfire Risk Hazard Area by Agency

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Accounting & General Services	66	$946,504,656	18	27.3%	$135,477,027	14.3%
Dept of Agriculture	70	$133,065,375	27	38.6%	$58,329,017	43.8%
Dept of Attorney General	15	$95,151,863	5	33.3%	$9,867,852	10.4%
Dept of Budget & Finance	16	$26,624,294	6	37.5%	$1,314,797	4.9%
Dept of Business, Economic Development and Tourism	25	$612,574,032	2	8.0%	$31,908,972	5.2%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Dept of Commerce & Consumer Affairs	2	$35,611,360	0	0.0%	$0	0.0%
Dept of Defense	69	$246,099,477	28	40.6%	$118,869,059	48.3%
Dept of Education	4,090	$9,604,111,443	2,170	53.1%	$3,923,400,182	40.9%
Dept of Hawaiian Home Lands	12	$100,471,477	2	16.7%	$2,184,543	2.2%
Dept of Health	44	$387,068,440	10	22.7%	$18,295,256	4.7%
Dept of Human Resources Development	1	$5,523,320	0	0.0%	$0	0.0%
Dept of Human Services	130	$420,004,555	42	32.3%	$68,850,782	16.4%
Dept of Labor and Industrial Relations	22	$79,322,626	14	63.6%	$19,066,946	24.0%
Dept of Land and Natural Resources	90	$98,666,185	32	35.6%	$26,218,269	26.6%
Dept of Public Safety	154	$427,884,909	54	35.1%	$197,856,566	46.2%
Dept of Taxation	1	$6,864,408	0	0.0%	$0	0.0%
Dept of Transportation	68	$2,912,510,888	31	45.6%	$332,820,414	11.4%
Hawai'i State Ethics Commission	1	$891,212	0	0.0%	$0	0.0%
Hawaiʻi Health Systems Corporation	106	$1,223,962,810	51	48.1%	$759,605,877	62.1%
Hawaiʻi Housing Finance & Development Corporation	86	$333,526,064	79	91.9%	$211,766,892	63.5%
Hawaiʻi Public Housing Authority	273	$933,255,767	108	39.6%	$214,609,563	23.0%
Hawaiʻi State Legislature	2	$43,024,855	0	0.0%	$0	0.0%
Hawaiʻi State Public Library System	53	$525,584,082	28	52.8%	$105,523,199	20.1%
Judiciary	41	$511,093,204	17	41.5%	$101,539,545	19.9%
Legislative Reference Bureau	1	$2,686,408	0	0.0%	$0	0.0%
Office of Hawaiian Affairs	11	$53,991,251	4	36.4%	$1,400,487	2.6%
Office of the Auditor	2	$1,789,788	0	0.0%	$0	0.0%
Office of the Governor	1	$2,686,408	0	0.0%	$0	0.0%
Office of the Lieutenant Governor	2	$3,977,640	1	50.0%	$1,956,330	49.2%

Agency	Total Number of State Buildings	Total Replacement Cost Value	Number of State Buildings in Hazard Area	Percent (%) of Total Buildings	Replacement Cost Value in the Hazard Area	Percent (%) of Total Value
Office of the Ombudsman	1	$1,620,944	0	0.0%	$0	0.0%
Research Corporation of the University of Hawai'i	3	$3,713,497	0	0.0%	$0	0.0%
University of Hawai'i	637	$5,000,692,783	166	26.1%	$607,911,786	12.2%
Total	**6,095**	**$24,780,556,017**	**2,895**	**47.5%**	**$6,948,773,361**	**28.0%**

Source: *Hawaiʻi State Risk Management Office 2017*

Roads provide a vital transportation link between populated areas. Road closures, as a result of a wildfire event, will have significant impacts on those communities and each island as a whole. The state has more than 336 miles of state-owned roads located in the high wildfire risk areas.

Table 4.15-7 summarizes the length of state roads in the high wildfire hazard areas by county. The City and County of Honolulu has the greatest number of road miles (166.1 miles) exposed which is 44.3% of the total length of state roads in the County. A complete list of state roads located in the low, moderate, and high wildfire risk areas is included in Appendix G (State Profile and Risk Assessment Supplement).

Table 4.15-7. State Roads Located in the High Wildfire Risk Hazard Area by County

County	Length (in miles)		
	Total Length	Length of Road in Hazard Area	Length as Percent (%) of Total Length
County of Kauaʻi	104.0	32.8	31.5%
City and County of Honolulu	375.3	166.1	44.3%
County of Maui	238.6	70.1	29.4%
County of Hawaiʻi	378.7	67.4	17.8%
Total	**1,096.5**	**336.4**	**30.7%**

Source: State of Hawaiʻi SDOT State Routes GIS layer 2017; HWMO 2013
Notes: GIS Geographic Information System
HWMO Hawaiʻi Wildfire Management Organization
SDOT State Department of Transportation

Critical Facilities

Due to the State's geography, each county needs to be self-sufficient in terms of wildfire response and recovery personnel and equipment. The City and County of Honolulu has the greatest number of critical facilities (335) located in the high wildfire risk hazard area compared to the other counties. Table 4.15-8 summarizes the total number of critical facilities by core category located in the high wildfire risk area by county. Table 4.15-9 summaries the number and percentage of exposed critical facilities by core category. Transportation Services has 51.8% of their facilities located in the high wildfire risk hazard area.

Table 4.15-8. Critical Facilities by County Located in the High Wildfire Risk Hazard Area

County	Core Category of Critical Facilities										Total in the Hazard Area
	Commercial Facilities	Communications	Emergency Services	Energy	Food and Agriculture	Government Facilities	Healthcare and Public Health	Mass Care Support Services	Transportation Services	Water, Waste, and Wastewater Systems	
County of Kauaʻi	2	7	19	7	3	8	11	23	5	17	102
City and County of Honolulu	14	31	34	26	0	17	31	90	4	88	335
County of Maui	2	12	14	2	3	18	41	44	16	40	192
County of Hawaiʻi	3	4	7	1	11	1	8	14	4	12	65
Total[a]	**21**	**54**	**74**	**36**	**17**	**44**	**91**	**171**	**29**	**157**	**694**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; HWMO 2013
Note: HWMO Hawaiʻi Wildfire Management Organization

Table 4.15-9. Critical Facilities by Core Category Located in High Wildfire Risk Hazard Area

Core Category	Total Number of Critical Facilities	Total Replacement Cost Value	Number of Critical Facilities in Hazard Area	Percent (%) of Total Facilities	Value in the Hazard Area	Percent (%) of Total Value
Commercial Facilities	60	$206,894,206	21	35.0%	$109,837,686	53.1%
Communications	130	$523,848,060	54	41.5%	$183,739,490	35.1%
Emergency Services	149	$1,017,628,710	74	49.7%	$530,341,080	52.1%
Energy	90	$2,591,975,628	36	40.0%	$1,027,752,170	39.7%
Food & Agriculture	39	$829,869,410	17	43.6%	$321,855,340	38.8%
Government Facilities	100	$399,781,575	44	44.0%	$181,478,175	45.4%
Healthcare & Public Health	193	$3,399,521,375	91	47.2%	$1,652,077,958	48.6%
Mass Care Support Services	353	$11,497,547,155	171	48.4%	$6,244,829,525	54.3%
Transportation Services	56	$1,739,256,960	29	51.8%	$897,784,320	51.6%
Water, Waste, & Wastewater Systems	305	$9,481,445,760	157	51.5%	$4,870,026,240	51.4%
Total[a]	**1,475**	**$31,687,768,838**	**694**	**47.1%**	**$16,019,721,983**	**50.6%**

Source: Makani Pahili 2017 Emergency Power Prioritization Workshop Series final report; Hazus v4.2; HWMO 2013
Note: HWMO Hawaiʻi Wildfire Management Organization

Assessment of Local Vulnerability and Potential Losses

A wildfire has the potential to kill people, livestock, fish, and wildlife. Wildfires often destroy property, valuable forested watersheds, native species and their habitats, and recreational and scenic resources. Many communities in the State of Hawaiʻi are at high risk from wildfire due to unmitigated fuels, limited community engagement, insufficient water and firefighting resources, and under addressed pre- and post-fire planning and preparedness

(HWMO 2018b). A wildfire would impact not only residents, visitors and valued resources, but also the State's economy which relies heavily on revenues from the tourism industry. This section provides a summary of vulnerability and potential losses to population, general building stock, environmental resources and cultural assets by county. Statewide exposure is examined; however, it is highly unlikely that a wildfire event would take place across all islands at the same time.

Population

Given the historic response times to reported fires, the potential of injuries and casualties is minimal. 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. It should be noted that wildfires can also pose significant threats to the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

Table 4.15-10 lists the estimated population living in the high wildfire risk hazard areas that could be impacted should a wildfire occur. The analysis indicates that the population in the County of Maui has the greatest percent of its population exposed, and the City and County of Honolulu has the greatest number of people located in the high wildfire risk hazard areas. This analysis does not include the number of tourists and visitors in the State whose lodgings are also located in these high-risk areas. Therefore, these results may be underestimating exposure and vulnerability.

Population living along the WUI may only have one ingress/egress to their communities making them highly vulnerable in the event of an evacuation. In addition, the elderly (persons over the age of 65) and individuals living below the U.S. Census poverty threshold are also considered highly vulnerable based on a variety of factors including their physical and financial ability to react or respond during a hazard, the location and construction quality of their housing, and the ability to be self-sustaining for prolonged periods of time after an incident because of limited ability to stockpile supplies. The population over 65 makes up about 6.4% of the total population of the State of Hawaiʻi located in the high wildfire risk hazard area. Overall, 7.4% of the total population of the State of Hawaiʻi is classified as low-income population, and the County of Kauaʻi has the highest percent with 14.9% located in the high wildfire risk areas.

Table 4.15-10. 2010 U.S. Census Population Located in the High Wildfire Risk Hazard Area by County

County	Population						
	Total Population	Population in Hazard Area	Population Exposed as % of Total Population	Population Over 65 in Hazard Area	Population Over 65 Exposed as % of Total Population	Income <$30K/yr in Hazard Area	Income <$30K/yr Exposed as Percent (%) of Total
County of Kauaʻi	67,091	39,493	58.9%	6,064	9.0%	10,008	14.9%
City and County of Honolulu	953,207	454,509	47.7%	61,690	6.5%	57,492	6.0%
County of Maui	154,924	94,000	60.7%	13,089	8.4%	21,819	14.1%
County of Hawaiʻi	185,079	42,045	22.7%	5,729	3.1%	11,172	6.0%
Total	**1,360,301**	**630,047**	**46.3%**	**86,572**	**6.4%**	**100,491**	**7.4%**

Source: U.S. Census 2010; HWMO 2013

Note: HWMO Hawaiʻi Wildfire Management Organization
Yr Year
The poverty threshold for the State is $24,000/year (Federal Register 2017). Utilizing the demographic layer in Hazus, the total households with an income of $30,000 or less was calculated. Per the U.S. Census Bureau QuickFacts, the average number of persons per household (2012-2016) is 3.03 for the State of Hawaiʻi. To convert households to residents, three people per household was used.

Land Use Districts

Table 4.15-11 shows the square miles of high wildfire risk areas in each State Land Use District statewide; refer to Appendix G (State Profile and Risk Assessment Supplement) for results by county. Urban Districts in each county have a significant portion of their total land area in the high-risk areas. This can be explained by the fact that only communities which were included in the CAR data were used to determine the high-risk areas. Agricultural District land in each county, aside from the City and County of Honolulu, has the greatest number of square miles located in high wildfire risk areas. Conservation District land is exposed to high, moderate, and low wildfire risk areas in each county; however, the percent of each county's total Conservation District lands in high wildfire risk areas is generally low (between 1% and 7%). Conservation District lands contain valuable environmental resources. Additional discussion of exposure and vulnerability of these resource areas can be found in the Environmental Resources section below.

Table 4.15-11. State Land Use Districts Located in the High Wildfire Risk Hazard Area

Land Use District	Total (square miles)	Square Miles in High Wildfire Risk Area	% of Total Area
Agricultural	2,942.8	321.1	10.9%
Conservation	3,156.3	66.0	2.1%
Rural	16.1	5.7	35.3%
Urban	319.7	139.8	43.7%
Total	**6,434.9**	**2.6**	**8.3%**

Source: HWMO 2013; State Land Use Commission, 2016
Notes: Total area was calculated from the State of Hawaiʻi State Land Use District GIS layer
Hazard area clipped to coastline were downloaded from State of Hawaiʻi GIS Program Geospatial Data Portal
Total area may differ slightly between this and other calculations due to slight differences in the shoreline geography.
GIS Geographic Information System

General Building Stock

Similar to the analyses presented earlier, the general building stock data was overlaid with the high wildfire risk hazard area to assess vulnerability. Table 4.15-12 summarizes these values by county. Approximately $101 billion, which represents 42% of the total building stock replacement cost value in the state, is located in the high wildfire risk hazard area. As noted earlier, due to the State's geography, it is highly unlikely that wildfire loss will occur statewide as events are typically isolated to one island. The County of Kaua'i has the largest percent (64.4%) of their building stock located in the high wildfire risk hazard area while the City and County of Honolulu has the highest dollar amount exposure with over $65 billion. The replacement cost value of buildings exposed is provided as an estimate for total loss. Appendix X provides the general building stock values located in the low and moderate wildfire hazard areas.

Table 4.15-12. General Building Stock Located in the High Wildfire Risk Hazard Area by County

County	Total Value	Replacement Value in Hazard Area	Replacement Value Exposed as % of Total
County of Kauaʻi	$13,287,882,000	$7,773,287,000	58.5%
City and County of Honolulu	$164,787,212,000	$65,492,432,000	39.7%
County of Maui	$31,320,693,000	$20,169,285,000	64.4%
County of Hawaiʻi	$33,326,392,000	$8,416,647,000	25.3%
Total	**$242,722,179,000**	**$101,851,651,000**	**42.0%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal; Hazus 4.2; HWMO 2013
Notes: GIS Geographic Information System
HWMO Hawaiʻi Wildfire Management Organization

From an economic perspective, traffic and road closures during fire events and post-fire flooding resulting in blocked access to critical transportation facilities, such as airports, leads to loss of productivity. Impacts to environmental resources such as damage to nearshore resources (e.g., fishponds, coral reefs, fisheries), recreational areas, discussed below could have a negative impact to tourism as well (HWMO 2018).

Environmental Resources

Overall, wildfires have physical, chemical, and biological impacts on ecosystem resources and the environment (DeBano et al. 1998). Wildfires threaten air quality, water quality, soil properties, nutrient cycling, vegetation and wildlife habitat. During periods of heavy rainfall, the burned areas can erode becoming mud flows, debris flows, thereby increasing sedimentation loads in streams and rivers and the ocean and potentially impacting water quality, fisheries and long-term coral health. Further impacts include stream bank destabilization, which could worsen impacts of heavy rainfall and lead to riparian flooding.

The State of Hawaiʻi's native ecosystems have evolved with little or no fire. Therefore, wildfire is a significant threat to native forested watersheds and native species, including threatened and endangered species. According to the Hawaiʻi Forest Action Plan, approximately 90-percent of the State's 10,000 native species are endemic; in some cases being endemic to a portion of one island making them extremely vulnerable and potentially one wildfire away from extinction (ʻOhu Gon 2016). Approximately 39 square miles of parks and reserves and 30 miles of critical habitat are located in high wildfire risk areas for CARs (refer to Table 4.15-13 below). As noted, the wildfire risk rankings used for analysis are based on the CAR data and focus on communities and developed areas. Therefore, these results are underestimating environmental resources' exposure and vulnerability to wildfire. Refer to Appendix G which summarizes the environmental resources located in the moderate and low wildfire risk areas by county.

Table 4.15-13. Environmental Resources Located in the High Wildfire Risk Hazard Area

Environmental Resource	Statewide		
	Total Square Miles of Resources[c]	Square Miles in High Risk Area	Percent (%) of Total Resource Area
Critical Habitat[a]	915.2	30.4	3.3%
Wetlands	260.0	10.8	4.2%
Parks and Reserves	2,607.7	38.8	1.5%
Reefs[b]	54.7	0.0	0.0%
Total	**3,837.6**	**80.0**	**2.1%**

Source: State of Hawaiʻi GIS Program Geospatial Data Portal; HWMO 2013
Notes: a. Critical habitat includes the habitats that are known to be essential for an endangered or threatened species. The area mileage includes the combined area of coverage of individual critical habitat areas.
b. Reefs include artificial and coral reefs
c. Total square miles may be over reported as some environmental asset areas may overlap.
GIS Geographic Information System
HWMO Hawaiʻi Wildfire Management Organization

Wildfires impact watershed function—they destroy vegetation in watersheds resulting in a diminished capacity of the soils to absorb rainfall and fog drip that replenishes groundwater resources. Watersheds on all islands are subject to frequent tropical downpours and these brief but intense events can quickly cause erosion and landslides in areas impacted by wildfire. Without vegetation that is resilient to fire and/or does not carry heavy fuel loads, terrestrial plants and animals, fresh and marine water species, and the quality of streams and wetland ecosystems will diminish and their capacity to function properly will degrade (DLNR 2016).

The watershed areas in high wildfire hazard areas were evaluated by county and are summarized in Table 4.15-14. Approximately 2% of the total in these areas is affected by high wildfire risk areas for CARs. Risk rankings have not been developed for most watershed partnership areas.

Table 4.15-14. Watershed Partnership Areas Located in the High Wildfire Risk Hazard Area

Watershed Partnership	Area (in square miles)		
	Total Area	Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi			
Kauaʻi Watershed Alliance	144,004.4	1,185.5	0.8%
City and County of Honolulu			
Koʻolau Mountains Watershed Partnership	100,899.5	3,097.1	3.1%
Waiʻanae Mountains Watershed Partnership	46,412.1	4,688.0	10.1%
County of Hawaiʻi			
Kohala Watershed Partnership	74,120.5	1,195.4	1.6%
Mauna Kea Watershed Alliance	256,250.4	245.7	0.1%
Three Mountain Alliance	1,131,012.0	14,545.3	1.3%
County of Maui			
East Maui Watershed Partnership	119,504.9	1,835.2	1.5%
East Molokaʻi Watershed Partnership	41,668.5	1,689.8	4.1%
Leeward Haleakalā Watershed Restoration Partnership	43,058.0	1,420.5	3.3%
Total	**2,004,251.9**	**29,960.9**	**1.5%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal, 2017
Note: GIS Geographic Information System

The DLNR-DOFAW is the primary responder for wildfires on lands they managed. The DOFAW managed land accounts for 26% of the land statewide. The DOFAW co-responds with county fire departments and federal agencies to wildfires on an additional 32% of statewide lands, as determined by Mutual Aid Agreements and Memoranda of Agreement or Memoranda of Understanding. Therefore, the DOFAW is responsible for fire response on nearly 60% of the lands statewide. The DOFAW-managed lands and the wildfire hazard risk exposure for these lands is listed in Table 4.15-15. Statewide, more than 18 square miles of DOFAW-managed lands are located in high wildfire risk areas for CARs. Risk rankings have not been developed for most DOFAW-managed lands.

Table 4.15-15. DOFAW-Managed Lands Located in High Wildfire Risk Hazard Area

County	Area (in square miles)						
	Total Area	Low Hazard Area	Hazard Area as Percent (%) of Total Area	Moderate Hazard Area	Hazard Area as Percent (%) of Total Area	High Hazard Area	Hazard Area as Percent (%) of Total Area
County of Kauaʻi	166.2	0.0	0%	0.2	<1%	0.5	<1%
City and County of Honolulu	69.5	1.5	2%	3.1	5%	1.7	2%
County of Maui	217.2	0.1	<1%	0.0	<1%	5.0	2%
County of Hawaiʻi	1,124.5	37.8	3%	1.8	0%	11.1	1%
Total	**1,577.4**	**39.5**	**3%**	**5.1**	**<1%**	**18.2**	**1%**

Source: State of Hawaiʻi GIS layers, State of Hawaiʻi GIS Program Geospatial Data Portal, 2017

Notes: DOFAW-managed lands are included in the Parks and Reserves Environmental Resource Area included in Table 4.14-12.

DOFAW Division of Forestry and Wildlife
GIS Geographic Information System

Cultural Assets

Consistent with Native Hawaiian culture, Hawaiian Home Lands include areas from mauka to makai (from the mountain to the ocean). Structures located on Hawaiian Home Lands are considered more vulnerable to wildfire events if located in the categorized high wildfire risk areas (Table 4.14-16). The County of Maui has the greatest number of square miles (36.6) and the City of County of Honolulu has the highest percentage (44.7%) of Hawaiian Home Lands located in high wildfire risk hazard areas.

Table 4.15-16. Hawaiian Home Lands Located in the High Wildfire Risk Hazard Area

County	Area (in square miles)		
	Total Area	Hazard Area	Hazard Area as % of Total Area
County of Kauaʻi County	32.0	2.0	6.3%
City and County of Honolulu	10.9	4.9	44.7%
County of Maui	92.6	36.6	39.5%
County of Hawaiʻi	190.3	5.9	3.1%
Total	**325.8**	**49.4**	**15.2%**

Source: State of Hawaiʻi GIS layer Trust Land, State of Hawaiʻi GIS Program Geospatial Data Portal; HWMO 2013
Notes: GIS Geographic Information System
HWMO Hawaiʻi Wildfire Management Organization

Future Changes that May Impact State Vulnerability

Understanding future changes that impact vulnerability in the State can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Potential or Projected Development

Non-urban zoned lands throughout the State are being urbanized rapidly (Stein, Carr, Liknes, Comas, 2014). From 2000 to 2030, housing density is projected to substantially increase on approximately 8% (65,000 acres) of Hawaiʻi's private forest land (Stein, Carr, Liknes, Comas 2014). On Oahu, the directed growth policy of the City and County of Honolulu encourages growth to occur beyond the primary urban center (City and County of Honolulu 2014). Some new developments have sprawled into dry parts of Oahu while encroaching into the WUI. In wildfire prone areas across the State, new developments would benefit from ensuring that the state fire code, including WUI codes, as well as recommendations are followed. This includes the design of roads (adequate width, fire truck access and turn-arounds, more than one ingress/egress, etc.), layout of structures (spacing), building materials (non-combustible and fire resistant), and maintenance of internal and surrounding vegetation. In other areas where land use changes have occurred due to the removal of active agriculture, fire hazard has increased and would be mitigated if converted and hardened for development. The number of communities rated to be at high risk from wildfire in the State has increased over time because of more people living proximate to wildland areas (DLNR 2016).

Projected Changes in Population

As stated previously, over 98% of wildfires in the State of Hawaiʻi are caused by humans. As the overall resident population increases, there may be an increase in the number of human-caused wildfires as more people move into currently less developed parts of the State and as more people engage in activities that may accidentally spark wildfires. In addition to the resident population, the visitor population coming to the State is also increasing. Visitors may be less familiar with wildfire risk and the precautions that should be taken to prevent or limit wildfire ignition. The increase in both resident and visitor populations may stress existing resources available for wildfire suppression activities as more water will be needed for human use and consumption.

Other Factors of Change

Climate change has the potential to significantly increase vulnerability to wildfire in the State. In the past 30 years, the State has experienced longer droughts, an increase in consecutive dry days, and decrease in the days of intense rainfall. All of which lead to perfect conditions for wildfires throughout the State (HWMO 2018c).

As drought conditions become more frequent and as sea level rise "squeezes" land available for development, this will result in development expansion closer to upland forest ecosystems. Increasing temperatures and, in some areas, reduced rainfall will stress native plant and animal populations and species, especially in high-elevation ecosystems, with increased exposure to non-native biological invasions and fire, and with extinctions a likely result (Pacific Islands Regional Climate Assessment 2012).

Overall, an increase in wildfire events means less native forests and drinking water, and more erosion/runoff, coastal brownouts and communities at risk in the State of Hawaiʻi (HWMO 2018c).

SECTION 4. RISK ASSESSMENT

4.16 Vulnerability Summary

2018 HMP Update Changes

- The 2013 HMP did not rank all hazards of concern based on the updated 2013 risk assessment; only the top five hazards were reported for each county. For the 2018 HMP Update, a hazard ranking methodology was developed to rank all hazards, both statewide and for each county. The methodology was expanded beyond an examination of impacts to include hazard event probability, warning time, spatial extent, duration, adaptive capacity, and future conditions.

44 CFR §201.4(c)(2)(ii): An overview and analysis of the state's vulnerability to the hazards [shall be summarized] ...based on estimates provided in local risk assessments as well as the state risk assessment.

At the conclusion of the risk assessment update documented in Sections 4.2 through 4.15, the 14 hazards of concern were ranked to summarize statewide vulnerability. The results of the hazard ranking were presented at the Forum and public meetings held in March 2018 to collect feedback (refer to Section 2 – Planning Process and Appendix X – Planning Process Documentation). The results were carefully reviewed by the HI-EMA and the Forum, and adjusted as needed and appropriate, to ensure the hazard ranking aligned with the perceived statewide hazard risk.

2018 Hazard Ranking

- ✓ *The purpose is to summarize statewide vulnerability and guide the updated mitigation strategy.*
- ✓ *The hazard ranking is provisional. It may change with time as additional data and analyses become available, capabilities in the state change, and changes associated with climate change become realized and fully predictable.*
- ✓ *Overall, the 2018 hazard ranking represents a snapshot in time for the state based upon best available data.*

The following summarizes the methodology and results of the State of Hawaii's hazard ranking. Refer to Appendix X (State Profile and Risk Assessment Supplement) for the hazard ranking results developed for each county using the same methodology.

It is important to emphasize that all hazards evaluated in the 2018 HMP Update are considered hazards of concern. Medium- and low-ranked hazards are of concern to the State of Hawaiʻi and potential future losses resulting from these hazard events should be mitigated. Mitigation strategies are included in Section 6 (Mitigation Strategy).

4.16.1 2013 State and County Hazard Ranking

The HI-EMA reviewed the 2013 HMP and the methodology utilized to rank the hazards of greatest concern to the state and each county. Each county's top hazards were identified utilizing annualized losses that may be quantified. As a result, the 2013 HMP did not rank all hazards assessed in the plan; only the top five hazards for each county were reported; refer to Table 4.16-1 below for the 2013 HMP county hazard rankings. All four counties have Tropical Cyclone (now called Hurricane in the 2018 HMP Update) as their highest ranked hazard risk.

Table 4.16-1. 2013 HMP Update Hazard Ranking

County of Kaua'i	City and County of Honolulu	County of Maui	County of Hawai'i
Tropical Cyclone	Tropical Cyclone	Tropical Cyclone	Tropical Cyclone
Tsunami	Tsunami	Tsunami	Earthquake
Coastal Erosion	Earthquake	Earthquake	Tsunami
Flood	Flood	Coastal Erosion	Lava Flow
Landslide and Rockfall	Landslide and Rockfall	Flood	Flood

Source: State of Hawai'i HMP 2013

In terms of a statewide hazard ranking, the 2013 HMP reported that the State Civil Defense Strategic Plan 2011 – 2015 conducted an independent assessment to rank hazards. Based on 'likelihood and effect on population and property' the top six highest risks were: 1) Hurricane, 2) Flash Flood, 3) Tsunami, 4) Earthquake, 5) Volcano/Lava, and 6) Landslide/Rockfall (State of Hawai'i HMP 2013).

4.16.2 2018 HMP Update Hazard Ranking

For the purposes of the 2018 HMP Update, an expanded and more holistic hazard ranking methodology was developed and utilized to evaluate the degree of risk for all identified hazards in the State of Hawai'i. It utilizes numerical values that allow identified hazards to be ranked against one another; the higher the relative risk factor calculated, the greater the hazard risk.

Methodology

The hazard ranking methodology designed for the State of Hawai'i includes risk factor categories that align with FEMA's State Mitigation Planning Key Topic Bulletin on Risk Assessment and FEMA's Comprehensive Preparedness Guide (CPG 101) risk analysis process. In addition, the methodology integrates the THIRA and State of Hawaii's capabilities into the evaluation.

It is recognized that certain hazards have undergone more detailed analyses than others based upon the available data and hazard modeling methodologies available and/or conducted over the course of the 2018 HMP Update. Therefore, for some hazards, qualitative assessments and professional judgement were used to assign the most appropriate numeric value for each category evaluated.

As described in Section 4.1 (Risk Assessment) and summarized in Table 4.1-6, three different levels of analysis were used to estimate potential impacts: 1) historic loss/qualitative analysis; 2) exposure analysis; and 3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the State will vary from the analysis presented here based on the factors described for each hazard of concern; namely location, extent, warning time, and mitigation measures in place at the time of an event. The hazard ranking methodology for some hazards of concern is based on a scenario event, while others are based on the potential vulnerability to the state as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgement and SME input and assumptions are included, as appropriate, in the following sections. The limitations of this analysis are recognized given the all scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence**—The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgement was used to estimate the probability of occurrence of an event that will impact the State.
- **Impact**—The following three hazard impact subcategories were considered: impact to people; impact to assets and the economy; and impact to environmental resources and cultural assets. The results of the 2018 HMP Update risk assessment and/or professional judgement were used to assign the numeric values for these three impact subcategories. For the statewide ranking, the impact to state assets and the overall state economy were considered. For the county-specific ranking, the impact to the general building stock and county economy were considered. A factor was applied to each subcategory, giving impact on population the greatest weight.
  - Population—Numeric value x 3
  - Assets/Economy—Numeric value x 2
  - Environment Resources/Cultural Assets—Numeric value x 1
- **Spatial Extent—**The area of impact was calculated in GIS for the hazards with a delineated spatial extent. For hazards that do not have a geographic extent, it was determined whether or not the hazard event would have local, regional or statewide impacts. Refer to Section 4.1 (Risk Assessment Overview), which describes the spatial datasets used.
- **Warning Tim**e—The lead time associated with the hazard event was researched, and the warning measures/systems in place to alert the state in advance of the event occurring were considered. Warning time is discussed in each hazard profile (refer to Sections 4.2 to 4.15).
- **Duration**—The duration was estimated by determining the approximate length a hazard event may last, and time until full recovery. An examination of the historic record was used as a point of reference.
- **Adaptive Capacity—**Adaptive capacity describes the State's current ability to protect from or withstand a hazard event. The State annually develops a State Preparedness Report (SPR) that rates the 32 core capabilities across five elements: planning, organization, equipment, training and exercises. Each core capability is rated on a scale of 1 to 5 across each element (5 indicating high proficiency in the capability). These ratings, conducted by the HI-EMA and supporting stakeholders, form the basis for the adaptive capacity assessment for each hazard of concern for the 2018 HMP update.

Adaptive Capacity

Describes the State's current ability to protect from or withstand a hazard event.

- **Changing Future Conditions—**Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was factored into the hazard ranking. This was important to the HI-EMA to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.2 through 4.15. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

Table 4.16-2 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. The relative hazard risk score was calculated for each hazard using the following formula. Using the weighting applied, the highest possible risk factor value is 6.75. The higher the number, the greater the relative risk.

Relative Risk = [(Probability × 0.25) + (Impact × 0.25) + (Spatial Extent × 0.15) + (Warning Time × 0.05) + (Duration × 0.1) + (Adaptive Capacity × 0.1) + (Changing Future Conditions × 0.1)]

Table 4.16-2. Summary of Hazard Ranking Approach and Associated Criteria

Category		Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
Probability of Occurrence		Unlikely	Hazard event is unlikely to occur with less than a 1% annual chance probability	0	25%
		Rare	Between 1 and 10% annual probability	1	
		Occasional	Between 10 and 100% annual probability	2	
		Frequent	100% annual probability; may occur multiple times per year	3	
Impact *(Sum of all 3)*	**Population (Numeric value x3)**	None	No anticipated displacement or injuries; minimal disruption on quality of life.	0	25%
		Low	Potential for measurable life safety impacts (displacement, injuries, fatalities) is less than 10% of the total population	1	
		Medium	Potential for measurable life safety impacts (displacement, injuries, fatalities) is 10-25% or less of the total population	2	
		High	Potential for measurable life safety impacts (displacement, injuries, fatalities) is greater than 25% of the total population	3	
	Assets/Economy (Numeric value x2)	None	No impact to minimal anticipated potential loss to property/assets; no anticipated economic impacts (interruption of services, businesses, jobs).	0	
		Low	Potential loss to property/assets is more than 10% of the total of all assets;	1	

Category		Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
			impacts are localized affecting only a relatively small or isolated area; no interruption of services or business continuity.		
		Medium	Potential loss to property/assets is more than 25% of the total of all assets; impacts are local and regional; temporary shut-down of critical facilities, businesses/delivery of services/jobs	2	
		High	Potential loss to property/assets is greater than 50% of the total of all assets; impacts are regional/multiple counties; shutdown of critical facilities; interruption of business continuity/delivery of services/jobs	3	
	Environment Resources/ Cultural Assets [a] **(Numeric value x1)**	None	No loss is estimated from the hazard	0	
		Low	Potential loss to environmental resources/cultural assets is less than 10% of total of all assets.	1	
		Medium	Potential loss to environmental resources/cultural assets is 10-20% of total of all assets.	2	
		High	Potential loss to environmental resources/cultural assets is greater than 20% of total of all assets.	3	
Spatial Extent		None	No spatially-delineated hazard area	0	15%
		Small	A portion of one island	1	
		Medium	2 to 3 islands	2	
		Large	Entire State (all islands)	3	
Warning Time		More than 24 hours	Warning time is more than 24 hours	0	5%
		12 to 24 hours	Warning time is 12 to 24 hours	1	
		6 to 12 hours	Warning time is 6 to 12 hours	2	
		0 to less than 6 hours	Warning time is 0 to 6 hours	3	
Duration of Event		Minimal	Less than 6 hours	0	10%
		Low	Less than 24 hours	1	
		Medium	Less than 1 week	2	
		High	Greater than 1 week	3	
Adaptive Capacity		Complete	The State has mitigated all hazard risk through mitigation measures and in-house capabilities.	0	10%
		Low	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; State has ability to recover quickly	1	

Category	Level	Degree of Risk/Benchmark Value	Numeric Value	Weight
		because resources are readily available and capabilities are high		
	Medium	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; State can recover but needs outside resources; moderate State capabilities	2	
	High	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery	3	
Changing Future Conditions [b]	No	Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future	0	10%
	Uncertain	No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence)	1	
	Likely	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence)	2	
	Highly Likely	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods)	3	

[a] The potential loss to environmental resources (critical habitat, wetlands, parks and reserves, reefs) and cultural assets (Hawaiian Home Lands) could not be estimated or monetized; therefore, the exposure analysis results in Sections 4.2 through 4.15 support this evaluation. It is recognized additional environmental resources and cultural assets may be impacted that were not included as part of the risk assessment.
[b] Similar to confidence levels outlined in the National Climate Assessment 2017

In an attempt to summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.

- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

Table 4.16-3 summarizes the hazard scenario or hazard area evaluated; highlights key impacts to population, state assets and environmental resources/cultural assets; and lists the associated certainty factor assigned for each hazard to convey the level of confidence in the data used. This table is not intended to be a complete and comprehensive list of all hazard impacts determined in the risk assessment and considered for the hazard ranking exercise. Refer to Sections 4.2 to 4.15 for a complete summary of all estimated statewide impacts for each hazard.

Table 4.16-3. Overview of the Hazard Scenario and Associated Estimated Impacts Considered in the Hazard Ranking

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Statewide Impacts			
		Population [d]	State Assets	Environment Resources/ Cultural Assets [a]	
Climate Change and Sea Level Rise	SLR-XA-3.2 and 1%CFZ-3.2	SLR-XA-3.2: 19,830 people displaced 1%CFZ-3.2: 145,948 people exposed	SLR-XA-3.2: 55 state buildings ($55.8M), 39.2 miles of state roads and 33 critical facilities ($675M) lost; 1%CFZ-3.2: 642 state buildings ($2.2B), 101.1 miles of state roads and 229 critical facilities exposed	SLR-XA-3.2: 79.3 sq.mi. of environmental resource areas and 1.1 sq.mi. of HHL lost; 1%CFZ-3.2: 105.7 sq.mi. of environmental resource areas and 3.8 sq.mi. HHL exposed	High
Chronic Coastal Flood	SLR-XA-1.1	4,160 people displaced	8 state buildings ($30.8M), 15.2 miles of state road and 8 critical facilities ($156.6M) lost	70.1 sq.mi. of environmental resource areas and <1 sq.mi. of HHL exposed	High
Dam Failure	Inundation area for all dams with spatial delineation	14,862 people exposed [b]	232 state buildings ($1.2B), 30 miles of state road and 91 critical facilities ($1.9B) exposed	2.6 sq.mi. of environmental resources areas and 3.2 sq.mi. of HHL exposed	Moderate
Drought	Drought event	Entire state population exposed; impacts to health and safety of individuals are estimated to be minimal.	Critical facility functionality may be impacted (e.g., water source for fire services); overall impacts to structures are low.	Environmental damages; increased wildfire risk; agricultural losses ($661M Market value exposed)	Low
Earthquake	100-Year Mean Return Period Event	Entire population exposed; 1,737 displaced households; 1,158 people need short-term sheltering	$754M state building damages; $517M critical facility damages	Impacts to environment from hazardous materials release; induced flooding/landslides; poor water quality	High

Hazard	Category					Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Statewide Impacts				
		Population [d]	State Assets	Environment Resources/ Cultural Assets [a]		
Event-Based Flood	1% Annual Chance Flood	95,216 people exposed	$78.9M state building damages; 84.4 miles of state road exposed; $306M critical facility damages	42.1 sq.mi. environmental resource areas and 3.9 sq.mi. HHL exposed		High
Hazardous Materials [c]	Release at a NPL site	Population impacted will depend on the type of material and scale of the incident. May include population within small radii of site.	The degree of damages to state asset depends on the scale of the incident.	The degree of damages depends on the scale of the incident.		Low
Health Risks	Pandemic Flu	Entire state population exposed	Loss of state services; Potential temporary closure of ports of entry impacting import/export of goods and vital resources	Livestock and poultry may become infected; impacts to food supply and water supply		Low
High Wind Storms	100-Year wind event	Entire state population exposed	All state buildings and critical facilities exposed; utility outages may cause disruption in services	All environmental resources and HHL exposed; potential agricultural losses and debris.		Low
Hurricane	Category 4 storm surge (SLOSH)	155,426 people exposed to storm surge (Category 4); all exposed to wind	654 state buildings ($3B); 77.4 miles of state road; 217 critical facilities ($4.4B) exposed	28.1 sq.mi. environmental resource areas and 2.4 sq.mi. HHL exposed		High
Landslide and Rockfall	High landslide susceptibility areas	54,239 people exposed	357 state buildings ($1.8B); 150.4 miles of state road; 95 critical facilities ($1.4B) exposed	602 sq.mi. environmental resource areas and 118 sq.mi. HHL exposed		Moderate
Tsunami	Great Aleutian Tsunami	236,357 people exposed	1,175 state buildings ($4.4B); 183 miles of state road; 388 critical facilities ($7.8B) exposed	46.6 sq.mi. environmental resources areas and 6.7 sq.mi. HHL exposed		High
Volcano (Lava flow and vog)	Lava Flow Zones (1-4 for County of Hawaiʻi; 1-2 for County of Maui)	161,024 people exposed	1,116 state buildings ($3B); 240.5 miles of state road; 239 critical facilities exposed (nearly $5B)	1,826 sq.mi. environmental resource areas and 70.2 sq.mi. HHL exposed		Moderate
Wildfire	High Wildfire Risk Hazard Area [e]	630,047 exposed	2,895 state buildings($6.9B); 336.4 miles of state road; 694 critical facilities ($16B) exposed	80 sq.mi. environmental resource areas, 18.2 sq.mi. of DOFAW-managed land; 29,961 sq.mi. watershed partnership area; and 40 sq.mi. HHL exposed		Moderate

Notes:
State building values are based on structure replacement cost; for SLR-XA-1.1 and SLR-XA-3.2 losses do not include land value.
[a] *Environmental resources include critical habitat, wetlands, parks and reserves and reefs. There may be overlap with the Hawaiian Home Land area calculated.*
[b] *Located in the 12 dam failure inundation areas selected for the county analysis (three per county); does not represent total population located in the total dam failure inundation areas in the state.*
[c] *The impacts and vulnerability from a hazardous materials event are greatly dependent on the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, maintenance/mechanical failures, and distance and related response time for emergency response teams.*
[d] *All population estimates do not include visitors.*
[e] *Statewide exposure is examined; however, it is highly unlikely that a wildfire event would take place across all islands at the same time. Therefore, the input to the risk ranking was adjusted to reflect this.*

Exposed	=	*This refers to the number of assets located in the hazard area; all of which may not incur losses as a result of the event.*
1%CFZ-3.2	=	*The 1% annual chance coastal flood zone (V zones only) with 3.2 feet of sea level rise was used to assess mid- to late century event-based coastal flooding.*
B	=	*Billion*
HHL	=	*Hawaiian Home Lands*
M	=	*Million*
SLR-XA-1.1	=	*Current or near-term exposure to coastal flood hazards is assessed using the Sea Level Rise Exposure Area with 1.1 feet of sea level rise.*
SLR-XA-3.2	=	*To assess mid- to late century sea level rise on chronic coastal flooding, the Sea Level Rise Exposure Area with 3.2 feet of sea level rise is used.*
sq.mi.	=	*Square miles*

HAZARD RANKING RESULTS

State Hazard Ranking

Table 4.16-5 provides the statewide hazard ranking for the 2018 HMP Update. The four highest ranked hazards for the State of Hawai'i when examining statewide risk are:

- Climate Change and Sea Level Rise
- Hurricane
- Tsunami
- Earthquake

Overall, the State of Hawaii's vulnerability to the identified hazards of concern have not drastically changed since the 2013 HMP. This makes sense to the HI-EMA and Forum because these statewide high-risk hazards require a long-term vision and mitigation strategy to reduce overall risk. Table 4.16-4 compares the 2013 top six highest ranked hazards to the 2018 top six-scoring hazards using the total Risk Factors. It is interesting to note that Climate Change and Sea Level Rise were not presented as a top hazard of concern in 2013 and is the highest-ranked hazard in 2018. This may be due to the advancements in climate science and the availability of data and studies conducted over the performance period of the 2013 plan to support a more detailed and quantitative assessment of this hazard for the 2018 HMP Update. Further, flash flood appeared in the 2013 top hazard list, however chronic coastal flood and event-based flood appear as medium-ranked hazards in 2018. The definition of the 'flash flood' hazard as defined by the State Civil Defense Strategic Plan 2011 – 2015 was not available. It is assumed to be a flood triggered by intense rainfall.

Table 4.16-4. Comparison Between the 2013 and 2018 HMP Update Statewide Hazard Rankings

Numeric Rank	2013 Hazard Rank Order [a]	2018 Hazard Rank Order
1	Hurricane	Climate Change and Sea Level Rise
2	Flash Flood	Hurricane
3	Tsunami	Tsunami
4	Earthquake	Earthquake
5	Volcano/Lava	Volcanic (Laval flow; vog)
6	Landslide/Rockfall	Wildfire and Landslide/Rockfall [b]

Notes:
a According to the 2013 HMP which reported that the State Civil Defense Strategic Plan 2011 – 2015 conducted an independent assessment to rank hazards; it is assumed the order in which they were presented is the order of descending risk.
b The wildfire and landslide/rockfall hazards have the same calculated risk factor score and are therefore listed together for the sixth ranked hazard for the 2018 HMP Update.

Table 4.16-5. 2018 HMP Update Hazard Ranking Results

Hazard Rank	Hazard	Category									Relative Risk Factor
		Probability	Impact			Spatial Extent	Warning Time	Duration	Adaptive Capacity	Changing Future Conditions	
			Population	Assets/ Economy	Environmental Resources/ Cultural Assets						
High	Climate Change and Sea Level Rise	3	1	3	2	2	0	3	2	3	4.6
High	Hurricane	2	2	2	1	3	0	3	2	3	4.5
High	Tsunami	1	2	2	1	2	3	3	2	3	4.3
High	Earthquake	1	2	2	1	3	3	3	2	1	4.2
Medium	Volcanic (Laval flow; vog)	2	1	2	3	2	1	3	2	1	4.0
Medium	Wildfire	2	2	1	1	2	1	2	2	3	3.8
Medium	Landslide/Rock fall	2	1	1	3	2	3	3	2	3	3.8
Medium	Health Risks	1	3	0	0	3	3	3	2	0	3.6
Medium	Event-Based Flood	1	1	2	1	2	1	3	2	3	3.4
Medium	Chronic Coastal Flood	3	1	1	1	2	0	3	2	3	3.4
Medium	Drought	2	1	1	1	3	0	3	2	3	3.3
Medium	High Wind Storm	2	1	1	1	3	0	3	2	2	3.2
Low	Dam Failure	1	1	1	1	2	2	3	2	2	2.9
Low	Hazardous Materials	2	1	1	1	1	3	1	2	0	2.6

Note: Relative Risk Factor Scores - High: > 4.0; Medium: 3.0 to 4.0; Low < 3.0

County Hazard Ranking

An updated hazard ranking was also conducted for each county; refer to Appendix X (State Profile and Risk Assessment Supplement) for each county's results. The following summarizes the county(ies) at greatest risk to each hazard based on the potential impacts to population and the built environment presented in Sections 4.2 through 4.15.

It is important to note that there is a difference in thought process when evaluating statewide risk, and risk for a particular county. Due to the state's geography, some hazards are contained by island; therefore, their statewide risk is lower compared to the risk presented to a specific county. For example, the hurricane hazard may be ranked high for all counties and the state because a hurricane event may impact all islands a result of the same event, leading to a potential disaster declaration. In comparison to a wildfire hazard, where a wildfire event is more than likely to be isolated to one island and not impact the state as a whole at the same time. Therefore, each county may have a high wildfire hazard ranking because impacts are measured relative to their individual county; whereas the statewide wildfire ranking is a medium because a wildfire event is not likely to impact multiple counties at the same time.

Table 4.16-6. Summary of Counties at Greatest Risk to the Hazards of Concern

Hazard	Summary of Most Vulnerable Counties and Estimated Impacts to Population and Buildings

Climate Change and Sea Level Rise	• All counties are vulnerable with millions to billions in estimated potential loss.
	• SLR-XA-3.2
	  • The County of Kauaʻi has the greatest percent of population displaced relative to the total county population (5%).
	  • The City and County of Honolulu has the highest estimated displaced population (13,3000 people) and economic loss (3,800 structures; $12.9B in structure and land value).
	• 1%CFZ-3.2
	  • The County of Kauaʻi has highest percent population exposed (16% of total population).
	  • The City and County of Honolulu has the greatest estimated potential loss to buildings ($120B) to 1%CFZ-3.2.

Chronic Coastal Flood	• The City and County of Honolulu has the highest estimated displaced population (2,000 people) and economic loss ($4.1B in structure and land value). • The County of Maui has the greatest number of structures permanently inundated (732). • The County of Kauaʻi has the greatest percent of population displaced relative to the total county population (1.5%).
Dam Failure	• All counties have high hazard dams and delineated dam failure inundation areas. • The Counties of Maui and Kauaʻi have the greatest number of dams, of all hazard levels (56 and 53, respectively) and total square miles of land located in dam failure inundation area. [b]
Drought	• All counties are vulnerable to droughts. • The Counties of Hawaiʻi and Kauaʻi have the largest areas with the highest water supply drought risk (rainfall catchment). • All counties have high agricultural drought risk.
Earthquake	• The majority of earthquakes occur on and around the County of Hawaiʻi, especially in the southern districts of the island.

Hazard	Summary of Most Vulnerable Counties and Estimated Impacts to Population and Buildings
	• The County of Hawaiʻi has the greatest estimated shelter requirements and potential estimated loss to buildings ($1.8B) based on the 100-year probabilistic earthquake event.
Event-Based Flood	• All counties are vulnerable. • The County of Kauaʻi and City and County of Honolulu have the greatest percent population and building exposure. • The City and County of Honolulu has the greatest number of repetitive loss properties and greatest estimated potential damages to buildings ($1.9B).
Hazardous Materials [a]	• All counties are vulnerable. • The City and County of Honolulu is the only county with NPL sites. • The City and County of Honolulu has the greatest number of hazardous materials releases reported to the HEER Office. • There are petroleum and gas transmission lines in the City and County of Honolulu, and petroleum gas transmission lines in the County of Hawaiʻi
Health Risks	• All counties are vulnerable to health risks. • Locations with higher density populations are more susceptible to outbreaks, as the disease can be transmitted more easily. The City and County of Honolulu has the greatest number of people per square mile compared to the other counties. • The Port of Honolulu may close due to a pandemic having cascading impacts statewide.
High Wind Storms	• All counties are vulnerable to high wind storms. Strong Kona storms bring wind, rain high wave heights and can cause extensive damage to south- and west-facing shores of all islands.
Hurricane	• All counties are vulnerable to hurricane winds and storm surge. • The City and County of Honolulu has the greatest number of square miles that may be inundated by storm surge (SLOSH categories 1 through 4).
Landslide and Rockfall	• All counties have high landslide susceptibility areas. • The County of Hawaiʻi has the largest area, 944.9 square miles or 23.5% of the county, located in the high landslide susceptibility area compared to the other counties. • The County of Hawaiʻi, followed by the City and County of Honolulu, has the greatest number of people and buildings exposed.
Tsunami	• All counties have population and buildings in the GAT inundation area. • The City and County of Honolulu has the greatest population (185,389 people; this estimate does not include visitors) and buildings ($58 B) exposed; and greatest estimated potential loss of $6B). • The County of Maui has the greatest percent of the buildings damaged (11.2% of the county total).
Volcano (Lava flow and vog)	• Five active volcanoes are located in the County of Hawaiʻi, and one is located in the County of Maui. • The County of Hawaiʻi has the largest area (2,645 square miles) located in high lava flow hazard area (Zones 1 through 4). • All counties may be impacted by vog, with greatest risk to the County of Hawaiʻi, County of Maui and City and County of Honolulu populations.
Wildfire	• All counties are vulnerable to wildfire. • The City and County of Honolulu has the greatest number of people and greatest building value ($65B) located in the high wildfire risk hazard area.

Hazard	Summary of Most Vulnerable Counties and Estimated Impacts to Population and Buildings
	• The County of Maui has the highest percent of their total population (60.7%) and building stock (64.4%) located in the high wildfire hazard area relative to the county totals followed by the County of Kauaʻi.

[a] The impacts and vulnerability from a hazardous materials event are greatly dependent the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, and maintenance failures. The severity of a hazardous material incident is dependent on these factors as well as the distance and related response time for emergency response teams.

[b] Analysis is based on spatially-delineated dam failure inundation areas available for the 2018 HMP Update.

B = Billion
HEER = State Department of Health Office of Hazard Evaluation and Emergency Response
NPL = National Priority List
SLOSH = Sea, Lake and Overland Surges from Hurricanes

SECTION 5. CAPABILITY ASSESSMENT

2018 HMP UPDATE CHANGES

- Discussion of the administration of hazard mitigation programs in the state has been revised and updated to reflect significant changes in the structure of emergency management since the 2013 HMP.
- State and local capabilities have been comprehensively reviewed, updated and reformatted.
- Discussion of the processes utilized by the State to support and promote mitigation planning at the county level and processes to help counties obtain funding and technical assistance for mitigation planning have been reviewed and updated to reflect current procedures.
- The following plan elements have been consolidated into a single section: State Capability Assessment, Effectiveness of Local Mitigation Capabilities, and Coordination of Local Mitigation Planning.

This section provides a comprehensive review and evaluation of state and local capabilities used to support and facilitate mitigation activities and describes the process utilized by the State of Hawai'i to support, promote and coordinate mitigation planning at the county level.

5.1 Administration of Hazard Mitigation Programs in the State

The Governor of the State of Hawai'i has the overall responsibility for emergency management activities in the state. Emergency management functions at the State level are coordinated by the HI-EMA and its five branches: Preparedness, Operations, Telecommunications, Logistics, and Finance Administration. The HI-EMA is located within the Department of Defense and the Adjunct General serves as its Director. A civilian Administrator is appointed by the Director and maintains the day-to-day operations of the agency. HRS §127-A (Emergency Management) was revised in June 2014 updating the State's emergency management statutes, moving from an outdated civil defense framework to the current emergency management structure. The revisions led to a number of changes intended to ensure coordination of the State and its counties to the maximum extent possible with the comparable functions of the federal government.

At the time of the 2018 HMP Update, counties are in the process of transitioning their agencies to correspond with the HI-EMA. Some counties have made the transition, while others are still in process. The HI-EMA serves as the coordinating agency for the four county emergency management agencies and as State Warning Point. The HI-EMA administers the State's hazard mitigation program with the State Hazard Mitigation Officer (SHMO) serving as the official point of contact.

5.2 Identification and Evaluation of State Pre- and Post-Disaster Capabilities

44 CFR §201.4(c)(3)(ii): [The State Plan must include]…a discussion of the State's pre- and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the areas, including: an evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas; a discussion of State funding capabilities for hazard mitigation projects

This section identifies and evaluates the State pre- and post-disaster capabilities including legal, regulatory and programmatic capabilities, participation in national programs, and funding capabilities. County capabilities are discussed in Section 5.3 (Summary of Effectiveness of Local Mitigation Capabilities).

5.2.1 Legal, Regulatory, Planning, and Programmatic Capabilities

State departments and agencies, in coordination with the HI-EMA, conducted a thorough review of laws, rules, plans and programs to identify and evaluate their hazard mitigation related capabilities, including those related to development in hazard-prone areas. Each identified capability was described, significant changes that occurred during the performance period of the 2013 HMP were noted, and opportunities or challenges in enhancing capability effectiveness or minimizing conflicts with mitigation goals were discussed. In addition, the hazard(s) of concern that the capability helps to mitigate, the type of hazard management capability (pre- and/or post-disaster), and the effect on loss reduction were identified. While some funding capabilities were identified in this discussion, funding is discussed in more detail in Section 5.2.3. Table 5.2-1. summarizes the full range of identified capabilities and the hazards which they mitigate. The detailed information upon which this summary table is based is in Appendix X (Capability Assessment).

Key Term

Mitigation Capabilities *provide the means to accomplish desired mitigation outcomes. Capabilities include laws, regulations, policies, programs, administrative and technical staffing and resources, funding, and people-powered capabilities, such as volunteer groups.*

In order to support program and plan integration, each capability was also assessed to determine the mitigation mission area core capability(ies) that each supports. Core capabilities are identified in the National Preparedness Goal and are used in other emergency management programs including the THIRA and State Preparedness Report. The mitigation mission includes seven core capabilities including, (1) Threat and Hazard Identification, (2) Risk and Disaster Resilient Assessment, (3) Planning, (4) Community Resilience, (5) Public Information and Warning, (6) Long-tern Vulnerability Reduction, and (7) Operational Coordination. These core capabilities and the results of the assessment are available in Appendix X (Capability Assessment).

5.2.2 Participation in National Mitigation-Related Programs

There are several national programs that incentivize or support mitigation activities including the National Flood Insurance Program (NFIP), Community Rating System (CRS), and Risk MAP. These programs are a key component of state hazard mitigation capabilities. The following sections discuss the administration and application of these programs in the State of Hawai'i.

National Flood Insurance Program and Community Rating System

The NFIP is a federal program, which was established to allow property owners in participating communities to purchase insurance protections against losses from flooding. Participation in the NFIP is based on an agreement between local communities and the federal government that states if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction and substantial improvements in Special Flood Hazard Areas (SFHAs), the federal government will make flood insurance available within the community (DLNR, 2018).

The NFIP is administered by the Federal Insurance and Mitigation Administration (FIMA) and the Mitigation Directorate, components of the FEMA. The Department of Land and Natural Resources (DLNR) has been designated as the State Coordinating Agency responsible for assisting the coordination of the program between the federal and county agencies in the State of Hawai'i. All four of the counties are participating communities in the NFIP and each community has a representative county floodplain manager (see Table 5.3-2 in Section 5.3.2 for information on county floodplain management programs; DLNR, 2018). As of January 1, 2018, there are 60,439 flood insurance policies in force within the state totaling more than $13.8 billion in insurance and more than $40 million in annual premiums (FEMA, 2018).

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. For participating communities, flood insurance premium rates are discounted in increments of 5%. For example, a Class 1 community would receive a 45% premium discount, and a Class 9 community would receive a 5% discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) 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% of the NFIP's policy base is located in these communities. Two of Hawaii's counties, the Counties of Maui (Class 8) and Hawai'i (Class 8), participate in the CRS. More information on their participation is available in Section 5.3.2.

NFIP Staffing, Resources and General Administration of Program

The State NFIP Coordinator sits in the Engineering Division of DLNR. There are five employees that generally administer the program including two full time staff and three staff who spend approximately half of their time on floodplain related issues. There are three Certified Floodplain Managers (CFMs) on staff. The staffing level for administration of the program is effective; however, the program previously had another staff person to support floodplain management efforts. Although resources are adequate, staff resources would be improved by the addition of staff with a focus on grant management and information technology skills, such as GIS and website development.

The State of Hawai'i participates in the Community Assistance Program State Support Services Element, which provides funding to the state to provide technical assistance to communities in the NFIP and to evaluate community performance in implementing NFIP floodplain management activities. An array of activities are conducted by the DLNR to support the mission of the program including:

- **Monitoring Compliance**—The State NFIP Coordinator regularly conducts Community Assistance Visits (CAVs). A goal has been set to meet with each county to conduct a CAV once per year. CAVs focus on activities conducted by the counties to maintain compliance including, requiring FEMA Elevation Certificates (pre- and post-construction submittals); reviewing applications for subdivisions and related construction plans, building permits and grading/grubbing permits for compliance; responding to complaints, and taking appropriate actions to correct noncompliance. This includes reviewing, approving, preparing and submitting to FEMA and maintaining a Letter of Map Changes, which are used to update

FEMA's FIRMs. In addition, state floodplain management staff assist county floodplain management programs with compliance efforts by conducting V zone (coastal high hazard area) property audits.

- **Conducting Training Workshops and Public Outreach**—A variety of training and outreach is conducted including outreach that was completed over the performance period of the 2013 HMP and other ongoing programs:
  - Conducted outreach on the Islands of O'ahu and Maui for participation in the State of Hawaiʻi Hazards Awareness and Resilience Program;
  - Conduct annual public outreach at the Building Industry Association (BIA) home building and remodeling show;
  - Coordinate with FEMA Region IX on an annual technical training, which usually has an attendance of approximately 100 people. Training topics are typically selected by FEMA;
  - Conduct realtor training on floodplain management related topics;
  - Conduct trainings on the Flood Hazard Assessment tool are when there are updates. Typically, there are 5 to 15 trainings with approximately 10 people at each event;
  - Conduct trainings and information sessions on Digital Flood Insurance Rate Maps (DFIRMs) when they are updated;
  - Publish a quarterly newsletter (Wai Halana);
  - Maintain an internet website dedicated to NFIP awareness (http://dlnreng.hawaii.gov/nfip/)
- **Attending National and Regional NFIP Related Conferences**—State floodplain management staff host an annual conference for floodplain managers and staff can travel to Flood Mitigation Association (FMA) or Association of State Floodplain Manager (ASFPM) conferences.
- **Providing Technical Assistance to Community Officials and the Public—**Technical assistance is provided by reviewing CRS standing/feasibility with counties; attending CRS/NFIP audit and compliance meetings with FEMA or contractor staff, meeting with the Building Code Council, and providing other technical assistance as requested.

NFIP and CRS Implementation Challenges and Opportunities

Each county has island-specific challenges in administering their floodplain management regulations. Coordination between the counties and state agencies is challenging, especially regarding data availability and sharing. Better imagery data would allow state and county floodplain managers to produce more useable and practical data. As of the 2018 HMP Update, a LiDAR imaging flight is scheduled to be conducted on the Island of Hawai'i to address this issue in the short-term.

Funding and resource availability is a challenge at the county level, especially regarding CRS participation. If funding was available to support the administrative requirements of CRS, additional counties may choose to participate or those that currently participate may work to improve their CRS classification. The State is interested in ways to increase collaboration on CRS thus reducing the burden of reporting requirements for individual counties and on opportunities to provide a financial incentive for counties participation in the program given that the cost savings are passed on to policy holders.

Funding to support flood control and drainage maintenance is also a challenge and is complicated by the fact that drainage and other flood control facilities are frequently located on privately-owned lands.

The State NFIP coordination staff and county floodplain managers discuss these and other implementation challenges and opportunities at the annual flood mitigation conference held in the state in August of each year and attended by FEMA Region IX. Efforts to address these and other issues are ongoing.

Risk Mapping, Assessment and Planning Program

FEMA works with federal, state, tribal and local partners across the nation to identify flood risk and promote informed planning and development practices to help reduce that risk through the Risk Mapping Assessment and Planning (Risk MAP) program. Risk MAP provides high quality flood maps and information, tools to better assess the risk from flooding and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk. Each Risk MAP flood risk project is tailored to the needs of each community and may involve different products and services.

According to the Risk MAP Progress interactive map available online, at the time of this plan update there is one active project in the preliminary phase in the County of Kaua'i. FEMA coordinates and works directly with county floodplain mangers during the Risk MAP project process. The State NFIP Coordinator is kept apprised of project activities and consults as needed.

Table 5.2-1. Summary of the State of Hawaii's Hazard Mitigation Capabilities by Hazard of Concern

Capability [a]	Hazards of Concern												
	Climate Change and Sea Level Rise	Chronic Coastal Flood	D am Failure	Drought	Earthquake	Event-Based Flood	Hazardous Materials	Health Risks	High Wind Storm	Hurricane	Landslide and Rockfall	Tsunami	Volcanic Hazards
Aircraft Alert System (HI-EMA)												◆	
Building Code Committee (SEAOH)					◆	◆			◆	◆	◆	◆	◆
Building Code Council (DAGS)					◆	◆			◆	◆	◆	◆	◆
Capital Improvements Budget (DBF)	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆
Clean Water Act Section 401 Water Quality Certifications (DOH EHA)						◆	◆	◆					
Climate 21C (OCCL)	◆	◆	◆										
Coastal Lands Program (OCCL)		◆								◆			
Coastal Zone Management Program (OP)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Commission on Water Resources Management (CWRM)				◆									
Community Development District Program (HCDA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Critical Systems Vulnerability Assessment (HI-EMA)					◆					◆		◆	
Dam Safety Program (Engineering)			◆										
Damage Assessments (DAGS)					◆			◆					
Department Emergency Operations Plan Template (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Department of Hawaiian Home Lands Land Trust (DHHL)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Department of Health All-Hazards Training and Exercise Program (DOH HRA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Capability [a]	Hazards of Concern												
	Climate Change and Sea Level Rise	Chronic Coastal Flood	D am Failure	Drought	Earthquake	Event-Based Flood	Hazardous Materials	Health Risks	High Wind Storm	Hurricane	Landslide and Rockfall	Tsunami	Volcanic Hazards
Department Operations Center (HI-EMA) Planning Guidance and Resources (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Disaster Response Committee (SEAOH)			◆		◆	◆				◆	◆	◆	◆
Energy Assurance Program (HSEO)	◆		◆		◆	◆			◆	◆	◆	◆	◆
Epidemiological Surveillance (DOH HRA)								◆					
Fire Program (DOFAW)				◆						◆			
Forestry Program (DOFAW)	◆			◆		◆			◆	◆	◆	◆	
Geography Department (UH)						◆							
Get Ready Website (HI-EMA)					◆	◆				◆		◆	◆
GoHawaiʻi Mobile App (HTA)		◆			◆	◆		◆		◆	◆	◆	
Hawai\`i Environmental Policy Act (DOH OEQC)		◆			◆	◆					◆	◆	◆
Hawai\`i Hurricane Relief Fund (DCCA)										◆			
Hawai\`i Emergency Planning and Community Right to Know Act (DOH EHA)							◆						
Hawaiʻi Advisory Council on Emergency Management (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Hawaiʻi Catastrophic Hurricane Plan (HI-EMA)										◆			
Hawaiʻi Earthquake & Tsunami Advisory Committee (HI-EMA)					◆							◆	
Hawaiʻi Hazards Awareness and Resilience Program (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Hawaiʻi Institute of Geophysics and Planetology (UH)	◆	◆	◆	◆		◆		◆	◆	◆		◆	◆

Capability [a]	Hazards of Concern												
	Climate Change and Sea Level Rise	Chronic Coastal Flood	D am Failure	Drought	Earthquake	Event-Based Flood	Hazardous Materials	Health Risks	High Wind Storm	Hurricane	Landslide and Rockfall	Tsunami	Volcanic Hazards
Hawai'i State Legislature Grant-in-Aid Program (HSL)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Hawai'i State Planning Act (OP)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Hawai'i Statewide Geographic Information System Program (OP)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Hazardous Materials Risk Management Program (DOT)							◆						
Hazardous Waste Section Regulations (DOH EHA)							◆						
Hospital Preparedness Program (DOH HRA)								◆					
Immunization Programs (DOH HRA)								◆					
Laboratory Preparedness and Response Program (DOH HRA)							◆	◆					
Land Acquisition Program (DAGS)	◆			◆		◆							
Mandatory Seller Disclosures in Real Estate Transactions (DCCA)						◆						◆	
Mass Feeding Operations (DOH EHA)								◆					
Medical Countermeasure Points of Distribution (DOH HRA)								◆					
National Disaster Preparedness Training Center (UH)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
National Flood Insurance Program (Engineering)	◆	◆	◆	◆		◆				◆		◆	
Native Ecosystems and Management (DOFAW)	◆			◆		◆				◆			

Capability [a]	Hazards of Concern												
	Climate Change and Sea Level Rise	Chronic Coastal Flood	D am Failure	Drought	Earthquake	Event-Based Flood	Hazardous Materials	Health Risks	High Wind Storm	Hurricane	Landslide and Rockfall	Tsunami	Volcanic Hazards
Natural Disaster Economic Recovery Strategy (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
NPDES Wastewater Discharge Permits (DOH EHA)						◆	◆	◆					
Pacific Disaster Center Technical Capabilities (PDC)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Pacific RISA (Pacific RISA)	◆			◆									
Polluted Runoff Control Program (DOH EHA)				◆		◆							
PRiMO (PRiMO)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Radiation Section- Radiation Assessment Team (DOH EHA)							◆	◆					
Risk MAP (Engineering)		◆				◆				◆		◆	
Roadside Fuel Reduction Program (DOT)													
Safe Drinking Water Emergency FAQs (DOH EHA)								◆					
School of Ocean and Earth Science Technology (UH)	◆	◆		◆		◆			◆	◆			◆
Shelter Upgrade Program (DAGS)								◆					
Shoreline Certification (Land Division)	◆	◆											
Silver Jackets (Engineering)	◆	◆	◆			◆				◆		◆	
State Board of Land and Natural Resources (BLNR)	◆	◆		◆		◆							
State Fire Council (SFC)													
State Land Use Law (OP)	◆	◆	◆	◆	◆	◆			◆	◆	◆	◆	◆
State Mitigation Forum (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆

Capability [a]	Hazards of Concern												
	Climate Change and Sea Level Rise	Chronic Coastal Flood	D am Failure	Drought	Earthquake	Event-Based Flood	Hazardous Materials	Health Risks	High Wind Storm	Hurricane	Landslide and Rockfall	Tsunami	Volcanic Hazards
State of Hawaiʻi Emergency Operations Plan (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
State-owned Building Insurance (DAGS)		◆	◆		◆	◆			◆	◆	◆	◆	◆
The Center for the Study of Active Volcanoes (UH)					◆	◆				◆		◆	◆
Threat Hazard Identification and Risk Assessment (HI-EMA)					◆	◆		◆		◆		◆	◆
Training & Exercise Plan (HI-EMA)	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Transportation Asset Climate Change Risk Assessment Project (O'ahuMPO)	◆												
Underground Storage Tank Section Regulations (DOH EHA)				◆		◆							
Vector Control Program (DOH EHA)								◆					
Weatherization Assistance Program (OCS)				◆									
Western States Seismic Policy Council (HI-EMA)					◆							◆	

Acronym in parenthesis refers to the state department detail table under which the capability is discussed (see Appendix X [Capability Assessment]). Listing under a particular department or agency should not be construed to imply that the department is the sole administrator of the capability. Additionally, in some instances the capability is associated with the duties of the department but the department does not have administrative authority over the capability.

5.2.3 State Pre- and Post-Disaster Funding Capabilities

44 CFR 201.4(c)(3)(iv): [The State Plan must include an] ...Identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.

This section discusses and evaluates the State's funding capabilities including, a summary of funding resources that the State has access to or is eligible to use; a description of how the State has used its own funding for hazard mitigation, and how FEMA funds have been used.

USE OF STATE FUNDING FOR MITIGATION ACTIVITIES

The State uses its own funding for a variety of mitigation activities. This use of funds includes earmarking resources for mitigation projects, providing grant monies to the counties and non-governmental organizations, supporting ongoing programs that further mitigation goals, and using state monies or in-kind contributions as matching funds for federal grants. The programmatic and regulatory programs summarized in Table 5.2-1. and outlined in detail in Appendix X (Capability Assessment) are supported, at least in part, by state general funds and the operating budgets of the various state departments and agencies. The progress update on the actions identified in the 2013 HMP included in Appendix X (Mitigation Strategy) includes a list of activities that the State undertook during the performance period of the plan and indicates those actions that were accomplished using state funds. In total, 9 of the 14 actions (64%) identified as completed during the performance period of the 2013 HMP used state funds (exclusively or in part) to support the completion of the action.

USE OF FEMA FUNDING FOR MITIGATION ACTIVITIES

There are four main FEMA grant funding opportunities that support state mitigation activities. Two of these are available pre-disaster (Pre-Disaster Mitigation [PDM] and Flood Mitigation Assistance [FMA]) and two are available post-disaster (Hazard Mitigation Grant Program [HMGP] and Section 406 funds). Of these four programs, the State has historically utilized HMGP and PDM to the greatest degree. HMGP funds are typically used for project implementation, while PDM funding is typically used to support mitigation planning activities at the state and county level.

It is important to note that HMGP funding is determined as a percentage of the funds spent on public and individual assistance for a Presidentially declared disaster. The State of Hawai'i has historically received less than $1 million in HMGP funds following declared disasters. The PDM monies are determined by congressional allocation and fluctuate from year-to-year. The FMA and Section 406 funding has historically been underutilized by the state. No FMA or Section 406 funds were used for mitigation activities during the performance period of the 2013 HMP. Table 5.2-2 summarizes key information on the location and the types of FEMA-funded mitigation projects during the performance period of the 2013 HMP. In total, 29 projects were identified, 11 are closed, 4 are ongoing, 2 were withdrawn, and 12 have been submitted for grant funding consideration.

These funds were used to reduce risk and increase resilience across the State in a variety of way:

- **Critical Facility Hardening**—Several critical facilities were hardened including the Waiakea High Gym in the County of Hawaii, the Community Clinic of Maui in the County of Maui, and HI-EMA Warehouse in the City and County of Honolulu.
- **Capability Building**—State and county capabilities were expanded by increasing understanding of tsunami risk through a tsunami hazard mapping project, development of local wind amendments for adoption, upgrading warning systems through a siren upgrade project, and updating the State Building Code administrative rules to implement updated standards for hurricane mitigation.
- **Focus on Planning**—Three planning efforts were supported by FEMA grant funds including two local HMP updates and the 2018 HMP Update.

The State has been very effective in maximizing the use of the 5% initiative under HMGP funding, which targets projects that are not typically eligible under the program or that are difficult to measure cost-effectiveness. Three projects used 5% initiative funding over the performance period of the 2013 HMP including, the siren upgrade project, development of local wind amendments, and update of the State Building Code administrative rules.

Table 5.2-2. FEMA Funded Mitigation Projects During Performance Period of 2013 HMP

Criterion		Project Costs
Project Costs by FEMA Grant Program	HMGP	$1,549,570
	PDM	$564,600
	FMA	$0
	PA Category C-G (Section 406 funds)	$0
Project Costs by Location	Statewide	$591,341
	County of Kaua’i	$36,000
	City & County of Honolulu	$930,000
	County of Maui	$45,306
	County of Hawai’i	$511,523
Project Costs by Activity Type	Hardening/Retrofit	$1,205,829
	Management Costs	$114,361
	Local Mitigation Planning (Including 5% Initiative)	$317,000
	State Mitigation Planning (Including 5% Initiative)	$417,000
	Warning (Including 5% Initiative)	$59,980

Note: Excludes projects that were withdrawn and those that were submitted, but not awarded as of 11/2017; Information in this table was based on data provided by HI-EMA in November 2017

FMA = Flood Mitigation Assistance
HMGP = Hazard Mitigation Grant Program
PA = Public Assistance
PDM = Pre-Disaster Mitigation

Other Funding for Mitigation Activities

A wide array of funding is available to support mitigation activities within the State of Hawai'i. Non-state and non-FEMA funding resources that state departments and agencies have indicated that are actively being used or pursued to support mitigation activities include the following:

- Clean Water Act Section 319 Funding, U.S. EPA
- Coastal and Estuarine Land Program, NOAA
- Coastal Resiliency Grant Funding, NOAA
- Coastal Zone Enhancement Program (Section 309) Funding, NOAA
- Conservation Reserve Enhancement Program, Farm Service Agency
- Forest Legacy Program, U.S. Forest Service
- Forest Stewardship Program, U.S. Forest Service
- Hospital Preparedness Program, U.S. Department of Health & Human Services
- National Earthquake Hazards Reduction Program
- Silver Jackets Interagency Program, U.S. Army Corps of Engineers
- State and Private Forestry Branch, U.S. Forest Service
- Weatherization Assistance Program, U.S. Department of Energy
- Wildland Urban Interface Grant Program, U.S. Forest Service

More detailed information on how these funds are being used is available in Appendix X (Capability Assessment) and Appendix X (Mitigation Strategy). State and FEMA funding are discussed in Sections 0 and 0.

5.2.4 Summary of Changes in State Capabilities and Progress on Integration

The State of Hawai'i has strengthened and enhanced it capabilities over the performance period of the 2013 HMP and has continued to make progress on integration. The following sections provide a summary of the detailed information available in Appendix X (Capability Assessment).

Summary of Changes in State Capabilities

The following are a selection of notable changes that have influenced or impacted State capabilities over the performance period of the 2013 HMP:

- **Public Education and Information**
  - The GoHawaiʻi Mobile App was developed by the Hawai'i Tourism Authority
  - The Ocean Resources Management Plan (ORMP) dashboard was launched, which provides information on the progress of implementing the ORMP.
  - The annual, unified multi-agency Wildfire LOOKOUT! Campaign was launched.
  - The Hawai'i Hazards Awareness and Resilience Program (HHARP) was established in 2014 and, as of December 2016, six communities have reached recognition level in the program.
- **Staffing and Technical Resources**
  - Thirty (30) staff positions statewide were added to support the State's Vector Control Program.

- A number of federally-funded positions were added to support Epidemiological Surveillance at the HDOH Disease Investigation Branch.
- A new position was created to alleviate the backlog of potential projects, engage landowners, and increase participation in the Forest Stewardship Program.
- A number of wave buoys were installed around the islands, bringing the current total maintained by the Pacific Islands Ocean Observing System (PacIOOS) to ten.
- The HI-EMA Mitigation Section, who lead the state mitigation program, experience significant challenges to adequately staff all the responsibilities for which they are charged during regular operations. This challenge is exacerbated when staff is deployed for special occurrences, such as disaster events.

- **Program Scale-Back**
  - The annual Stop Flu at School program has been scaled back. It is no longer offered to all schools statewide. Selected schools have been chosen based on students with the greatest need for assistance, which allowed for the maximization of the benefit to the public while utilizing the limited funds and resources available.
- **New and Updated Planning Resources**
  - Twelve (12) *Community Wildfire Protection Plans* were developed or updated.
  - The *State General Flood Control Plan* is being updated and will utilize digital database and website technologies to provide educational information and public awareness tools on flood risks, flood histories, hydrologic data, mitigation initiatives, a library for flood studies and post-flood reports, and other related information.
  - The *Hawai'i Catastrophic Hurricane Plan* was developed in 2015
  - The *HI-EMA Strategic Plan* was Updated in May 2017.
  - The *Statewide Highway Shoreline Protection Study* was completed in 2018.
  - *Makani Pahili 2017 Emergency Power Prioritization Workshop Series Report* was competed in 2017.
  - The *Hawaii Drought Plan* was updated in 2017.
- **New Collaborative Approaches**
  - A Silver Jackets Team for Hawai'i was established.
  - The Hawai'i Climate Change Mitigation & Adaptation Commission was formed and has adopted the *Hawai'i Sea Level Rise Vulnerability and Adaptation Report*.

Progress on Integration into State Programs

The State has used the update of the plan as an opportunity to further promote integration:

- **Resource for County Local HMPs**—The HI-EMA envisions the 2018 HMP Update as a reference for local HMPs to integrate risk assessment results to reduce work and focus on strengthening other areas of plans
- **Goal Development**—Goals identified in local HMPs were used to inform the development of goals for the 2018 HMP Update. County leaders worked with the State in goal development and all aspects of plan development through their involvement on the State Hazard Mitigation Forum.

- **THIRA**—The HI-EMA intends to leverage the 2018 HMP Update for the next THIRA update – the full update is in 2018. The 2018 HMP Update risk and capability assessments will be integrated into the updated document.
- **State Preparedness Report**—The HI-EMA will more fully integrate the updated mitigation goals into the 2018 State Preparedness Report.
- **Hawai'i Mitigation Program Consultation—**The results of the mitigation program consultation conducted with FEMA Region IX mitigation staff and HI-EMA was used to identify challenges and opportunities to mitigation within the state and will be used in the future to help monitor progress on addressing challenges and identifying emerging issues.

Additional components of program integration are discussed in Section 2 (Planning Process – Program Integration). Opportunities for additional integration have been identified and are included in the Action Plan in Section 6 (Mitigation Strategy).

5.3 Summary of Effectiveness of Local Mitigation Capabilities

44 CFR §201.4(c)(3)(ii): [The State Plan must include]…a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.

Disasters are inherently local events; therefore, the assessment of state capabilities would not be complete without an examination of local (County) capabilities. This review and examination was used to inform and influence the State's mitigation priorities as discussed in Section 6 (Mitigation Strategy). The review was conducted by examining the local hazard mitigation plans (local HMPs) of the four counties. This review focused on the following aspects of the local HMPs:

- **Foundational Capabilities**—A list of foundational capabilities relevant for hazard mitigation in the state was developed and local HMPs were reviewed to determine if these capabilities were identified and discussed. It should be noted that this list is not intended to be a comprehensive assessment of all capabilities identified in local HMPs.
- **Floodplain Management Capabilities**—The local HMPs were reviewed for discussion of county floodplain management capabilities including, adoption of higher standards; general information on effectiveness and process; and efforts to address repetitive loss and severe repetitive loss properties.
- **Land Use Planning**—The local HMPs were reviewed for discussion on General Plans and Community Plans and for information on integrating hazard mitigation into land use planning (i.e. plan integration).
- **Evaluation and Effectiveness**—The local HMPs were reviewed to determine challenges and opportunities, unique sources of funding, mitigation successes, and determinations on effectiveness of mitigation actions.

The local HMPs, like state HMPs, are required by FEMA to be updated every five years. The counties' local HMPs are midway through their performance periods; therefore, the 2018 HMP Update includes discussion on emerging capabilities that have arisen in the counties during their performance period that are not reflected in those plans. The following sections summarize the results of the review of the local HMPs and emerging capabilities identified during the 2018 HMP Update.

5.3.1 Local Foundational Capabilities for Hazard Mitigation

County policies, programs, funding, and other capabilities are used to support and accomplish hazard mitigation goals and objectives. The county local HMPs identify and evaluate county capabilities for implementing hazard mitigation. In order to summarize these capabilities for the 2018 HMP Update, a list of foundational capabilities for accomplishing hazard mitigation was developed based on FEMA local mitigation planning guidance, professional judgement, and suggestions from the State Hazard Mitigation Forum. This list was not intended to be inclusive of every capability discussed in the local HMPs or every capability that may be used to support hazard mitigation at the county level.

Table 5.3-1 includes a summary of foundational capabilities relevant for hazard mitigation in the state and if these capabilities were identified and discussed in the county local HMPs. It is important to note that the absence of a capability does not mean that the capability does not exist in the county. It simply means that no discussion was found describing or identifying the capability in the local HMP. This suggests that the capability may not be being used to its full potential to support mitigation within the county or it may suggest that the department or agency responsible for implementing the capability may not have been fully involved in the local HMP planning process. In addition, it is important to note that codes, regulations, and/or plans may have been updated or developed since the time of the local HMP publication (see Table 5.4-1). A table with more detailed information on the foundational capabilities summarized below can be found in Appendix X (Capability Assessment). In addition, many aspects of these foundational capabilities and changes that may have occurred over the last several years are discussed in the detailed tables supporting the State Capability Assessment described above (see Appendix X [Capability Assessment]).

Table 5.3-1. Foundational Capabilities as Identified and Reflected in County Local Hazard Mitigation Plans

Foundational Capabilities	County of Kaua'i	City and County of Honolulu [a]	County of Maui	County of Hawai'i
Building Code [b]	◆	◆	◆	◆
Capital Improvement Program	◆	◆	◆	◆
Climate Action/Resilience Plan	◆			
Community Development Plans	◆	◆	◆	◆
Community Wildfire Protection Plan [c]	◆	◆	◆	◆
Emergency Operations Plan	◆	◆	◆	◆
Continuity of Operations Plan	◆			
County Owned Building Insurance				
Economic Development Plan	◆		◆	
Firewise USA™ [d]			◆	◆
Flood Damage Prevention Ordinance	◆	◆	◆	◆
General Plan	◆	◆	◆	◆
Get Ready Website				
Hawaiʻi Hazards Awareness and Resilience Program			◆	
Hawai'i State Legislature Grant-in-Aid Program			◆	
Legacy Lands Conservation Program				
Land Acquisition Plan / Willing Seller Program		◆	◆	
Post-Disaster Recovery	◆		◆	◆
Public Health Preparedness Plan [e]	◆			◆
Real Estate Disclosure [f]	◆	◆	◆	
Risk MAP Program				
Sea Level Rise Study/Plan	◆		◆	
Shoreline Setbacks	◆	◆	◆	◆
Site Plan Review		◆	◆	
Special Management Area Permits [g]	◆	◆		◆
State Hazard Mitigation Forum	◆	◆	◆	
Storm Ready/ Tsunami Ready [h]			◆	
Stormwater Management / Low Impact Development		◆	◆	◆
Subdivision Requirements [i]	◆	◆	◆	◆
Threat & Hazard Identification & Risk Assessment [j]			◆	
Water Management Plan	◆	◆		◆
Zoning Code or Land Use Ordinance [k]	◆	◆	◆	◆

Note: ◆ = Capability discussed in hazard mitigation plan; Information presented in this table reflects information as it is presented in the County hazard mitigation plans unless otherwise noted. Codes, regulations, and/or plans may have been updated since the time of their publication.

a. *An interim City and County of Honolulu HMP was developed and approved in 2017; however, this update included only limited information. Volume 1 of the 2012 local HMP was reviewed for this assessment.*

b. The State Building Code is included in HAR §3-180 State Building Code; Counties may make local amendments; At the time of the 2018 HMP Update, not all counties have adopted the current version of the State Building Code, which includes provisions related to the special wind hazard in the State (See Section 4.9 [High Wind Storms] for additional discussion on wind hazards in the state. It should also be noted that the County of Kaua'i implemented a HMGP 5% initiative project to develop and adopt local wind amendments.
c. Progress on the development of Community Wildfire Protection Plans has occurred since the last updates of the County hazard mitigation plans. One new plan (Western Maui) was completed in 2015 (1 in Maui County), 6 new plans (Kauai, Western Oahu, Molokai, South Maui, Upcountry Maui, and North Kona) were completed in 2016 (1 covering Kauai County, 1 in the City and County of Honolulu, 3 in Maui County, and 1 in Hawaii County), 5 plans (Northwest Hawaii Island, South Kona, Ocean View, Kau, and Volcano) were updated in 2016 (5 in Hawaii County), and 1 plan (Kahikinui) was slated to be updated during 2017/2018 (1 in Maui County).
d. As of March 2018 there are 11 Firewise USA recognized sites in County of Hawai'i (8) and County of Maui (3).
e. There are no county equivalent public health agencies within the state; however, plans have been developed for all counties either directly by the Department of Health (for Oahu) or via the District Health Offices of the Neighbor Islands (County of Kaua'i, County of Maui, and County of Hawai'i). In addition, the State of Hawai'i Health Risk and Vulnerability Assessment (2014) pertains to the entire state.
f. Disclosure of hazard risk is required in some real estate transactions by the State Uniform Land Sales Practices Act.
g. Special Management Area Permits are part of the State Coastal Zone Management Program and are administered at the County level
h. All four counties are Storm Ready and Tsunami Ready.
i. Required as part of the Uniform Land Sales Practices Act
j. County representatives have participated in the development of the State THIRA.
k. County government have regulatory authority over Urban District lands and shared authority over Agricultural and Rural District Lands. Conservation District lands are reserved for the State.

5.3.2 County Floodplain Management

Table 5.3-2 includes a summary of the county's floodplain management programs. All counties are in good standing in the NFIP program at the time of this plan update.

5.3.3 County Land Use Planning

As indicated in Table 5.3-1 all Hawai'i counties have general plans, community plans, and zoning ordinances (referred to as the land use ordinance in some counties) and all three of these capabilities are discussed in the four county local HMPs. All of the counties have recognized the importance of land use planning and have identified actions to integrate the local HMPs into these plans. An example of actions included in the local HMPs addressing this integration are as follows:

- **County of Kaua'i**— Ensure hazard mitigation is incorporated into the Kauaʻi County General Plan (ten-year plan, 2015-2025).
- **City and County of Honolulu**—Incorporate all-hazard assessments in land development application process.
- **County of Maui**—Continue to include hazard mitigation initiatives in future capital improvements planning and include hazard mitigation goals and objectives into the general and community plans. Consider all hazard mitigation initiatives when developing the county 6-year budget and 20-Year Plan.
- **County of Hawai'i**— Incorporate elements of this Hazard Mitigation Plan into the county general plan and future community development plans, to make all-natural hazards explicit factors for planning considerations that include community resilience.

Current and future development trends are discussed in more detail in Section 3 (State Profile) and in Section 4 (Risk Assessment).

Table 5.3-2. County NFIP and CRS Participation

Criterion	County of Kaua'i	City & County of Honolulu	County of Maui	County of Hawai'i
County Department That Is Responsible for Floodplain Management	Department of Public Works, Engineering Division	Department of Planning and Permitting	Department of Planning	Department of Public Works, Engineering Division
Floodplain Administrator	Floodplain Manager	Floodplain Manager	Floodplain Manager	Floodplain Manager
Date of Entry into the NFIP Program [a]	11/04/81	09/03/80	06/01/81	05/03/82
Current Effective FIRM Date	11/26/10	11/05/14	11/04/15	09/29/17
Date That Flood Damage Prevention Ordinance Was Last Modified [b]	2005	2016	2017	2017
Floodplain Management Program Higher Regulatory Standards [c]	Definition and development standards added for repetitive loss structures disallowing grandfathered unsubstantial improvement 10-year cumulative substantial improvement	Not discussed in local HMP	Not discussed in local HMP	3-year cumulative substantial improvements
Most Recent Community Assistance Visit or Community Assistance Contact [c]	2012	2007	2015	2007
Known Outstanding NFIP Compliance Violations That Need to be Addressed [c]	No; Issues identified during 2012 CAV were addressed in 2015	Various issues with administrative and enforcement procedures including improperly completed elevation certificates	No	No
Community Rating System (CRS) Participant	No; but expressed interest in participating in local HMP	No; but expressed interest in participation in 2017 Interim local HMP	Yes	Yes
Date of Entry into the CRS Program	N/A	N/A	10/1/95	05/1/11
Current CRS Classification	N/A	N/A	8	8
Flood Insurance Policies in Force in the County [d]	5,327	38,367	12,422	4,514

Criterion	County of Kaua'i	City & County of Honolulu	County of Maui	County of Hawai'i
Insurance in Force [d]	$1,119,654,600	$8,956,450,900	$2,724,319,900	$1,085,890,600
Premium in Force [d]	$4,428,642	$24,467,992	$7,623,822	$3,656,679
Total Loss Claims Filed in the County [d]	1,174	2,324	536	732
Claims That Are Still Open/Were Closed Without Payment [d]	0/520	6/814	7/225	1/230
Total Payments for Losses [d]	$37,127,247	$29,949,924	$6,411,534	$18,240,426
Total Number of Repetitive Loss Properties [e]	19	107	35	45
Severe Repetitive Loss Properties [f]	Unknown; Local HMP states that there are 0 SRLPs; 2013 HMP states there is 1 pending SRL property	Unknown; Local HMP states there are 8 SRL properties; 2013 HMP states there are 3 SRL properties	Unknown; 2013 HMP states there is 1 SRL property	Unknown; Local HMP states there are 3 SRLPs; 2013 HMP states there are 5 SRL properties and 1 pending SRL property
Repetitive Loss Properties That Have Been Mitigated [f]	Unknown; Local HMP states there is one remaining RL property	Unknown; Local HMP states that no properties have been mitigated	Unknown	Unknown

a. Date indicates entry into the Regular Program
b. There is no state-level model flood damage prevention ordinance.
c. As discussed and described in the County's Local Hazard Mitigation Plan.
d. According to FEMA statistics as of December 31, 2018
e. Provided by FEMA Region IX, NFIP Regulations and Compliance, 2/19/2018; See Section 4.7 (Event-Based Flood) for more information
f. Information provided by FEMA on 2/19/2018 did not provide enough information in order to determine the number of severe repetitive loss properties; See Section 4.7 (Event-Based Flood) for more information
LHMP = Local hazard mitigation plans
RL = Repetitive loss
SRL = Severe repetitive loss

5.3.4 Evaluation of Local Hazard Mitigation Plans

All counties in the state have identified, leveraged, and developed capabilities that are effective in mitigating risk from natural hazards. These capabilities are discussed in their local HMPs and serve the basis for the implementation of many successful actions. A review of the county local HMPs was conducted to:

- Determine how the counties are evaluating the effectiveness of their plans;
- Determine challenges, barriers and unmet needs the counties had identified in reaching their mitigation goals;
- Identify opportunities to address challenges and leverage existing capabilities.

A review of the county local HMPs reveals that there is limited discussion of the effectiveness of mitigation actions and overall plan effectiveness. A summary of the results of the review are provided in the sections that follow. The results of this assessment were used by the State to develop its mitigation strategy for the 2018 HMP Update.

Challenges and Barriers to Effective Local Hazard Mitigation

A number of challenges and barriers to implementing effective mitigation actions were identified in local HMPs. A summary of these challenges and barriers follows; however, it should be noted that the following section (Emerging Local Capabilities) discusses progress on how some of these challenges are currently being addressed:

- **Sources of Funding Impact Implementation**—Activities and actions that required outside sources of funding for implementation were less likely to be implemented over the performance period of plans due to economic fluctuations and budget delays.
- **Social Factors Influence Mitigation Strategy Effectiveness**—Effective disaster mitigation goes beyond scientific and technical data. Social factors, such as poverty, social justice and high costs of living, must be considered in the development and implementation of effective mitigation actions and strategies.
- **Coordination and Collaboration is Needed**—Additional coordination and collaboration among and between agencies is needed to successfully implement many mitigation activities. An example of this is provided by the need for strong coordination and collaboration as well as clear policies for coordinating information and responses to landslides and rockfalls on critical highway areas and the trifurcation of jurisdiction in coastal areas of the state.
- **Floodplain Management Presents Challenges for Counties**—A few counties have experienced challenges with effectively administering floodplain management regulations. In addition, updated FIRMs have resulted in more properties falling within SFHA boundaries and properties that do not conform to current flood damage prevention standards. Older levees are subject to failure or do not meet current building practices for flood protection. Issues with levee accreditation have emerged in the past few years.
- **Data Sharing and Information Management could be Improved**—Data sharing and information management for hazard mitigation has been a challenge and is a priority concern. Information

regarding satellite imagery was noted as example issues. A sustained effort to gather historical damage data, such as high-water marks on structures and damage reports, would be useful in measuring the cost-effectiveness of future mitigation projects.

- **Funding for Critical Facility and Infrastructure Mitigation is Needed**—Funding is needed to upgrade and retrofit public facilities and shelters as well as communication infrastructure. In addition, detailed assessments on some critical facilities, such as major health care centers, need to be conducted to determine appropriate mitigation measures.
- **Public Awareness of Risk could be Improved**—Increased awareness and better understanding of risks and impacts is needed across stakeholder groups including the general public and decision makers.
- **Visitors Present Special Challenges**—Visitors present a special challenge for disaster planning activities, especially education and awareness campaigns, warning, and planning for accommodations post-event.
- **Capabilities could be Enhanced/Updated**—Some county and state plans, such as community plans and drainage plans, have not been updated regularly. Development codes could be improved to better account for hazard risk, such as requiring defensible space in new subdivisions and increasing the design capacity of stormwater systems. Coastal AE zones may be subject to wave action that would cause damage to structures. Current flood damage prevention ordinances in the counties do not include standards that account for this risk. 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. It should be noted; however, that the State Coastal Zone Management program has identified tsunami mapping in its five-year coastal hazards strategy and initial mapping is underway.
- **Conditions are Changing**—Guidance on effective approaches and time horizons for planning for sea level rise are needed. Increases in impervious surfaces due to growth and development are altering historical drainage patterns and amounts. Coastal erosion and beach loss are significant causes of concern and are expected to be exasperated by sea level rise.
- **Pre-Event Planning could be Improved**—There are a number of planning and administrative activities that can be conducted before a hazard event to reduce post-event recovery times. For example, post-storm debris management is a significant issue on the islands and many counties have not conducted appropriate planning efforts. In addition, redundancy of power supply, especially for critical facilities is a significant issue of concern.
- **Structures are Vulnerable**—Many structures across the state were constructed before modern building codes were widely adopted and enforced. Mechanisms for bringing these structures into compliance are limited and may be cost prohibitive to owners.
- **Development Pressures Can Increase Risk**—There is continued pressure to convert floodplain compatible uses, such as agricultural lands, to more intensive uses during periods of growth. This pressure may intensify as sea level rise.

Opportunities to Address Local Challenges and Leverage Capabilities

The following are some of the opportunities identified in local hazard mitigation plans to address challenges and leverage capabilities. It should be noted that the following section (Emerging Local Capabilities) discusses the status of some efforts to capture these opportunities:

- **Resiliency Efforts Have Gained Momentum**—Community interest and political support for resiliency planning provides an opportunity to engage stakeholders and integrate hazard mitigation into a number of policies and programs.
- **Opportunities for Partnerships are Available**—Forming partnerships with community and non-profit organizations can maximize limited financial resources. Several working groups have formed to determine protocols for data sharing, transfer, and use.
- **Counties are Poised to Capture Funding**—Local planning efforts have resulted in risk assessment and modeling efforts that; provide enough detail for submission to FEMA grant programs. In addition, the counties have sought and received funding for mitigation activities such as beach warning and tsunami evacuation signage (NOAA, FEMA, and NIST funding).
- **Natural Resources can be Harnessed for Mitigation Goals**—Maintenance and management programs can be developed for natural mitigation features, such as wetlands, beaches and dunes.
- **State Resources and Assistance Support County Efforts**—The State provides a number of technical resources and programs that support the counties in their hazard mitigation activities.

5.3.5 Emerging Local Capabilities

In the years since the counties' local hazard mitigation plans have been developed, there have been advances in the understanding and development of strategies to address community resilience and climate change. A few emerging capabilities in these areas include:

- **Post-Disaster Reconstruction Guidelines**—In May 2015 the County of Maui finalized a report entitled *Post-Disaster Reconstruction Guidelines and Protocols for the Conservation of Coastal Resources and Protection of Coastal Communities. Maui County, Hawai'i*. The stated goal of the project, funded by a NOAA Coastal Resilience Grant, was to develop post-disaster reconstruction guidelines and protocols that will conserve sensitive coastal ecosystems while also streamlining the repair and reconstruction of homes, businesses, structures and private property. At the time of the 2018 HMP Update, this work is being leveraged in an additional NOAA Regional Coastal Resilience Grant focused on building resilience to coastal hazards and climate change in the State of Hawai'i.
- **Resiliency Work in the City and County of Honolulu**—In May 2016 the City and County of Honolulu was selected as a member of the 100 Resilient Cities Network. Also in 2016, the City and County of Honolulu's Office of Climate Change, Sustainability, and Resiliency was established by approval from O'ahu voters.
- **Sea Level Rise Proclamation in the County of Maui**—In March 2018 Maui Mayor Alan Arakawa signed a proclamation that directs "County departments to use the [Sea Level Rise Vulnerability and Adaptation] in their plans, program and capital improvement decisions" (MauiNow, 2018).

These capabilities and others identified during the course of the 2018 HMP Update performance period will be monitored to determine their effectiveness at achieving hazard mitigation goals.

5.4 State Process for Developing Local Plans, Projects and Continued Planning

44 CFR 201.3(c)(5): [The key responsibilities of the State are to…]…provide technical assistance and training to local governments to assist them in applying for HMGP planning grants, and in developing local mitigation plans.

44 CFR 201.4(c)(4)(i): [The State Plan must include]…a description of the State process to support, through funding and technical assistance, the development of local mitigation plans.

The State of Hawai'i recognizes that reducing the impact of hazards occurs at many different levels in many different categories, and therefore, needs to involve multiple sectors, organizations, government agencies, and communities in mitigation. The HI-EMA is the state agency responsible for mitigation throughout the state. The HI-EMA works closely with the State Hazard Mitigation Forum, which includes participants from state and county agencies with mitigation responsibilities and public and private interests and serves an important role in local mitigation plan monitoring. This section:

- Indicates the current status of county local Hazard Mitigation Plans (local HMPs)
- Evaluates the prior plan's approach to local assistance and coordination
- Describes the State's process for supporting the update of local plans
- Describes the process by which the State reviews, coordinates and links with local mitigation plans.

5.4.1 County Local Hazard Mitigation Plan Status

The four counties in Hawai'i are participating in the hazard mitigation planning program through the development and update of local hazard mitigation plans. Table 5.4-1 lists the status of the local mitigation plans and plan adoption dates.

Table 5.4-1. Status of the State of Hawai'i Local Hazard Mitigation Plans

County	Approval Date	Expiration Date	Comments
County of Kaua'i	8/26/2015	8/26/2020	Funded by County Resources
City and County of Honolulu	2012; Interim 7/31/2017	7/31/2022	Funded by PDM FY08 & County Resources
County of Maui	9/2/2015	9/2/2020	Funded by County Resources
County of Hawai'i	8/26/2015	8/26/2020	Funded by PDM FY14 & County Resources

Note: Status as of January 1, 2018; PDM = Pre-Disaster Mitigation Grant, FY = Fiscal Year

5.4.2 Evaluation of Prior Approach to Local Assistance and Coordination

2018 HMP Update – Mitigation Goal

The 2018 HMP Update process included a review of the State's mitigation goals. To ensure effective local assistance and coordination, a new goal was identified:

Goal 6 - *Provide a framework for local mitigation planning and mitigation strategy implementation in alignment with this plan.*

Please see Section 6 for additional information.

The 2013 HMP did not include a formalized, established approach to prioritizing local assistance, nor did it provide guidance on steps to take to encourage affected communities to update their plans to reflect changes in vulnerability or in State priorities following a major disaster declaration. However, local assistance was still effective during the performance period of the plan. An example of this effectiveness is exemplified by the City and County of Honolulu interim plan that was developed in 2017. The City and County, the HI-EMA, and FEMA Region IX all worked together to update the expiring plan, with the FEMA region staff instrumental to the successful effort. Although the update was quick work to maintain funding eligibility, the City and County of Honolulu are fully committed to conducting a comprehensive review and update in the short-term and, as of the 2018 HMP Update, the planning process for the update to the local HMP is underway. Additionally, over the performance period of the 2013 HMP, the HI-EMA notified counties of grant funding availability prior to plan expiration and provided local HMP assistance upon request.

The HI-EMA has identified and prioritized the need for the development of a formalized approach to local assistance. The HI-EMA structured the 2018 HMP Update process so that the plan could be the foundation or and resource for the next round of local HMPs. In addition, a new mitigation goal was identified to ensure effective assistance and coordination moving forward (See Section 6 [Mitigation Strategy]). The HI-EMA, in coordination with the State Hazard Mitigation Forum, intends to develop and document standard operating procedures regarding local assistance for supporting the update of local hazard mitigation plans and their implementation including documentation of the grants management process, application packets for grants management, and procedures for encouraging counties to update local HMPs following major disasters. The HI-EMA notes that the State of Hawai'i Homeland Security Office has been successful in documenting and standardizing procedures for the similar programs that it administers. The HI-EMA will work to adapt the information for use in the mitigation program over the performance period of the 2018 HMP Update.

5.4.3 State Support for the Update of Local Hazard Mitigation Plans

The HI-EMA is committed to a comprehensive mitigation program that actively supports local mitigation planning by providing technical assistance such as workshops and training for both planning and post-disaster activities. The following sections describe how the State of Hawai'i supports the development and update of FEMA-approvable local mitigation plans through planning support, funding opportunity education and outreach, training programs, and technical assistance.

Planning Support and Technical Assistance

The HI-EMA provides guidance and technical assistance to counties upon request to support the update of their local HMP through the assistance of state planners, as needed and as resources are available. Generally, the HI-EMA notifies each county of their upcoming plan expiration and works with them to identify a funding source for the plan update. The HI-EMA is committed to the continued funding of local HMPs through its state allocation of Pre-Disaster Mitigation (PDM) monies. Local plan status is also regularly discussed at State Hazard Mitigation Forum meetings held quarterly. Each of the four county mayors, or their designated official representatives, are members of the State Hazard Mitigation Forum, which allows county officials to stay informed about mitigation planning. The type of technical assistance is flexible in that it is based on the particular needs and resources available to the county requesting the assistance.

The HI-EMA is committed to this close level of support for county plan development and intends to continue to participate in county plan development over the performance period of the 2018 HMP Update. The HI-EMA also intends to coordinate with FEMA Region IX mitigation staff to encourage their participation in plan development whenever possible.

Funding Opportunity Outreach and Technical Assistance

The HI-EMA is committed to educating its counties on grant availability, grant applications, and managing mitigation funds. When funding opportunities become available the HI-EMA places notifications in local newspapers, notifies appropriate state and county agencies via email and other means, and communicates opportunities through networks via word of mouth. In addition, the HI-EMA has provided training in groups and/or one-on-one on benefit-cost analysis (BCA), the E-Grants system, the environmental and historic preservation (EHP) review process, the Hazard Mitigation Assistance (HMA) program, and applicant briefings and trainings for the Hazard Mitigation Grant Program (HMGP) after DR-4201, DR-4062, DR-1967, and DR-1976. Over the performance period of the 2013 HMP, education related to funding has been focused on the FEMA mitigation grant programs. Over the performance period of the 2018 HMP Update, the HI-EMA will work to expand discussion and outreach for other programs that provide funds for mitigation activities. This expanded discussion was started during the 2018 HMP Update process with the Hazard Mitigation Workshop held in February 2018, which discusses FEMA grant funding as well as the U.S. Housing and Urban Development's Community Development Block Grant Disaster Resilience (CDBG-DR) funding program (see Section 2 [Planning Process] for more information on this workshop. Additional information on trainings is provided in the Training Program and Offerings section below.

Training Program and Offerings

The HI-EMA administers a standard training and exercise program similar to other states, which includes full-scale and table top exercises that follow a National Incident Management System (NIMS) protocol. The Training and Exercise Plan (TEP) establishes training, exercise, and planning priorities for the State of Hawai'i. The TEP is updated annually by the HI-EMA and is informed by the Training and Exercise Planning Workshop (TEPW), hosted by the HI-EMA and attended by stakeholders from all levels of government, the non-profit, and private sectors. The TEPW is generally held in the latter half of each year. In general, the exercise program tends to focus on the predominant hazards of concern for the state (e.g. hurricane, tsunami, event-based flooding, and volcanic hazards). Given the risk posed to the state by hurricanes, an annual, statewide hurricane exercise (Makani Pahili) is conducted. After action reports are developed after each exercise allowing the state and other stakeholders to capture lessons learned on how best to build capabilities.

Table 5.4-2 outlines the hazard mitigation-related trainings offered over the performance period of the 2013 HMP. Counties may direct ad hoc requests for trainings not addressed in the TEP to the SHMO and they will be conducted as time and resources allow. During the performance period of the 2013 HMP there have not been any issues with providing trainings that have been requested. Mitigation-related trainings overlap to some extent with trainings offered by the State of Hawai'i Homeland Security Office and between the two agencies all mitigation-related requested trainings have been addressed. The HI-EMA is committed to continue to offer regular trainings to improve county capabilities for hazard mitigation and will coordinate with the counties through their participation in the State Hazard Mitigation Forum over the performance period of the 2018 HMP Update to ensure responsiveness to ongoing county training needs and emerging training issues.

In addition to the trainings provided by the HI-EMA, several other agencies have reported mitigation-related trainings:

- All-Hazards Training and Exercise Program, Department of Health
- Crisis Response Training Program, Department of Geology and Geophysics, UH
- Dam Safety Program Training Events and Materials, Engineering Division, DLNR
- FEMA Certified Training Courses, NDPTC
- NFIP Community Assistance Program, Engineering Division, DLNR
- Ready Set Go! Wildfire Training, HWMO
- Special Management Area Training, CZM Program OP
- Teacher Training Workshops, CSAV, UH
- Training and Exercise Support, PDC.

Additional information on these trainings can be found in the detailed tables in Appendix X (Capability Assessment).

Table 5.4-2. The HI-EMA Offered Mitigation-Related Trainings during the 2013 HMP Performance Period

Training	Comment
Benefit Cost Analysis	Offered though State Hazard Mitigation Forum
Environmental and Historic Preservation	Offered though State Hazard Mitigation Forum
Extreme Tsunami Evacuation Zone	None provided.
FEMA E-74 Reducing the Risks for Nonstructural Earthquake Damage	Offered in various counties
FEMA L-320 Hurricane Preparedness for Decision Makers	None provided.
FEMA L-705 Fundamentals of Grants Management	None provided.
FEMA P-767 Earthquake Mitigation for Hospitals	Offered in various counties

Training	Comment
HMA Grants	▪ City and County of Honolulu Board of Water Supply and Honolulu Fire Department ▪ Department of Hawaiian Homelands ▪ County of Hawai'i Civil Defense Agency and Department of Water Supply ▪ Kaua'i Emergency Management Agency ▪ Maui Emergency Management Agency
HURREVAC Training	Offered with FEMA, multiple years
Mitigation Grants Training and Workshop	Offered in various counties
NOAA Storm Surge Modeling (SLOSH)	None provided.
Storm Surge Modeling/NOAA National Hurricane Center	None provided.
Wind Design Provisions of the Hawai'i State Building Code	Offered in various counties

Source: HI-EMA

5.4.4 State Review, Coordination and Linkage with Local Plans

44 CFR 201.4(c)(4)(ii): [The State Plan must include a] ...description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan.

The HI-EMA is committed to building its hazard mitigation program to support a coordinated approach to mitigation within the State of Hawai'i. This will occur through coordinated and linked state and county local hazard mitigation plans. The following sections describe the process for county local HMP review and the process to coordinate and link state and county plans, identifies barriers for county local HMP development and suggested solutions, describes the criteria for prioritizing mitigation planning and project grants, and outlines the strategy for continued planning.

Process for County Local HMP Plan Review and Submission to FEMA

As discussed in Section 5.4.3, the HI-EMA works closely with the counties to develop and update the county local hazard mitigation plans and is committed to continuing this close working relationship. This commitment includes early and on-going technical assistance before and during the plan development process. The State is positioned to provide informal reviews as well as a formal review prior to submittal to FEMA. This level of involvement reduces the uncertainty in the plan review process when local plans are submitted to the State for review and ultimately reduces the number of plan revisions required to achieve approval pending adoption notification from FEMA.

The State has not developed any additional planning requirements for local HMPS, so the FEMA Region IX Plan Review Tool provides the complete set of plan requirements. Typically, plan reviews are conducted by the state in less than 45 days and the HI-EMA will continue to strive for a shorter review period whenever staffing and resources allow. On more than one occasion during the performance period of the 2013 HMP, the state and FEMA reviews were conducted concurrently. It is the preference of the HI-EMA that concurrent reviews occur whenever feasible to reduce the amount of time that county plans are undergoing review.

There is currently no defined, formalized process for a plan that does not meet all requirements after State review. This process will be documented as part of the operating procedure documentation discussed in Section 5.4.2. At the time of the 2018 HMP Update, the HI-EMA is committed to developing, documenting and implementing an established protocol, including a local HMP update schedule, to work together with the counties in a coordinated manner. The HI-EMA envisions that this protocol will involve:

- A memorandum of understanding with defined roles and responsibilities signed at the beginning of a plan update process.
- Formal transmission of the plan to the State for review.
- In the event that there are any requirements determined to have not been met, the HI-EMA will formally transmit the plans back to the county with required changes noted.
- When all requirements are met to the satisfaction of the HI-EMA, the HI-EMA will transmit the local HMP to FEMA Region IX.

The SHMO serves as the lead plan reviewer at the time of this plan update. It is anticipated that another HI-EMA staff person will assist with plan reviews at some point during the performance period of the 2018 HMP Update. The counties and FEMA Region IX will be notified via writing if the lead plan reviewer changes.

PROCESS TO COORDINATE AND LINK STATE AND LOCAL PLANS

There was no formal effort to coordinate and link the 2013 HMP and county local HMPs during the performance period of the 2013 State HMP; however, some coordination and linkage occurred as a result of the HI-EMA's participation in local plan updates, the State Hazard Mitigation Forum, and the 2013 HMP serving as a resource for local plan development. Linkage occurred during the 2013 HMP development process through the risk assessment. Because the State worked with the four counties in developing their risk and vulnerability assessments for their local HMPs, the counties included the state's critical facilities and lifeline infrastructure in their risk and vulnerability assessments. The county assessments formed the initial basis of the state's risk and vulnerability assessment in the 2013 HMP (State of Hawai'i HMP 2013).

The State recognizes the benefits of developing the 2018 HMP Update and local mitigation plans in a more integrated manner, which ultimately can result in building a more resilient state. The 2018 HMP Update strives to develop a framework, including a risk assessment methodology, upon which local HMPs can build upon their update. The HI-EMA has developed the 2018 HMP Update to be a resource for the development of local HMPs to improve their overall effectiveness. Specifically, the 2018 HMP Update coordinates risk assessment and mitigation strategy information as follows:

- Includes an enhanced risk assessment that:
    - Conducted extensive hazard SME outreach to ensure best-available data, methodologies and science were utilized
    - Assessed local vulnerability and conducted local hazard ranking utilizing a holistic approach to prioritize the updated mitigation strategy
- Included enhanced coordination among sectors as part of the planning process to maximize planning efforts and to inspire continued collaboration and implementation beyond the 2018 HMP Update

- Includes high priority mitigation actions identified at the county level in the state mitigation strategy (see Section 6 [Mitigation Strategy])

The 2018 HMP Update will serve as a catalyst for all county local HMPs to be updated. The HI-EMA envisions that this will allow for wise use of resources and better coordination of risk assessment and mitigation strategies among the counties and with the state. In addition, it is the intention of HI-EMA to implement an annual review coordinated with and through the annual mitigation program consultation with FEMA Region IX. During this consultation methods and progress on linking the 2018 HMP Update and local HMPs will be discussed and evaluated.

Barriers For Local Plan Development and Suggested Solutions

At the time of this plan update, all four counties have adopted and approved local hazard mitigation plans; therefore, no insurmountable barriers to local plan development have been identified. As mentioned previously, the City and County of Honolulu worked with FEMA Region IX and the HI-EMA to develop an interim plan so that they would not lose eligibility for FEMA's Hazard Mitigation Assistance grant program. The situation that precipitated the need for this interim solution was, in part, due to the delay in the release of the 2016 PDM funding from FEMA. PDM funding had been awarded to the City and County of Honolulu to complete an update of the local HMP; however, funds were not released until March 2017. By the time funds were released, the City and County's local funding match for the grant was no longer available.

If funding resources currently being used for plan updates are no longer available or are significantly delayed, this may be a barrier for local plan development in the future. The HI-EMA is committed to supporting local plan updates via PDM grant support as long as these funds remain available. It is the HI-EMA's goal to align all four county plans on the same planning cycle as described previously.

Criteria for Prioritizing Planning and Project Grants

44 CFR 201.4(c)(4)(iii): [The section on the Coordination of Local Mitigation Planning must include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs which should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures. Further, that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.

The HI-EMA administers the State's hazard mitigation program; however, hazard mitigation is a shared responsibility between state agencies; county governments; private companies; and non-governmental groups and organizations within the State of Hawai'i, including local residents. Recognizing this, the State of Hawai'i has formed the State Hazard Mitigation Forum (Forum) with representatives from a broad spectrum of state and county agencies and the non-governmental sector, which serves as an advisory body to HI-EMA on mitigation matters. Two of the most important roles of the Forum are to assist in the development of the State HMP and to make mitigation project recommendations to the HI-EMA Director.

The HI-EMA Director makes the ultimate determination on what projects will be submitted for grant funding consideration.

The Hawai'i State Hazard Mitigation Forum reviews, ranks, and prioritizes project proposals submitted by the State and its counties for FEMA grant funding programs. The ranking criteria has evolved over the performance period of the 2013 HMP as the capabilities of the mitigation forum and of the HI-EMA staff have increased. The ranking criteria used for project prioritization at the time of the 2018 HMP Update is available in Appendix X (Capability Assessment). It should be noted; however that the ranking procedures and criteria are being revised to be more consistent with the change in ideology resulting from the adoption and implementation of HRS 127A. The HI-EMA looks forward to working with the Forum to refine the criteria and to formalize the process to best meet the needs of the state over the performance period of the 2018 HMP Update. Developing these criteria and a formalized process is identified as an action in this plan and has been given a high priority. The criteria referenced above will continue to be used for ranking project proposals until the updated procedures have been developed. Any changes to the criteria will be widely publicized and the HI-EMA will ensure that the counties are aware of changes so that project proposals can be formulated appropriately.

Strategy for Continued Planning

The HI-EMA has reviewed and conducted a comprehensive evaluation of the State's hazard mitigation program and has identified opportunities for a number of enhancements, which have been included as actions in the mitigation strategy (see Section 6 [Mitigation Strategy]) and included in the plan implementation and maintenance strategy (see Section 7 [Plan Maintenance]). The HI-EMA, with the help of the Forum, will continue to refine and enhance the program to best meet the needs of the State of Hawai'i over the performance period of the 2018 HMP Update.

SECTION 6. MITIGATION STRATEGY

2018 HMP Update Changes

- The mitigation goals were reviewed and validated. Two of the 2013 HMP goals were combined and one new goal was added.
- A comprehensive review and evaluation of the 2013 HMP mitigation action plan was conducted and a synopsis of notable achievements was developed.
- The 2013 HMP mitigation actions, updated risk assessment, updated capability assessment, and county local HMP actions were used to identify mitigation actions for the 2018 HMP Update.
- All identified mitigation actions now include implementation details, such as responsible agency, possible sources of funding, timeline, etc.
- All identified mitigation actions are prioritized using a standardized process for prioritization.
- High priority county-led mitigation actions have been included in the 2018 HMP Update to enhance the linkage between the State and county mitigation strategies.
- The State Repetitive Loss Strategy has been comprehensively reviewed and updated.

6.1 Overview

The mitigation strategy sets the state's mitigation program priorities and helps guide the counties as they update their plans. The mitigation strategy is composed of goals and actions that directly address the risks and vulnerabilities identified in the risk assessment as well as the findings of the capability assessment. The following sections outline the state's mitigation goals; reviews, evaluates and updates the mitigation actions identified in the 2013 HMP; identifies new actions; and prioritizes all actions for implementation over the performance period of the 2018 HMP Update.

6.2 Mitigation Goals

44 CFR 201.4(c)(3)(i): [The State Plan must include a] ...description of the State goals to guide the selection of activities to mitigate and reduce potential losses

Mitigation goals are broad, long-term policy and vision statements that explain what is to be achieved by implementing the mitigation strategy. The goals represent what the state seeks to accomplish through mitigation plan implementation. As part of the 2018 HMP Update process, the 2013 HMP goals were reviewed and validated. This review was led by the HI-EMA with input from the Forum and was conducted over the course of the planning process. It was decided to focus on stronger goals for the State instead of updating the 2013 objectives. For the purposes of the 2018 HMP Update, the mitigation strategy only consists of goals and actions to mitigate and reduce future losses.

At the January 2018 Forum meeting, the 2013 HMP goals were initially reviewed and discussed to determine if the goals: (1) led to mitigation projects and changes in policy that reduced risk over the performance period of the 2013 HMP; and (2) continue to articulate the long-term vision for mitigation activities in the state addressing both current and future vulnerabilities. Based on this discussion, modifications were made to the wording of goals to more closely align with the state's updated vision; two of the 2013 HMP goals were combined; and a new goal was added (please see Appendix B [Mitigation Strategy Appendix] to review the 2013 HMP goals and modifications that were made).

The March 2018 Forum meeting focused on a review of the updated risk assessment and capability assessment. At this meeting the updated goals were reviewed to ensure that the goals: (1) reflected the updated risk assessment; (2) supported changes in mitigation capabilities; and (3) supported other state-level priorities. Upon this review HI-EMA and the Forum confirmed the goals for the 2018 HMP Update as follows:

- **Goal 1**—Reduce the long-term vulnerability of Hawaii's people and property to natural hazards while conserving the State's natural, historical, and cultural assets
- **Goal 2**—Promote actions designed to ensure long-term resiliency
- **Goal 3**—Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards
- **Goal 4**—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 5**—Promote public awareness of natural hazard risks and public action to reduce the long-term risks
- **Goal 6**—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.

Mitigation actions were selected and prioritized to move the state and its counties closer to achieving these goals over the performance period of the 2018 HMP Update. Actions that were selected are discussed in Section 6.4 (Updated Mitigation Actions).

6.3 Review and Evaluation of 2013 HMP Mitigation Actions

44 CFR 201.4(d): [The Updated State] Plan must be reviewed and revised to reflect […] progress in statewide mitigation efforts.

6.3.1 Comprehensive Review and Evaluation of the 2013 HMP Mitigation Actions

The 2018 HMP Update included a comprehensive review of the 110 mitigation actions identified in the 2013 HMP. This review was led by the HI-EMA and involved a wide array of state and county agencies and other stakeholders. Progress on each identified mitigation action was reviewed to determine the status of each action, the source of funding used to implement the action, and, for those actions that were not completed, if the action should be carried forward to the 2018 HMP Update or discontinued. Actions that were identified for inclusion in the updated mitigation strategy were reviewed and evaluated to determine if the action should be revised to reflect any new information obtained as part of the plan update process (for example, changes in the risk assessment or in capabilities).

The following is a summary of the progress in mitigation efforts over the performance period of the 2013 HMP:

- 14 actions (13% of total actions) were completed
- 44 actions (40% of total actions) were initiated, but were not completed
- 40 actions (36% of total actions) were determined to be ongoing activities that were incorporated into the capability assessment
- 12 actions (11% of total actions) were not initiated or had no reported progress
- 52 actions were reviewed and revised for inclusion in the 2018 HMP Update mitigation strategy either by revising the 2013 HMP mitigation action or by incorporating the intent of the action into newly submitted mitigation action worksheets developed as part of the 2018 HMP Update process.

The comprehensive review and evaluation of the 2013 HMP actions can be found in Appendix B (Mitigation Strategy).

6.4 Updated Mitigation Actions

44 CFR 201.4(c)(3)(iii): [The State Plan must include an] ...identification, evaluation, and prioritization of the cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified.

6.4.1 Identification of Mitigation Actions

Mitigation actions for inclusion in the 2018 HMP Update were identified through four primary sources:

- **2013 HMP Mitigation Strategy**—Actions that were not completed during the 2013 HMP were reviewed, revised, and included as described in Section 6.3 (Review and Evaluation of 2013 HMP Mitigation Actions).
- **Risk Assessment**—The results of the updated risk assessment were reviewed with the Forum and problem statements were developed (see Appendix B (Mitigation Strategy Appendix). Mitigation actions were considered to address identified problems.
- **Capability Assessment**—Challenges and opportunities identified during the capability assessment were reviewed with the Forum (see Appendix B (Mitigation Strategy Appendix). Mitigation actions were considered to address challenges and capture opportunities.
- **County Actions**—County local HMPs were reviewed to understand community vulnerabilities and priorities and to identify opportunities for the state to develop actions to support its counties in their mitigation efforts (see Appendix B (Mitigation Strategy Appendix). In addition, each county was invited to submit priority mitigation actions for inclusion in the state's mitigation strategy (see Section 6.5 [High Priority County Mitigation Actions]).

Not all potential actions identified from the above sources were ultimately selected for inclusion in the 2018 HMP Updated mitigation strategy. Those actions that were selected are described in the following sections.

6.4.2 State Mitigation Action Plan

Implementable mitigation actions require more than just a statement of activity as actions are led by different departments and agencies, have different levels of effort, and have varied resource needs. The State of Hawaiʻi Mitigation Action Plan (see Table 6.4-1) includes information on implementation including:

- Mitigation action title
- Department(s) or agency(ies) responsible for implementation
- Location of the mitigation action
- If the mitigation action applies to existing or future development
- Benefits or losses avoided
- Estimated costs
- Potential funding sources
- Anticipated timeline during which the action can be completed.

Table 6.4-2 shows the goals that each action supports, the mitigation action type, and the priority for implementation (prioritization process discussed below). Additional implementation information can be found in the mitigation action worksheets and detailed tables in Appendix B (Mitigation Strategy Appendix).

6.4.3 Action Plan Prioritization

All mitigation actions included in the 2018 HMP Update must be prioritized based on the risk assessment, capabilities and progress on previously identified actions. The following summarizes the prioritization schema for action implementation. This prioritization process differs from the process and associated criteria the Forum uses to rank planning and project proposals for FEMA mitigation grant funding programs (refer to Appendix A – Capability Assessment). Each action included in the 2018 MP Update was ranked numerically based on the following criteria:

- Will the action result in life safety?
- Will the action result in property protection?
- Will the action be cost-effective? (future benefits exceed cost)
- Is the action technically feasible?
- Is the action politically acceptable?
- Does the jurisdiction have the legal authority to implement?
- Is funding available for the action?
- Will the action have a positive impact on the natural environment?
- Is the action socially acceptable?
- Does the jurisdiction have the administrative capability to execute the action?
- Will the action reduce risk to more than one hazard?
- Can the action be completed in less than 5 years?
- Is there an agency/department local champion for the action?
- Will the action meet other local objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?

Actions were given a score of 0 to 4 based on responses to these criteria and scores were added to assign a priority. The following outlines the 0 to 4 scale used; as well as the high, medium and low priority action total scores.

- Numeric Scale for Each Criteria:

- Definitely Yes = 4
- Maybe Yes = 3
- Unknown/Neutral = 2
- Probably No = 1
- Definitely No = 0

- Priority Categories Based on Total Score:
  - Low =< 35
  - Medium = 35-49
  - High => 50

Table 6.4-2 indicates the implementation priority for each action in the 2018 HMP Update. Please see mitigation action worksheets in Appendix B (Mitigation Strategy Appendix) for more information and score for individual actions.

Table 6.4-1. 2018 HMP Update State of Hawai'i Mitigation Action Plan

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
2018-001—Conduct non-structural retrofits of schools and hospitals in Hawai'i and County of Maui						
HI-EMA, HETAC, DOE (Schools), HAH (Hospitals)	Hawai'i; Maui	Existing	Life safety; Damage Reduction; Loss of Function; Other	\$10,000 to \$100,000; >\$100,000	State DOE and DOH budgets; FEMA; PDM; HMGP	Short
2018-002—Multi-hazard, Non-Structural Retrofit of Hawai'i and County of Maui Hospitals and Schools						
HI-EMA, HETAC	Hawai'i; Lāna'i; Moloka'i	Both	Life safety; Damage Reduction; Loss of Function	>\$100,000	FEMA Mitigation Grants, NEHRP	Short
2018-003—Retrofit of Kalaheo Gym-Emergency Sheltering						
HI-EMA, County of Kaua'i Department of Public Works	Kaua'i	Both	Life safety; Damage Reduction; Loss of Function	>\$100,000	State CIP	Short
2018-004—Additional Mitigation Staffing						
HI-EMA	All islands	Both	Damage Reduction	>\$100,000	State funding to DOD HI-EMA	Long
2018-005—Earthquake Mitigation Training						
HETAC, HI-EMA	All islands	Both	Life safety; Damage Reduction; Loss of Function	>\$100,000	HI-EMA Department Funds	Short
2018-006—Implement Actions from Natural Disaster Economic Recovery Strategy						
HI-EMA	All islands	Both	Damage Reduction; Loss of Function	\$10,000 to \$100,000	FEMA, EDA, State Funding	Short
2018-007—Better Coordination between HI-EMA and DLNR on Flood Mitigation Projects						
HI-EMA and DLNR	All islands	Both	Life safety; Damage Reduction; Loss of Function	<\$10,000	Operating Budgets – State Funding	Ongoing
2018-008—Long Term Plan for GIS Staff, Training, and Technology – Implementation of GIS Assessment						
HI-EMA, Counties	All islands	Both	Life safety; Damage Reduction; Loss of Function; Other	>\$100,000	FEMA Grants, cost reduction through State/ESRI (ArcGIS developer) Enterprise	Other

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
					Licensing Agreement for software license and instructor-led training, County matching funds	
2018-009—Short Term Plan for GIS Staff, Training, and Technology – GIS Needs Assessment						
HI-EMA, Counties	All islands	Both	Loss of Function; Other	$10,000 to $100,000	FEMA Grants, cost reduction through State/ESRI (ArcGIS developer) Enterprise Licensing Agreement for software license and instructor-led training	Short
2018-010—Water Bags for Distribution						
HI-EMA, Honolulu Board of Water Supply	All islands	Both	Life safety; Loss of Function	$10,000 to $100,000	FEMA Mitigation Grants, Tsunami Mitigation Program, Honolulu Board of Water Supply, Donations	Short
2018-011—Housing Vulnerability Assessment						
HI-EMA, HETAC	All islands	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	FEMA Mitigation Grants, NEHRP	Short
2018-012—Retrofit of the Kaua'i War Memorial Convention Hall (KWMCH)-Emergency Shelter						
HI-EMA, County of Kaua'i Department Parks and Recreation	Kauaʻi	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	State CIP Funds	Short
2018-013—Retrofit of Molokaʻi High School Gym-Emergency Shelter						
HI-EMA, State DOE, State DAGS	Molokaʻi	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	State CIP Funds, HMGP	Short
2018-014—Retrofit of Molokaʻi High School Locker Room and Cafeteria-Emergency Shelter						

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
HI-EMA, State DOE, State DAGS	Molokaʻi	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	State CIP Funds	Short
2018-015—Retrofit of Kapaa Middle School-Emergency Shelter						
HI-EMA, State DOE, State DAGS	Kauaʻi	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	State CIP Funds	Short
2018-016—Development of Standard Operating Procedures for State Technical Assistance Program for County Local Hazard Mitigation Plans and Mitigation Activities						
HI-EMA, Forum	All islands	Not applicable	Other	$10,000 to $100,000	Operating Budget – State Funds	Short
2018-017—Monitor water resources and conduct drought forecasts and impact assessments						
DLNR – CWRM	All islands	Not applicable	Other	$10,000 to $100,000	Federal (NOAA), State (CWRM, University of Hawai'i), County (water departments)	Other
2018-018—Increase water conservation, reuse, and recharge						
DLNR – CWRM, DLNR – DOFAW, County water and wastewater departments, County planning departments	All islands	Both	Other	>$100,000	Federal (Bureau of Reclamation Title XVI program), State (CWRM, DOFAW Watershed Grant), County (water departments, watershed funding), Private grant funding	Other
2018-019—Support the Hawai'i Association of Watershed Partnerships						
DLNR - DOFAW	All islands	Not Applicable	Other	>$100,000	Federal (USDA Forest Service), State (DOFAW Watershed Grant, general funds), County (water departments), private (Firewise Grant), Private funding	Other

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
2018-020—Develop water sources						
County water departments, public and private water purveyors, irrigation system owner/operators	All islands	Not Applicable	Loss of Function	>$100,000	Federal (EPA Drinking Water State Revolving Funds), State (DLNR – Engineering Division CIP), County (water department CIP), Private funding (water system owners/operators)	Other
2018-021—Provide drought public education awareness and outreach						
DLNR – CWRM, county water departments, Soil & Water Conservation Districts	All islands	Not Applicable	Other	$10,000 to $100,000	Federal (USDA, NOAA), State (CWRM; DOFAW; University of Nebraska – NDMC), County (water departments), Private funding	Other
2018-022—Statewide Public Information Campaign to Increase Citizen Resilience to Flooding						
DLNR	All islands	Existing	Life safety; Damage Reduction	< $10,000	FEMA	Short
2018-023—Integrated Hazard Mitigation of State Coastal Highways and Beaches from Chronic Coastal Flooding						
DLNR, OCCL, Hawaiʻi DOT, Highways Division	All islands	Both	Life safety; Damage Reduction; Loss of Function; Other	>$100,000	FEMA, Federal DOT, State DLNR and DOT	Short
2018-024—Reduce and/or convert hazardous fuels on fallow agricultural lands.						
DLNR-DOFAW and DOA	All islands	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	USFS Grant (Federal Funds); Private Landowner Assistance Programs (State and Federal Funds); Private Sector Funds	Ongoing

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
2018-025—Reduce and/or convert hazardous fuels in the Wildland Urban Interface (WUI) to reduce the threat of wildfires to communities and conservation land near them.						
DLNR, DHHL, DOA, County Fire Departments, HWMO	All islands	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grants (Federal Funds); Private Landowner Assistance Programs (State and Federal Funds); Private Sector Funds	Ongoing
2018-026—Assess, identify, and implement state nursery improvements needed to provide native plants for green breaks.						
DLNR-DOFAW	All islands	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	CIP (State General Obligation Bond Funds); Operating Funds (State Funds)	Ongoing
2018-027—Develop water sources, including installation of water storage structures.						
DLNR-DOFAW, DLNR-CWRM, DOA, DHHL, County Water Supply Agencies	All islands	Both	Life safety; Loss of Function; Other	>$100,000	CIP (State General Obligation Bond Funds); Operating Funds (State Funds)	Ongoing
2018-028—Provide wildfire awareness, preparedness, and prevention education involving all sectors.						
DLNR-DOFAW, DLNR-CWRM, HWMO, PFX, County Fire Departments	All islands	Both	Life safety; Damage Reduction; Loss of Function; Other	$10,000 to $100,000	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grants (Federal Funds)	Ongoing
2018-029—Maintain and improve fire and fuel breaks/access roads on state land.						

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development[a]	Benefits[b]	Estimated Cost	Potential Sources of Funding	Timeline[b, c]
DLNR-DOFAW	All islands	Existing	Life safety; Damage Reduction; Loss of Function	>$100,000	Operating Funds (State Funds); CIP (State General Obligation Bond Funds); USFS and USFWS Grants (Federal Funds)	Ongoing
2018-030—Establish additional Community Wildfire Protection Plans (CWPP).						
HWMO, DLNR-DOFAW, County Fire Departments, County Emergency Management Agencies	Hawai'i; Lāna'i; Maui; O'ahu	Both	Life safety; Damage Reduction; Loss of Function; Other	>$100,000	Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grant (Federal Funds)	Long
2018-031—Prevent structure ignition from wildfires in the home ignition zone through home hardening.						
DLNR-DOFAW, DHHL, County Fire Departments, HWMO	All islands	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grant (Federal Funds); Private Sector Funds	Ongoing
2018-032—Install and maintain remoted automated weather stations (RAWS).						
DLNR-DOFAW for state operated RAWS.	All islands	Both	Life safety; Damage Reduction; Loss of Function; Other	>$100,000	Operating Funds (State Funds); USFS Grant (Federal Funds)	Ongoing
2018-033—Cesspool Abatement Program						
DOH, DBEDT – OP, City & County Planning Departments	All islands	Existing	Other	>$100,000	State & County - Capital Improvement Plan budgeting; Public-private partnership	Long term and on going
2018-034—Hardening State Laboratory Facility						

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
DOH	O'ahu	Existing	Damage Reduction; Loss of Function	>$100,000	FEMA Pre-Disaster Mitigation Grant; State appropriation of funding through CIP budget	Short and Long
2018-035—Enhance Hawai'i Rain Gauge Network						
HSCO, UH	All islands	Both	Damage Reduction; Other	$10,000 to $100,000	TBD	Short
2018-036—High-resolution Numerical Simulation of the April 2018 Kaua'i Flooding Events						
Hawai'i State Climate Office	Kaua'i	Both	Life safety; Damage Reduction; Loss of Function	>$100,000; $300,000 for a two year project	State and Federal	Short
2018-037—Estimating return periods of Extreme Rainfall Events for Kaua'i, Hawai'i						
UH, HSCO	Kaua'i	Both	Life safety; Damage Reduction	>$100,000; $200,000 for a 2 year project	State and Federal Funding	Short
2018-038—Model Resources for Streamlined and Resilient Disaster Reconstruction in Hawai'i						
UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA.	All islands	Both	Damage Reduction; Loss of Function	>$100,000	Funding from the NOAA FY16 Regional Coastal Resilience Grants Program with 50% cost-match from State of Hawai'i DLNR through Hawai'i Climate Adaptation Initiative (State Act 83, 2014)	Short
2018-039—Guidance for Addressing Sea Level Rise in Community Planning						
UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA.	All islands	Both	Damage Reduction; Loss of Function; Other	>$100,000	Funding from the NOAA FY16 Regional Coastal Resilience Grants Program with 50% cost-	Short

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development[a]	Benefits[b]	Estimated Cost	Potential Sources of Funding	Timeline[b, c]
					match from State of Hawai'i DLNR through Hawai'i Climate Adaptation Initiative (State Act 83, 2014)	
2018-040—Hawai'i Sea Level Rise Viewer						
UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA. Viewer was developed by PacIOOS at UH.	All islands	Both	Damage Reduction; Loss of Function; Other	$10,000 to $100,000	Funding from the NOAA FY16 Regional Coastal Resilience Grants Program with 50% cost-match from State of Hawai'i DLNR through Hawai'i Climate Adaptation Initiative (State Act 83, 2014)	Short
2018-041—Comprehensive Education/Outreach Plan for State						
UH Sea Grant	All islands	Both (Retrofits make home more resilient)	Life safety; Damage Reduction; Loss of Function	>$100,000	Some limited State Funding under HB571	University of Hawai'i, Sea Grant
2018-042—Homeowners Handbook to Prepare for Natural Hazards						
UH Sea Grant	All islands	Both (Includes Retrofits of existing houses – measures for new)	Life safety; Damage Reduction; Loss of Function; Other	$10,000 to $100,000	State – 20 partners (companies, flood insurance program, CZM) and FEMA	Short and Long
2018-043—Comprehensive Wastewater Management Plan						
DOH, County Planning Dept., OP, UH Sea Grant	All islands	Both	Damage Reduction; Loss of Function; Other	>$100,000	State and County – Capital improvement plan budgeting, public-private partnerships,	Long and ongoing

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
					Philanthropic Foundations (NOAA)	
2018-044—Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the City & County of Honolulu, Hawai'i						
State of Hawai'i DBEDT OP CZMP	O'ahu	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	National Oceanic and Atmospheric Administration Coastal Resilience Networks Grant Program	Short
2018-045—Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts for the Counties of Hawai'i, Maui and Kaua'i, State of Hawai'i						
State of Hawai'i DBEDT OP CZMP	Hawai'i; Kaua'i; Moloka'i; O'ahu	Both	Life safety; Damage Reduction; Loss of Function	TBD	National Oceanic and Atmospheric Administration and TBD	Short
2018-046—Green Infrastructure Study and Plan						
DBEDT OP	All islands	Both	Life safety; Damage Reduction; Loss of Function	$750,000	N/A	Short
2018-047—Report Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawai'i						
State of Hawai'i DBEDT OP CZMP	All islands	Both	Life safety; Damage Reduction; Loss of Function	$125,000	National Oceanic and Atmospheric Administration	Short
2018-048—Infrastructure Managed Retreat and/or Nature Based Solutions Engineering Pilot Project to Protect Threatened Hawai'i Infrastructure						
State of Hawai'i DBEDT OP CZMP	All islands	Both	Life safety; Damage Reduction; Loss of Function	TBD	National Oceanic and Atmospheric Administration and TBD	Long
2018-049—Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Oahu, State of Hawai'i						
State of Hawai'i DBEDT OP CZMP	O'ahu	Both	Life safety; Damage Reduction; Loss of Function	$430,000	National Oceanic and Atmospheric Administration	Short

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
2018-050—Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Counties of Hawai'i, Maui and Kaua'i, State of Hawai'i						
State of Hawai'i DBEDT OP CZMP	Hawai‘i Kaua‘i; Moloka‘i; Maui	Both	Life safety; Damage Reduction; Loss of Function	TBD	National Oceanic and Atmospheric Administration and TBD	Long and Ongoing
2018-051—Flood Engineering Analysis of Waimanalo Watershed						
HI-EMA	O‘ahu	Existing	Life Safety; Damage Reduction	>$100,000	FEMA, State funding, US Geological Survey, US Department of Agriculture, Natural Resources Conservation Service	Short
2018-052—Include Climate Change in North Shore Coastal Flooding Restudy						
HI-EMA	O‘ahu	Both	Life Safety; Damage Reduction	>$100,000	FEMA Risk MAP	Short
2018-053—Coordinate the compilation of projected development to assist with future local and State HMPs						
HI-EMA	All islands	Future	Other	< $10,000	Operating Funds (State Funds)	Ongoing
2018-054—Pending action to address repetitive loss flooding						
TBD	All islands	TBD	TBD	TBD	TBD	TBD
2018-055—Reduce and/or convert hazardous fuels along roadsides.						
State DOT and County Departments of Transportation	All islands	Both	Life safety; Damage Reduction; Loss of Function	>$100,000	Operating Funds (State Funds)	Ongoing
2018-056—Annually evaluate progress on linking the 2018 HMP Update and local HMPs as part of the Mitigation Program Consultation						
HI-EMA, Counties, FEMA Region IX	All islands	Not applicable	Other	< $10,000	Operating Funds (State Funds)	Ongoing
2018-057—Coordinate access to Hawai`i State Historic Preservation Division maintained cultural resource information						

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
HI-EMA and State Historic Preservation Division	All islands	Existing	Damage Reduction; Other	< $10,000	Operating Funds (State Funds)	Short
2018-058—Implement recommendations of the Statewide Highway Shoreline Protection Study						
State of Hawaiʻi DOT	All islands	Existing	Damage Reduction; Loss of Function	>$100,000	TBD	Long
2013-001—By 2020, update the design standards for new high-occupancy public buildings that can provide enhanced hurricane protective areas, and consider Mass Care Council recommendations						
HI-EMA	All islands	Future	Life Safety; Damage Reduction; Loss of Function	$10,000 to $100,000	Department funding; FEMA CTP	Short
2013-002—Evaluate vulnerability of critical infrastructure systems in the storm surge inundation zone (power, water, fuel, communications, ports, airports) and implement protective measures or back-up resources to the most practical extent						
HI-EMA	All islands	Existing	Damage Reduction; Loss of Function	>$100,000	EMPG Funding; Department Funding; FEMA CTP	Long
2013-004—Improve Building Codes. (a) Adopt wind design standards for the installation of photovoltaic panels on residential rooftops. (b) Adopt 2012 IBC and related codes per HRS 107 Part II. (c) Adopt 2018 IBC after 2012 adoption is complete.						
HI-EMA, Building Code Council	All islands	Future	Life Safety; Damage Reduction	$10,000 to $100,000	DR4062 HMGP Funds	Short
2013-005—When HAZUS is updated to represent State of Hawaiʻi specific building types (anticipated late 2018), develop building geodatabase and incorporate into HAZUS MH Hurricane loss estimation module, and make model adjustments to enable reasonable hurricane scenario loss estimates.						
PDC	All islands	Existing	Other	$10,000 to $100,000	TBD	Short
2013-006—Develop hurricane shelter capacity estimates and identify alternative hurricane evacuation/sheltering policies prioritizing the most vulnerable population areas.						
HI-EMA, Support from FEMA Region IX	All islands	Existing	Life Safety	$10,000 to $100,000	Department funding, FEMA CTP	Short
2013-007—Identify the types of buildings that can function as temporary refuges and create a voluntary program for certifying “storm-ready” private facilities through a standardized procedure. Determine the number of low vulnerability buildings available for refuge in the private sector.						

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
HI-EMA	All islands	Existing	Life Safety	$10,000 to $100,000	Department funding, FEMA CTP	Long
2013-009—Develop State of Hawaiʻi Hurricane Relief Fund standards for hurricane retrofits and debris protection, to enable insurance premium credits. Develop a post & pier/single wall hurricane retrofit Expert Tool Graphical User Interface, similar to earthquake retrofits.						
DCCA	All islands	Existing	Life Safety; Damage Reduction	$10,000 to $100,000	TBD	Short
2013-018—Continue to support the Counties in the evaluation of existing policies for the use of buildings for vertical evacuation and update as necessary. Develop a standard procedure for evaluating existing multi-story buildings as tsunami (and hurricane) refuge structures						
HETAC, Counties	All islands	Existing	Life Safety	<$10,000	TBD	Ongoing
2013-021—Develop maps of probabilistic tsunami inundation and runup for use in designing or retrofitting critical infrastructure facilities, including bridges, major multi-story buildings and vertical evacuation refuge buildings (required ASCE-7 implementation). Adopt tsunami-resistant design provisions. Enable "tsunami-ready" designation for risk category III and IV structures.						
DBEDT OP CZMP	All islands	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	NOAA Funding	Short
2013-024—Conduct all hazard evaluations and develop cost-effective seismic retrofits for priority facilities in the Counties of Hawaiʻi and Maui						
HETAC, Counties of Hawaiʻi and Maui	Hawaiʻi, Maui, Molokaʻi, Lānaʻi	Existing	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA CTP Funding; Department Funding; NOAA Funding	Short
2013-025—Provide public outreach on how to retrofit and establish anchorage of post & pier foundations of Hawaiʻi light-frame housing						
HETAC, Counties of Hawaiʻi	Hawaiʻi, Maui, Molokaʻi, Lānaʻi	Existing	Life Safety; Damage Reduction	$10,000 to $100,000	FEMA CTP Funding; Department Funding	Short
2013-026—Require implementation of seismic bracing requirements for equipment and ceiling systems in renovation and post-disaster repairs of schools and hospitals, and assisted living facilities						
Building Code Council	All islands	Existing	Life Safety; Damage Reduction; Loss of Function	<$10,000	FEMA CTP Funding; Department Funding	Short
2013-028—Compile detailed County of Maui bridge seismic retrofit performance objective information from DOT for 50-60 bridges, and update HAZUS inventory to reflect more accurate expected bridge loss estimates in data products.						
State of Hawaiʻi DOT	Maui, Molokaʻi, Lānaʻi	Existing	Life Safety; Damage Reduction; Loss of Function	<$10,000	State Funding	Short

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
2013-030— Confirm Seismic Rating Criteria for Shelters in Counties of Hawai'i and Maui						
HI-EMA	Hawai'i, Maui, Moloka'i, Lāna'i	Existing	Life Safety; Loss of Function	<$10,000	Department Funding; FEMA CTP	Short
2013-033—Conduct Testing of the Performance of Single Wall Construction when subjected to major earthquakes and hurricanes. Develop more reliable retrofit procedures. Improve modeling of this building type in HAZUS MH.						
HI-EMA, UH	All islands	Future	Life Safety; Damage Reduction; Loss of Function	$10,000 to $100,000	Department Funding; FEMA Grants	Short
2013-034—Track and evaluate current development of Earthquake Early Warning systems						
HETAC, USGS	All islands	Not applicable	Life Safety	<$10,000	Operating Funds (State Funds)	Ongoing
2013-035—Generate shake maps that incorporate soil conditions						
HETAC	All islands	Future	Life Safety; Damage Reduction; Loss of Function	$10,000 to $100,000	Department Funding; FEMA Grants	Short
2013-061—Develop Zones of Required Special Investigations near hillsides. If mandated by the State Legislature, use these zones to define as a duty to notify during real estate transactions.						
UH, DLNR, State of Hawai'i DOT	All islands	Both	Life Safety; Damage Reduction	$10,000 to $100,000	TBD	Short
2013-070—Develop clear Standard Operating Procedures for Medical Reserve Corps activation and deployment						
DOH	All islands	Not applicable	Life Safety	$10,000 to $100,000	HPP	Short
2013-071—Develop a pre-incident mission-ready package (MRP) for EMAC requests (Emergency Mutual Aid Compact) for licensed healthcare professionals						
DOH	All islands	Not applicable	Life Safety	$10,000 to $100,000	PHP; HPP	Short
2013-072—DOH to develop standard operating procedures for sharing information across agencies						
DOH	All islands	Not applicable	Life Safety	$10,000 to $100,000	PHP	Short
2013-078—Develop templates for public health messaging						

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development[a]	Benefits[b]	Estimated Cost	Potential Sources of Funding	Timeline[b, c]
DOH	All islands	Not applicable	Life Safety	<$10,000	PHP/Operating Funds	Short
2013-083—Contract secured to develop Alternate Care Capacity Plan						
DOH, HHEM	All islands	Not applicable	Life Safety; Loss of Function	>$100,000	PHP; HPP	Short
2013-084—Coordinate and credential Medical Reserve Corps volunteers						
DOH, ARC, HI-EMA	All islands	Not applicable	Life Safety	$10,000 to $100,000	PHP	Ongoing
2013-086—Investigate how to warehouse supplies to account for supply chain disruption. Continue preparedness messaging to residents to have food and water on hand for 14 days.						
HI-EMA	All islands	Existing	Life Safety; Other	$10,000 to $100,000	Department Funding, FEMA Grants, EDA	Short
2013-088—Continue to retrofit public shelter buildings to increase capacity to decrease the sheltering deficit. Achieve EHPA rated hurricane shelters or alternative types of refuge buildings						
HI-EMA	All islands	Existing	Life Safety	>$100,000	State Program Funding	Long
2013-095—Augment and Expand Hawaiian Hazard Awareness and Resilience Program.						
HETAC	All islands	Both	Life Safety; Damage Prevention; Loss of Function	$10,000 to $100,000	NOAA Funding	Short
2013-116—Develop Emergency Operations Plans to account for adequacy of critical marine/ground transportation elements and supply chain disruption and comprehensive alternate port operations/offloading plan						
HI-EMA	All islands	Existing	Life Safety; Loss of Function	>$100,000	EMPG Funding	Short
2013-121—Continue to develop harbor maps to define regimes of currents and timeframes for several scenarios of tsunami to estimate necessary period of ship evacuation						
HI-EMA	All islands	Existing	Damage Reduction; Loss of Function	$10,000 to $100,000	NOAA Funding	Short

Note: See Appendix B (Mitigation Strategy) for additional information on implementation; Those actions that begin 2013- were carried forward from the 2013 HMP.
a. Action mitigates risk to existing or future development
b. See mitigation action worksheet for an explanation of "Other"

c. *Timeline: Short (1-5 years); Long (5 years or more); Ongoing (Ongoing program)*

ARC=	=	
CIP	=	*Capital Improvement Program*
CWRM	=	*Commission on Water Resource Management*
CZMP	=	*Coastal Zone Management Program*
DAGS	=	*Department of Accounting and General Services*
DBEDT	=	*Department of Business Economic Development and Tourism*
DCCA	=	*Department of Commerce and Consumer Affairs*
DHHL	=	*Department of Hawaiian Home Lands*
DLNR	=	*State of Hawai'i Department of Land and Natural Resources*
DOA	=	*Department of Agriculture*
DOD	=	*Department of Defense*
DOE	=	*Department of Education*
DOFAW	=	*Division of Forestry and Wildlife*
DOH	=	*Department of Health*
EDA	=	*Economic Development Administration*
EOC	=	*Emergency Operations Center*
EPA	=	*Environmental Protection Agency*
FEMA	=	*Federal Emergency Management Agency*
Forum	=	*State Hazard Mitigation Forum*
GIA	=	*Grant-in-Aid*
HAH	=	*Healthcare Association of Hawai'i*
HETAC	=	*Hawai'i Earthquake and Tsunami Advisory Committee*
HHEM	=	*Hawaiʻi Healthcare Emergency Management*
HI-EMA	=	*State of Hawai'i Emergency Management Agency*
HMGP	=	*Hazard Mitigation Grant Program*
HPP	=	*Hospital Preparedness Program Cooperative Agreement Grant via CDC*
HRS	=	*Hawai'i Revised Statues*
HSCO	=	*Hawai'i State Climate Office*
HWMO	=	*Hawai'i Wildfire Management Organization*
NDMC	=	*National Drought Mitigation Center*
NEHRP	=	*National Earthquake Hazard Reduction Program*
NOAA	=	*National Oceanic and Atmospheric Administration*
OCCL	=	*Office of Conservation and Coastal Lands*
OP	=	*Office of Planning*
PacIOOS	=	*Pacific Islands Ocean Observing System*
PDC	=	*Pacific Disaster Center*
PFX	=	*Pacific Fire Exchange*
PHP	=	*Public Health Emergency Preparedness Cooperative Agreement Contract via CDC*
RAWS	=	*Remote Automated Weather Stations*
TBD	=	*To be determined*
UH	=	*University of Hawai'i*
USDA	=	*U.S. Department of Agriculture*
USFS	=	*U.S. Forest Service*
USFWS	=	*U.S. Fish and Wildlife Service*
USGS	=	*U.S. Geological Survey*

Table 6.4-2. 2018 HMP Update State of Hawaiʻi Action Plan Goal, Action Type, and Priority

Action Number	Mitigation Goals [a] 1	2	3	4	5	6	Action Type [b] State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	Priority [c]
2018-001	❖	❖						◆			High
2018-002	❖	❖	❖					◆			High
2018-003	❖	❖	❖	❖		❖	◆	◆			High
2018-004	❖	❖	❖				◆				Medium
2018-005	❖	❖	❖	❖						◆	High
2018-006	❖	❖		❖	❖	❖	◆				Medium
2018-007	❖		❖				◆				Medium

Action Number	Mitigation Goals [a]						Action Type [b]				Priority [c]
	1	2	3	4	5	6	State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	
2018-008	❖	❖	❖	❖	❖	❖	◆	◆	◆	◆	High
2018-009	❖	❖	❖	❖	❖	❖	◆	◆		◆	High
2018-010	❖	❖	❖		❖	❖				◆	High
2018-011	❖	❖	❖				◆	◆			High
2018-012	❖	❖	❖	❖			◆	◆			High
2018-013	❖	❖	❖	❖			◆	◆			High
2018-014	❖	❖	❖	❖		❖	◆	◆			High
2018-015	❖	❖	❖	❖		❖	◆	◆			High
2018-016	❖	❖	❖	❖	❖	❖	◆			◆	Medium
2018-017	❖		❖	❖			◆			◆	Medium
2018-018	❖	❖	❖		❖		◆	◆	◆		Medium
2018-019	❖	❖	❖						◆		High
2018-020	❖	❖	❖			❖		◆			Medium
2018-021	❖	❖	❖		❖					◆	Medium
2018-022	❖	❖			❖					◆	High
2018-023	❖	❖	❖	❖	❖	❖	◆	◆	◆	◆	High
2018-024	❖	❖	❖	❖			◆		◆		High
2018-025	❖	❖	❖	❖			◆		◆		Medium
2018-026	❖	❖	❖				◆	◆	◆		High
2018-027	❖	❖	❖				◆	◆	◆		High
2018-028	❖	❖	❖	❖	❖	❖	◆		◆	◆	High

Action Number	Mitigation Goals [a]						Action Type [b]				Priority [c]
	1	2	3	4	5	6	State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	
2018-029	❖		❖				◆	◆	◆		High
2018-030	❖	❖	❖	❖	❖	❖	◆	◆	◆	◆	High
2018-031	❖	❖	❖		❖		◆	◆		◆	High
2018-032	❖		❖	❖			◆		◆		High
2018-033	❖	❖						◆	◆	◆	Medium
2018-034		❖		❖				◆			High
2018-035	❖			❖					◆	◆	High
2018-036	❖	❖	❖	❖	❖	❖	◆	◆	◆	◆	High
2018-037	❖	❖	❖	❖	❖	❖	◆	◆	◆	◆	High
2018-038	❖	❖	❖	❖	❖	❖	◆		◆	◆	High
2018-039	❖	❖	❖	❖	❖	❖	◆		◆	◆	High
2018-040	❖	❖	❖	❖	❖		◆		◆	◆	High
2018-041	❖	❖	❖		❖	❖				◆	High
2018-042	❖	❖	❖		❖					◆	High
2018-043	❖	❖	❖		❖		◆			◆	Medium
2018-044	❖	❖	❖		❖		◆				Medium
2018-045	❖	❖	❖		❖		◆				High
2018-046	❖	❖	❖	❖	❖	❖	◆		◆	◆	High
2018-047	❖	❖	❖	❖	❖	❖	◆		◆	◆	Low
2018-048	❖	❖	❖	❖	❖	❖		◆	◆	◆	Medium
2018-049	❖	❖	❖	❖	❖	❖	◆			◆	Medium

Action Number	Mitigation Goals [a] 1	2	3	4	5	6	Action Type [b] State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	Priority [c]
2018-050	❖	❖	❖	❖	❖	❖	◆			◆	Medium
2018-051	❖	❖			❖					◆	Medium
2018-052	❖	❖		❖	❖	❖	◆				Medium
2018-053	❖	❖				❖	◆			◆	Medium
2018-054											TBD; Action Pending
2018-055	❖		❖				◆		◆		High
2018-056			❖	❖		❖	◆			◆	Medium
2018-057	❖		❖	❖		❖	◆			◆	Medium
2018-058	❖	❖						◆			High
2013-001	❖	❖		❖			◆				TBD
2013-002	❖	❖		❖			◆	◆			TBD
2013-004	❖			❖		❖	◆				TBD
2013-005				❖		❖	◆			◆	TBD
2013-006				❖			◆				TBD
2013-007	❖		❖				◆	◆		◆	TBD
2013-009	❖	❖	❖	❖	❖		◆			◆	TBD
2013-018	❖		❖			❖	◆				TBD
2013-021	❖			❖		❖	◆			◆	TBD
2013-024				❖		❖	◆	◆			TBD
2013-025	❖				❖					◆	TBD
2013-026	❖		❖					◆			TBD

Action Number	Mitigation Goals [a] 1	2	3	4	5	6	Action Type [b] State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	Priority [c]
2013-028			❖	❖		❖	◆			◆	TBD
2013-030		❖		❖		❖	◆				TBD
2013-033		❖		❖		❖		◆		◆	TBD
2013-034	❖	❖	❖	❖	❖		◆			◆	TBD
2013-035				❖		❖	◆				TBD
2013-061	❖			❖	❖		◆		◆	◆	TBD
2013-070			❖				◆				TBD
2013-071			❖				◆				TBD
2013-072			❖			❖	◆			◆	TBD
2013-078			❖		❖					◆	TBD
2013-083	❖	❖	❖				◆				TBD
2013-084	❖	❖	❖				◆				TBD
2013-086			❖		❖		◆			◆	TBD
2013-088		❖		❖				◆			TBD
2013-095	❖	❖	❖	❖	❖	❖	◆			◆	TBD
2013-116	❖			❖		❖	◆				TBD
2013-121				❖		❖	◆				TBD

a. *Goal 1—Reduce the long-term vulnerability of Hawaii's people and property to natural hazards while conserving the State's natural, historical, and cultural assets; Goal 2—Promote actions designed to ensure long-term resiliency; Goal 3—Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards; Goal 4—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 5—Promote public awareness of natural hazard risks and public action to reduce the long-term risks; Goal 6—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.*

b. *State & Local Plans and Regulations— Include government authorities, policies, or codes that encourage risk reduction, such as building codes and state planning regulations. This may also include planning studies; Structure & Infrastructure Projects—Involve modifying existing structures and infrastructure or constructing new structures to reduce* *the impact of hazards; Natural Systems Protections—Minimize losses while also preserving or restoring the function of natural systems; Education and Awareness Programs—Include long-term, sustained programs to inform and educate citizens and stakeholders about hazards and mitigation options. This category could also include training*

c. *See ranking criteria discussed in Section 6.4.3 (Action Plan Prioritization)*

6.5 High Priority County Mitigation Actions

A state's mitigation program is a symbiotic relationship between the state and its communities. In order to further this relationship, the HI-EMA invited the counties to submit high priority mitigation actions for inclusion in the 2018 HMP Update. A review of mitigation actions included in the county local HMPs was also conducted and was used to inform the 2018 HMP Update State Mitigation Strategy; however, it was recognized that the county local HMPs are mid-cycle so there were likely to be actions not included in the local HMPs that were county priorities. The county mitigation actions shown in Table 6.5-1 and Table 6.5-2 have the same implementation and prioritization information as is discussed in Section 6.4 (Updated Mitigation Actions).

It should be noted that the County of Kauaʻi experienced a significant hazard event resulting a Presidential Disaster Declaration during the 2018 HMP Update, specifically, at the time when these county actions were being requested. As a result, the County of Kauaʻi was not able to submit actions for inclusion and placeholders are being left so that such actions can be added when the County is further along in its recovery.

Table 6.5-1. 2018 HMP Update County Mitigation Action Plan

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
Kaua‘i-001—Actions to be developed						
TBD	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
Honolulu-001— Long-term Recovery and Adaptation Plan						
City and County of Honolulu Department of Emergency Management	O‘ahu	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	County, State, and Federal	Short
Honolulu-002—Lualualei Navy Lands Drainage Improvements						
U.S. Navy, City and County of Honolulu DDC, DLNR	O‘ahu	Both	Damage Reduction	>$100,000	U.S. Navy, County, State, USGS, NRCS, FEMA	Long
Honolulu-003— Makiki Stream Flood Mitigation Project						
City and County of Honolulu DCC, DLNR	O‘ahu	Both	Life Safety; Damage Reduction	>$100,000	County, State & Federal (FEMA, USGS, USACE, NRCS, NOAA, Sea Grant)	Long
Honolulu-004— Hardening of Critical Facilities, Utilities, and Port Facilities						
City and County of Honolulu Department of Emergency Management	O‘ahu	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	County, State, and Federal	Ongoing
Honolulu-005—Long Term Congregate Care Shelters						
City and County of Honolulu Department of Emergency Management	O‘ahu	Both	Life Safety; Loss of Function	>$100,000	County, State, and Federal	Ongoing
Honolulu-006—Post-Disaster Staging Areas						
City and County of Honolulu Department of Emergency Management	O‘ahu	Both	Life Safety; Damage	>$100,000	County, State, and Federal	Long

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
			Reduction; Loss of Function			
Honolulu-007—Temporary Electrical Charging Stations for Oʻahu Post Disaster						
City and County of Honolulu Department of Emergency Management	Oʻahu	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	County, State, and Federal	Short
Honolulu-008—Tsunami Evacuation Signage						
City and County of Honolulu Department of Emergency Management	Oʻahu	Both	Life Safety	$10,000 to $100,000	County, State and Federal (FEMA, NOAA< Tsunami Hazard Mitigation Program)	Short
Honolulu-009—Micro Grids for Critical Health Infrastructure Support						
City and County of Honolulu Department of Emergency Management	Oʻahu	Future	Life Safety	>$100,000	County, State, and Federal	Long
Honolulu-010—Structural Retrofitting of Existing Buildings and Construction of Safe Rooms						
City and County of Honolulu Department of Emergency Management	Oʻahu	Both	Life Safety	>$100,000	County, State, and Federal	Long
Honolulu-011—Lualualei Drainage Improvements						
US Navy, City and County of Honolulu, DLNR	Oʻahu	Both	Life Safety; Damage Reduction	>$100,000	County, State & Federal (FEMA, USGS, USACE, NRCS, NOAA, Sea Grant)	Long
Maui-001—Dam Inundation - Public Awareness Campaign						
DLNR, HI-EMA, MEMA	Lānaʻi; Molokaʻi; Maui	Both	Life Safety	$10,000 to $100,000	PDM	Short
Maui-002—Emergency Barge and Ferry Service						
Transportation, HI-EMA, County of Maui	Lānaʻi; Molokaʻi	Both	Life Safety; Loss of Function	< $10,000	Staff Time	Short

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
Maui-003—Realign Honoapiilani Highway						
DOT and County of Maui Planning Department	Maui	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA HMGP, PDM and FMA, CDBG; Hawai'i DOT; Staff Time; Federal Highway Fund	Long
Maui-004—Retrofit Shelter Facilities						
State of Hawai'i Department of Education and County of Maui Parks and Recreation	Lāna'i; Moloka'i; Maui	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA HMGP and PDM, CDBG, Hawai'i EMA, DLNR	Long
Hawai'i-001—Damage Assessment Software Licenses & Field Data Collection Equipment						
Hawai'i County Civil Defense Agency, County of Hawai'i	Hawai'i	Both	Other	$60,000	Hazard Mitigation Grant, County Operational Budget	Ongoing
Hawai'i-002—Waimea Operations Facility Emergency Power System Hardening						
Department of Water Supply, County of Hawai'i	Hawai'i	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA Hazard Mitigation Grant Program funds	Short
Hawai'i-003—Hilo Operations Facility Hardening and Improvements						
Department of Water Supply, County of Hawai'i	Hawai'i	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA Hazard Mitigation Grant Program funds, FEMA Pre-Disaster Mitigation Program funds, DWS Capital Improvement Plan	Short
Hawai'i-004—Kona Operations Facility Emergency Power System Hardening						
Department of Water Supply, County of Hawai'i	Hawai'i	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA Hazard Mitigation Grant Program, DWS Capital Improvement Plan	Short

Responsible Department(s)/ Agency(ies)	Location (Island)	Existing or Future Development [a]	Benefits [b]	Estimated Cost	Potential Sources of Funding	Timeline [b, c]
Hawaiʻi-005—Kona Operations Facility Hardening and Improvements						
Department of Water Supply, County of Hawai'i	Hawaiʻi	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA Hazard Mitigation Grant Program funds, FEMA Pre-Disaster Mitigation Program funds, DWS Capital Improvement Plan	Short
Hawaiʻi-006—Community-based 2-way Radio Communications Repeater Equipment						
Hawai'i County Civil Defense Agency	Hawaiʻi	Both	Life Safety	$70,000	Hazard Mitigation Funding, County Capital Improvement Program	Short
Hawaiʻi-007— Hardening of the Parker No. 2, Waiaha and Keonepoko Nui Water Well						
Department of Water Supply, County of Hawai'i	Hawaiʻi	Existing	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA Hazard Mitigation Grant Program, DWS 20-year Capital Improvement Program	Short
Hawaiʻi-008— Furnishing two (2) Water Hauling Tankers to Harden the Potable Water System						
Department of Water Supply, County of Hawai'i	Hawaiʻi	Not applicable	Life Safety; Damage Reduction	>$100,000	FEMA Hazard Mitigation Grant Program, DWS Operations Budget	Short
Hawaiʻi-009—Waimea Operations Facility Hardening and Improvements						
Department of Water Supply, County of Hawai'i	Hawaiʻi	Both	Life Safety; Damage Reduction; Loss of Function	>$100,000	FEMA Hazard Mitigation Grant Program funds; FEMA Pre-Disaster Mitigation Program funds; DWS Capital Improvement Plan	Short

Note: See Appendix B (Mitigation Strategy) for additional information on implementation.
a. Action mitigates risk to existing or future development
b. See mitigation action worksheet for an explanation of "Other"
c. Timeline: Short (1-5 years); Long (5 years or more); Ongoing (Ongoing program)
CDBG = Community Development Block Grant

DDC = Department of Design and Construction
DEM = Department of Emergency Management
DLNR = State of Hawai'i Department of Land and Natural Resources
DOT = State of Hawai'i Department of Transportation
DWS = Department of Water Supply
FEMA = Federal Emergency Management Agency
FMA = Flood Mitigation Assistance
HI-EMA = State of Hawai'i Emergency Management Agency
HMGP = Hazard Mitigation Grant Program
MEMA = County of Maui Emergency Management Agency
NOAA = National Oceanic and Atmospheric Administration
NRCS = National Resource Conservation Service
PDM = Pre-Disaster Mitigation Grant Program
TBD = To be determined
USACE = U.S. Army Corps of Engineers
USGS = U.S. Geological Survey

Table 6.5-2. 2018 HMP Update County Action Plan, Goals, Action Type and Priority

Action Number	Mitigation Goals [a]						Action Type [b]				Priority [c]
	1	2	3	4	5	6	State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	
Kaua'i-001	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Honolulu-001	❖	❖	❖				◆	◆	◆	◆	High
Honolulu-002	❖	❖	❖					◆	◆		Medium
Honolulu-003	❖	❖						◆	◆		Medium
Honolulu-004	❖	❖	❖			❖		◆			Medium
Honolulu-005		❖				❖	◆	◆			Medium
Honolulu-006	❖	❖	❖			❖		◆			Medium
Honolulu-007	❖	❖	❖			❖		◆			Medium
Honolulu-008	❖	❖	❖		❖	❖		◆		◆	High
Honolulu-009	❖					❖		◆			Medium
Honolulu-010	❖	❖	❖			❖		◆			Medium
Honolulu-011	❖	❖						◆	◆		Medium
Maui-001	❖				❖					◆	High
Maui-002			❖				◆				Medium
Maui-003	❖	❖	❖					◆			High

Action Number	Mitigation Goals [a]						Action Type [b]				Priority [c]
	1	2	3	4	5	6	State & Local Plans and Regulations	Structure & Infrastructure Project	Natural Systems Protection	Education & Awareness Programs	
Maui-004	❖	❖						◆			High
Hawai’i-001				❖		❖		◆			High
Hawai’i-002	❖	❖	❖			❖		◆			High
Hawai’i-003	❖	❖	❖		❖	❖		◆			High
Hawai’i-004	❖	❖	❖			❖		◆			High
Hawai’i-005	❖	❖	❖		❖	❖		◆			High
Hawai’i-006		❖						◆			High
Hawai’i-007	❖	❖	❖			❖		◆			High
Hawai’i-008	❖	❖	❖		❖	❖	◆				High
Hawai’i-009	❖	❖	❖		❖	❖		◆			High

a. *Goal 1—Reduce the long-term vulnerability of Hawaii’s people and property to natural hazards while conserving the State’s natural, historical, and cultural assets; Goal 2—Promote actions designed to ensure long-term resiliency; Goal 3—Strengthen partnerships and leverage existing resources and capabilities to identify, assess and reduce the impact of natural hazards; Goal 4—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 5—Promote public awareness of natural hazard risks and public action to reduce the long-term risks; Goal 6—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.*

b. *State & Local Plans and Regulations— Include government authorities, policies, or codes that encourage risk reduction, such as building codes and state planning regulations. This may also include planning studies; Structure & Infrastructure Projects—Involve modifying existing structures and infrastructure or constructing new structures to reduce the impact of hazards; Natural Systems Protections—Minimize losses while also preserving or restoring the function of natural systems; Education and Awareness Programs—Include long-term, sustained programs to inform and educate citizens and stakeholders about hazards and mitigation options. This category could also include training*

c. *See ranking criteria discussed in Section 6.4.3 (Action Plan Prioritization)*

6.6 Repetitive Loss Strategy

44 CFR 201.4(c)(3)(v): A State may request the reduced cost share authorized under §79.4(c)(2) of this chapter for the FMA and SRL programs, if it has an approved State Mitigation Plan … that also identifies specific actions the State has taken to reduce the number of repetitive loss properties, which must include properties identified as severe repetitive loss, and specifies how the State intends to reduce the number of such repetitive loss properties.

To be eligible for an increased federal cost share, a FEMA-approved state mitigation plan that addresses repetitive loss (RL) properties must be in effect at the time of grant award and the property must be a RL property. The State of Hawai'i received approval for its Repetitive Loss Strategy in October 2013. The State of Hawaii's updated RL Strategy, as detailed in this section, identifies actions the State has taken to reduce the number of RL properties. In addition, it describes the State's strategy to ensure that counties with RL properties take actions to reduce the number of these properties, including the development of local HMPs.

6.6.1 Repetitive Loss Properties in the State of Hawai'i

Properties that are located within the SFHA and have federally backed mortgages or were constructed using federal or federally-related financial assistance are required to purchase flood insurance. When an NFIP-insured property is damaged by flooding, they file a claim. If the NFIP-insured property has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978, they are referred to as a Repetitive Loss (RL) property. An NFIP-insured property is known as a Severe Repetitive Loss (SRL) property if: (1) the insured property has had four or more paid flood losses of $5,000 (amount of each claim) and a total amount of claims payments of $20,000; or (2) the insured property filed at least two separate claims that have been paid with the cumulative amount of claim payments exceeding the fair market value of the insured building on the day before each loss (FEMA 2017).

Section 4.7 (Event-Based Flood) summarizes the repetitive loss properties in each county. As of February 2018, the State has 206 repetitive loss properties throughout all four counties. FEMA did not provide the number of severe repetitive loss properties to the State; therefore, the 2013 HMP and the local county HMPs were referred to for this assessment. Refer to Table 6.6-1 for a summary of these statistics. As discussed, over the performance period of the 2013 HMP, the number of repetitive loss properties has increased from 197 to 206 (an approximate 5% increase). The City and County of Honolulu is the only county to experience an increase in repetitive loss properties; 10 properties over the last five years. The County of Maui experienced a decrease of one property. The number of repetitive loss properties in the Counties of Kauaʻi and Hawaiʻi have remained the same since 2013. However, as noted above, these statistics do not include the April 2018 flood event (DR-4365). It is difficult to draw a conclusion if the SRL properties have changed over the performance period due to the varying dates of the data available.

Table 6.6-1. NFIP Statistics for the State of Hawaiʻi

County	Repetitive Loss Properties					Severe Repetitive Loss Properties	
	2013	2018				2013	Documented in local HMP
	Total	Total	A-Zone	V-Zone	Outside the Floodplain	Total	Total
County of Kauaʻi	19	19	12	2	5	1 (pending)	0[a]
City and County of Honolulu	97	107	53	13	31	3	8[b]
County of Maui	36	35	20	5	10	1	Not available [c]
County of Hawaiʻi	45	45	13	25	4	6 (includes 1 pending)	3
Total	**197**	**206**	**98**	**45**	**50**	**11**	**11**

Source: FEMA Region IX, NFIP Regulations and Compliance, 2/19/2018; State of Hawaiʻi HMP 2013
[a] County of Kaua'i HMP 2015
[b] City and County of Honolulu 2012
[c] County of Maui HMP 2015
[d] County of Hawai'i HMP 2015
HMP = Hazard Mitigation Plan

6.6.2 Goals to Address RL and SRL Properties

The State of Hawai'i is committed to reducing the number of RL and SRL properties by increased education, outreach, and successfully maximizing grant opportunities. This strategy aligns with the State's overall 2018 updated goals as outlined in subsection 6.2 above. More specifically, Goal 1 is to reduce long-term vulnerability of Hawaii's people and property which includes high-risk properties such as RL and SRL properties. Goal 6 centers on the State providing a framework for robust local hazard mitigation planning and implementation of their mitigation strategy, including the support to reduce RL and SRL properties.

Goal 1—Reduce the long-term vulnerability of Hawaii's people and property to natural hazards while conserving the State's natural, historical, and cultural assets

Goal 6—Provide a framework for robust local hazard mitigation planning and mitigation strategy implementation in alignment with this plan.

The local HMPs were reviewed to identify goals that also address the reduction of RL and SRL properties.

- **County of Kaua'i**
  - Goal 1 – Develop disaster resilient communities
  - Objective 1.4 – Ensure availability of disaster-proof affordable homes for Kaua'i residents
- **City and County of Honolulu**
  - Goal 3 – Ensure the protection of Oahu's natural, built, historical and cultural assets
- **County of Maui**
  - Goal 1 – Protect the life, health, safety and welfare of Maui County residents and visitors
  - Goal 3 – Protect property, including but not limited to critical facilities and infrastructure, from the impacts of natural hazards.

- Objective 3 – Retrofit, purchase or relocate structures in high hazard areas, especially those known to be repetitively damaged.

- **County of Hawai'i**
  - Goal 11 – Minimize losses by adopting mitigation regulations for future development, and retrofit existing structures within hazard areas
  - Objective 11.3 – Develop incentives, such as tax deductions and insurance discounts, to encourage retrofitting of existing structures for resilience against earthquake hurricane, tsunamis and floods.

6.6.3 Prioritization of RL and SRL Mitigation Actions

The State's criteria to rank project proposals for FEMA mitigation grant funding programs is listed below and described in greater detail in the Capability Assessment Appendix (Appendix B – Capability Assessment). Several ranking criteria ensure the reduction of RL and SLR properties are ranked high to proceed with proposal submittal and project award. One of the ranking criteria for project selection is to give priority to problems that are 'repetitive' (Resolve Significant Problems); and projects that are long-range solutions (Long-range). In addition, the hardening or retrofit of essential facilities and flood control projects are determined as high priority project types (Priority in the State). At the time of the 2018 HMP Update, the HI-EMA was working on revisions to the ranking protocol and criteria described below. However, the HI-EMA will ensure that any changes to the ranking protocol continue to highly prioritize projects that address RL and SRL properties.

- **Environmental/Historic Preservation**—Must be environmentally sound and in conformance with Floodplain Management, Historical Preservation, and Protection of Wetlands and Endangered Species laws and regulations.
- **Resolve Significant Problems**—Addresses a problem that has been repetitive or a problem that poses a significant risk to public health and safety if left unresolved.
- **Long-range**—Solution should be long-range.
- **Cost-effective**—Be cost-effective and substantially reduce the risk of future damage, loss, hardship, or suffering from a major disaster.
- **Priority in State Plan**—Types of projects which have been determined high priority for the State of Hawaiʻi.

6.6.4 Current and Potential Funding Sources to Implement Repetitive Loss Mitigation Activities

The primary source of mitigation funding for flood mitigation projects is through FEMA's Hazard Mitigation Assistance grant programs which provide funding for eligible mitigation activities that reduce disaster losses and protect life from future disaster damages. These three funding opportunities require an approved HMP and are listed below.

- Hazard Mitigation Grant Program
- Pre-Disaster Mitigation
- Flood Mitigation Assistance (FMA)*

*In July 2013, the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12) consolidated the Repetitive Flood Claims and Severe Repetitive Loss grant into FMA (FEMA Hazard Mitigation Assistance Guidance 2015).

The Capability Assessment and Capability Assessment Appendix (Section 5 and Appendix B, respectively) describes the pre- and post-disaster funding sources available for mitigation in the State. The FEMA HMA grant programs are also described in Table 6.6-2 below, followed by their cost share (Table 6.6-3) and eligible activities under each program (Table 6.6-4). Therefore, with the inclusion of the RL strategy in this plan, cost shares of up to 90%/10% and 100%/0% are available for eligible projects as noted below.

Table 6.6-1. Summary of FEMA Hazard Mitigation Assistance Grant Programs

Hazard Mitigation Grant Program (HMGP)
Purpose: To provide funds to states, territories, Indian tribal governments, and local communities to significantly reduce or permanently eliminate future risk to lives and property from natural hazards. HMGP funds projects in accordance with priorities identified in state or local hazard mitigation plans, and enables mitigation measures to be implemented during the recovery from a disaster. **Availability:** Post-Disaster. When authorized under a Presidential major disaster declaration, in the areas of the State requested by the Governor.
Pre-Disaster Mitigation (PDM)
Purpose: To provide funds to States, territories, federally-recognized tribes, and local communities to implement a sustained pre-disaster natural hazard mitigation program, to include hazard mitigation planning and the implementation of projects prior to a disaster event, to reduce overall risk to the population and structures from future hazard events. **Availability:** Pre-Disaster
Flood Mitigation Assistance (FMA)
Purpose: To implement cost-effective measures that reduce or eliminate the long-term risk of flood damages to buildings, manufactured homes and other structures insured under the National Flood Insurance Program (NFIP). As noted, the FMA combines the previous Repetitive Flood Claims and Severe Repetitive Loss grants into one grant program. **Availability:** Pre-Disaster

Source: Hazard Mitigation Assistance Guidance 2015

Table 6.6-2. FEMA Hazard Mitigation Assistance Grant Program Cost Share

Programs	Mitigation Activity (Percent of Federal/Non-Federal Share)	Recipient Management Costs (Percent of Federal/Non-Federal Share)	Subrecipient Management Costs (Percent of Federal/Non-Federal Share)
HMGP	75/25	100/0	–/–[(a)]
PDM	75/25	75/25	75/25
PDM – subrecipient is small and impoverished community	90/10	75/25	90/10
PDM – subrecipient is small and impoverished	90/10	90/10	90/10
FMA – insured properties and planning grants	75/25	75/25	75/25

Programs	Mitigation Activity (Percent of Federal/Non-Federal Share)	Recipient Management Costs (Percent of Federal/Non-Federal Share)	Subrecipient Management Costs (Percent of Federal/Non-Federal Share)
FMA – repetitive loss property [b]	90/10	90/10	90/10
FMA – severe repetitive loss property [2]	100/0	100/0	100/0

Source: FEMA Hazard Mitigation Assistance Guidance 2015

*a. Subapplicants should consult their State Hazard Mitigation Officer (SHMO) for the amount or percentage of **HMGP** subrecipient management cost funding their State has determined to be passed through to subrecipients.*

b. To be eligible for an increased Federal cost share, a FEMA-approved State or Tribal (Standard or Enhanced) Mitigation Plan that addresses repetitive loss properties must be in effect at the time of award, and the property that is being submitted for consideration must be a repetitive loss property.

Table 6.6-3. FEMA Hazard Mitigation Grant Program Eligible Activities

Eligible Activities	HMGP	PDM	FMA
Mitigation Projects			
Property Acquisition and Structure Demolition	√	√	√
Property Acquisition and Structure Relocation	√	√	√
Structure Elevation	√	√	√
Mitigation Reconstruction	√	√	√
Dry Floodproofing of Historic Residential Structures	√	√	√
Dry Floodproofing of Non-residential Structures	√	√	√
Generators	√	√	
Localized Flood Risk Reduction Projects	√	√	√
Non-Localized Flood Risk Reduction Projects	√	√	
Structural Retrofitting of Existing Buildings	√	√	√
Non-structural Retrofitting of Existing Buildings and Facilities	√	√	√
Safe Room Construction	√	√	
Wind Retrofit for One- and Two-Family Residences	√	√	
Infrastructure Retrofit	√	√	√
Soil Stabilization	√	√	√
Wildland fire Mitigation	√	√	
Post-Disaster Code Enforcement	√		
Advance Assistance	√		
5 Percent Initiative Projects*	√		
Aquifer and Storage Recovery**	√	√	√
Flood Diversion and Storage**	√	√	√
Floodplain and Stream Restoration**	√	√	√
Green Infrastructure**	√	√	√
Miscellaneous/Other**	√	√	√
Hazard Mitigation Planning	√	√	√
Technical Assistance			√
Management Costs	√	√	√

Notes: HMGP = Hazard Mitigation Grant Program; PDM = Pre-Disaster Mitigation; FMA = Flood Mitigation Assistance
** FEMA allows increasing the 5% Initiative amount up to 10% for a Presidential major disaster declaration under HMGP. The additional 5% Initiative funding can be used for activities that promote disaster-resistant codes for all hazards. As a condition of the award, either a disaster-resistant building code must be adopted or an improved Building Code Effectiveness Grading Schedule is required.*
***Indicates that any proposed action will be evaluated on its own merit against program requirements. Eligible projects will be approved provided funding is available.*
Source: https://www.fema.gov/hazard-mitigation-assistance-mitigation-activity-chart

6.6.5 Support of Local Hazard Mitigation Plans

44 CFR 201.4(c)(3)(v): In addition, the plan must describe the strategy the State has to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local mitigation plans.

As discussed in Section 5 (Capability Assessment), the HI-EMA is committed to educating its counties on grant availability, grant applications and managing mitigation funds. Over the performance period of the 2013 HMP, when funding opportunities become available the HI-EMA places notifications in local newspapers, notifies appropriate state and county agencies via email and other means, and communicates opportunities through networks via word of mouth. In addition, the HI-EMA has provided training in groups and/or one-on-one on benefit-cost analysis (BCA), the E-Grants system, the environmental and historic preservation (EHP) review process, the Hazard Mitigation Assistance (HMA) program, and applicant briefings and trainings for the Hazard Mitigation Grant Program (HMGP) after DR-4201, DR-4062, DR-1967, and DR-1976.

Over the performance period of the 2018 HMP Update, the HI-EMA will work to expand discussion and outreach for other programs that provide funds for mitigation activities. This expanded discussion was started during the 2018 HMP Update process with the Hazard Mitigation Workshop held in February 2018, which discussed FEMA grant funding as well as the U.S. Housing and Urban Development's Community Development Block Grant Disaster Resilience (CDBG-DR) funding program (see Section 2 [Planning Process] for more information on this workshop. Additional information on trainings is provided in the Section 5 (Capability Assessment).

As outlined in Section 7 (Plan Maintenance) the HI-EMA has updated the plan maintenance strategy. Through the coordination of the SHMO and/or Chair of the Forum, the Forum will continue to meet quarterly. In addition to these meetings, the SHMO and Forum Chair may request the Forum meet following disaster events, to assure that procedures and resources are appropriate for plan maintenance and implementation. It is at these Forum meetings that project proposals for FEMA mitigation grant funding programs are ranked.

As each county's expiration date on their current hazard mitigation plan approaches, the SHMO will continue to notify each county regarding their status and advise to submit a FEMA HMA planning grant application to FEMA; refer to Section 7 – Plan Maintenance for further details.

6.6.6 State and Local Capabilities for Funding and Implementing RL and SRL Mitigation Actions

State and local capabilities for funding and implementing the mitigation of RL and SRL properties provide a basis for effectiveness of the RL Strategy. As discussed in the Capability Assessment (Section 5), the HI-EMA administers the State's hazard mitigation program with the State Hazard Mitigation Officer (SHMO) serving as the official point of contact. As discussed in this plan, the HI-EMA recognizes that the HI-EMA Mitigation Section is limited in staffing capacity as discussed further in Section 5 (Capability Assessment) and that Forum support since the adoption of the 2013 HMP has been sporadic. In addition, the frequency of hazard events and the State's necessity to redirect attention to disaster response and recovery diverted attention and resources away from the outlined 2013 HMP maintenance process. The updated Repetitive Loss Strategy in the 2018 HMP Update re-emphasizes the State's commitment to reducing the number of RL and SRL properties in the State.

The DLNR is designated as the State Coordinating Agency responsible for assisting the coordination of the NFIP between the federal and county agencies in the State of Hawai'i. Refer to Table 5.2-1 in Section 5 for a summary of the State's capabilities for the flood-related hazards of concern (climate change and sea level rise, chronic coastal flood, dam failure, event-based flood, and hurricane storm surge).

The State's 2018 updated mitigation strategy includes focused actions to reduce the number of RL and SRL properties as follows:

- 2018-007—Better Coordination between the HI-EMA and DLNR on Flood Mitigation Projects
- 2018-022—Statewide Public Information Campaign to Increase Citizen Resilience to Flooding
- 2018-054—RL and SRL Mitigation Action

All four of the counties are participating in and are in good standing with the NFIP; and each community has a representative county floodplain manager (refer to Table 5.3-2 in Section 5 [Capability Assessment] for information on county floodplain management programs). Currently, two of Hawaii's counties, the Counties of Maui (Class 8) and Hawai'i (Class 8), participate in the CRS. In terms of local capabilities, the local HMPs were reviewed to examine the following (summarized further in Section 5.3 [Section 5 – Capability Assessment]):

- Foundational Capabilities
- Floodplain Management Capabilities
- Land Use Planning
- Evaluation and Effectiveness.

A review of the county local HMPs reveals that there is limited discussion of the effectiveness of mitigation actions and specifically regarding RL and SRL properties. A summary of the results of the review are provided below. In addition, the local HMPs were reviewed to examine the local mitigation actions identified to reduce the number of RL and SRL properties in the State. The following summarize these findings by county; this is not considered an exhaustive list of all flood-related hazard mitigation actions identified in each plan.

- **County of Kaua'i**
  - The County of Kauai's HMP summarizes the county's flood mitigation capability and progress made in reducing flood losses (Section 6.2 of the County of Kaua'i HMP). From 2009 to 2015, the County was able to reduce their RL properties to zero. Until 2015, the County did not have any SRL properties. The County has been proactive and conducting community meetings and outreach to ensure residents in the County are aware of their flood risks and that they know how to address these risks. The County Department of Public Works has worked with the FEMA NFIP Coordinators to improve issues with

permitting violations, especially in regard to RL properties. Due to the scarcity and high cost of land, the most likely solutions will either be elevation or implementation of small flood control projects.

- Mitigation Actions:
  - Reduce flood risks, especially in areas that have revealed frequent or repetitive flooding.
  - Engaged with FEMA and State Flood Coordinators to get RL properties in compliance.
  - Work with the State NFIP Coordinator to develop the program for participation in the Community Rating System
  - Ensure public awareness of flood risks and ways to mitigate flood hazards (County of Kaua'i HMP 2015).

- **City and County of Honolulu**
  - The City and County of Honolulu Office of Climate Change, Sustainability and Resiliency was established by City Charter in 2016. The City and County of Honolulu conducted an interim HMP update in 2017. The update included a new project to 'Mitigate repetitive loss structures for both residential and commercial structures.' The progress report indicates this action is in progress and that this work will be done in collaboration with the Office of Climate Change, Sustainability and Resiliency. In addition, the progress report indicates that the City has done much to mitigate flood hazards, and is currently contemplating joining the Community Rating System.
  - Mitigation Actions:
    - Develop policies for repetitive loss structures
    - Consider participating in the Community Rating System
    - Mitigate repetitive loss structures for both residential and commercial structures (City and County of Honolulu HMP 2012 and 2017).

- **County of Maui**
  - The County of Maui continues to participate in the Community Rating System and seeks ways to improve its CRS class. The 2015 HMP serves as CRS-credited Floodplain Management Plan.
  - Mitigation Actions:
    - Acquire residential and privately-owned structures in high hazard areas, including but not limited to those known to be or subject to repetitive damages.
    - Where appropriate, support retrofitting, purchase or relocation of structures located in hazard-prone areas to protect structures from future damage with repetitive loss and severe repetitive loss properties as priority.
    - Continue to participate in the CRS program and continually identify opportunities to improve CRS class.
    - Develop a Flood Acquisition/Elevation Plan that may be used to identify and prioritize acquisitions and elevation of RL/SRL properties (County of Maui 2015 HMP).

- **County of Hawai'i**
  - The County of Hawai'i has mapped their repetitive loss properties, nearly all along coastal sites, and identified those defined as RL and SRL properties per Biggert-Waters.
  - Mitigation Actions:

- Analysis of high hazard areas and studies to develop mitigation measures (County of Hawaiʻi 2015 HMP).

The results of this assessment were used by the State to develop its mitigation strategy, and strengthen the Repetitive Loss Strategy for the 2018 HMP Update.

SECTION 7. PLAN MAINTENANCE

2018 HMP Update Changes

- For the 2018 HMP Update, changes to this section are based on an evaluation of the operational feedback regarding the effectiveness of the plan maintenance procedures outlined in the 2013 HMP (formerly Chapter 21).

The development of a plan maintenance process ensures that the HMP remains a "living" document that is intended to be changed and updated throughout its performance period. Maintaining momentum in mitigation strategy implementation can lead to significant long-term changes and overall risk reduction. As such, a formal process is required to ensure that the HMP will remain an active and relevant document. The HI-EMA is the reponsible agency for the preparation and maintenance of the HMP; and the SHMO is the individual responsible for overseeing the coordination, implementation, maintenance of the plan collaboratively across the State.

This section evaluates the challenges and successes of the 2013 HMP maintanence procedures and outlines an updated strategy to maintain the 2018 HMP Update to ensure it remains current and reflects changes to the statewide mitigation program over time.

44 CFR 201.4 (c)(5): [The Standard Plan Maintenance Process includes:]
(i) An established method and schedule for monitoring, evaluating and updating the plan.
(ii) A system for monitoring implementation of mitigation measures and project closeouts.
(iii) A system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategies.

7.1 Review of the 2013 HMP Maintenance Procedures

It is the State's intent to ensure this plan remains a "living" document and will be updated and revised as appropriate and as new information becomes available. In recognition of the need for establishing and implementing a formal maintenance process, the HI-EMA, the lead to update and maintain the HMP, conducted an analysis of whether the previously approved plan's method and schedule for monitoring, evaluating and updating the plan was appropriate and successful. Further, it determined what elements or processes should be changed so that this plan remains current based on HI-EMA's current and evolving capabilities.

The previously approved 2013 HMP dated October 3, 2013, discussed monitoring, evaluating, and updating the plan in Chapter 21. Chapter 21 called for the update of the HMP following the actions or events listed below:

- Ongoing mitigation actions within the State and counties.
- Development of new mitigation recommendations.
- Updates on the benefit-cost performance of current mitigation options.
- Changes necessary because of federal, state, or county legislative acts, appropriations, mandates and recommendations.
- Public involvement in mitigation and other existing planning activities.

- Scientific and other technical data update recommendations based on new data, analysis, or scientific and GIS modeling capabilities.
- Events or new information on environmental conditions that indicate new mitigation needs or requirements.
- Incorporation of hazard identification in other plans that have impact on land use, zoning, etc.

In the process of updating the earlier versions of the HMP, it became apparent that mitigation processes, although well-intentioned, have been interrupted. This planning cycle was no exception. The HI-EMA recognizes that the HI-EMA Mitigation Section is limited in staffing capacity as discussed further in Section 5 (Capability Assessment) and that Forum support since the adoption of the 2013 HMP has been sporadic. In addition, the frequency of hazard events and the State's necessity to redirect attention to disaster response and recovery diverted attention and resources away from the outlined 2013 HMP maintenance process.

Since the adoption of the 2013 HMP, the HI-EMA experienced several staffing changes. From December 2014 to December 2016, the State did not have a SHMO. During this time there was only one mitigation program support member to cover all mitigation duties for the State. In January 2017, the current SHMO joined the HI-EMA and in March 2018 there was a change in the HI-EMA Director. In terms of Forum support, from 2014 to 2015, Forum activities included supporting the review of proposed projects under FEMA DR-4194 (Tropical Storm Iselle) and FEMA DR-4201 (Pu'u 'O'o Volcanic Eruption and Lava Flow). The Forum meeings lapsed during the end of 2015 and throughout 2016; however the Forum was re-energized in the spring of 2017. In addition, the State experienced five federal disaster declarations, two of which occurred back-to-back, in April and May 2018, during the 2018 HMP Update. Without enough capacity to dedicate to mitigation, there were increased challenges executing the 2013 HMP plan maintenance procedures. These events forced HI-EMA to re-evaluate the process for monitoring, evaluating and updating the plan.

Unfortunately, the monitoring, evaluation and update process outlined in the 2013 HMP was not fully actualized (refer to Table 7-1). During the 2013 plan performance period, the HI-EMA tracked progress on FEMA HMA-funded plans and projects and their implementation progress. In addition, the Forum met periodically to discuss the prioritization of projects to be submitted for FEMA HMA funding as well as special topics of interest. In 2016, the tsunami hazard chapter of the 2013 HMP (Chapter 6) was updated to reflect more current information and data available for the state.

However, due to limited staffing and the number of disaster declarations that occurred, the HI-EMA focused its priorities on sustaining those communities most affected by the hazard events, as well as other unanticipated needs. Overall, it is recognized that the plan maintenance and implementation should be redesigned to align with the HI-EMA's current capabilities and strengthened to ensure proper execution. The HI-EMA has identified tools and outlined procedures in the following sections describing how the updated plan maintenance strategy will be accomplished.

Table 7-1. Implementation Schedule of the 2013 HMP

Date	Implementation Milestone	Status
November 2013 to January 2014	• Review current mitigation strategy and ensure that the implementation schedule is followed.	The HI-EMA Mitigation Section reviewed the mitigation strategy.

Date	Implementation Milestone	Status
	• Discuss protocols for information and data sharing as part of an ongoing project to improve geographic information systems, data management, and decision-support tools development. • Prepare assistance strategy for implementing local mitigation plans. • As projects receive funding, set up project timeline and monitoring process. Work with regional hazard mitigation organizations to collaborate and leverage tools and resources. For example, work with the Pacific Risk Management ʻOhana (PRiMO), a hazard mitigation network coordinated by the NOAA Pacific Services Center.	
February 2014 to September 2014	• Convene the quarterly meeting of the Forum. • Convene advisory committees and task forces to develop partnerships, projects, standards, and recommendations. Set up additional committees as necessary to implement policies identified in the State Hazard Mitigation Plan. • Review Risk and Vulnerability Assessment and Mitigation Plan to assess for any gaps or new information that should be incorporated. • Look at proposal funding schedules and deadlines, and develop grants. Begin writing proposals for funding. Review proposals through email. • Formally develop information sharing protocols within the county, state agencies, federal agencies, and private interests.	No progress on stated items. FEMA DR-4194 (Tropical Storm Iselle) occurred redirecting the HI-EMA Mitigation Section to assist with disaster response and recovery. • Incident period: August 7 to 10, 2014 • Declared: September 12, 2014
September to October 2014	• Convene the fourth quarterly meeting of the committee. • Discuss findings. • Determine process for addressing gaps in hazard mitigation strategy. • Review new guidance criteria and requirements by FEMA. • Review project status, successes, and update project lists. Update cost-benefit analyses in preparation for grant program requirements. • Summarize any necessary risk and vulnerability assessments.	No progress on stated items. FEMA DR-4201 (Puʻu ʻOʻō Volcanic Eruption and Lava Flow) occurred redirecting the HI-EMA Mitigation Section to assist with disaster response and recovery. • Incident period: September 4, 2014 to March 26, 2015 • Declared: November 3, 2014
November 2014	• Convene the Annual Progress Review by the Hawaiʻi State Hazard Mitigation Forum. • Prepare annual report on progress to the Director and Vice Director of Hawaiʻi State Civil Defense. • Prepare one-page updates on progress to insert into the strategy. • Prepare detailed schedule and actions for Year Two.	No progress on stated items.
Years 2 to 4	• Continue with quarterly meetings, committee meetings, and additional meetings as needed to ensure implementation of mitigation efforts. • Continue to update sections of the plan and ensure implementation. • Review new FEMA requirements. • Prepare schedule for plan evaluation.	The HI-EMA Mitigation Section submitted and was awarded a FEMA PDM grant to fund the 2018 HMP update. The Forum supported the review of proposed projects under DR-4194 and DR-4201.
Year 5	• Continue with quarterly meetings. • Continue to update plan and ensure implementation. • At the beginning of the third year, a thorough review will be undertaken and an evaluation will be conducted.	• The Forum met four times between October 2017 and June 2018.

Date	Implementation Milestone	Status
	• Prepare updated plan for October 27, 2018, requirement.	• The HI-EMA led the 2018 HMP Update.

Notes: *FEMA* *Federal Emergency Management Agency*
HI-EMA *Hawai'i Emergency Management Agency*
HMP *Hazard Mitigation Plan*
NOAA *National Oceanic and Atmospheric Administration*

Note from the 2013 HMP regarding schedule contingency: *State Civil Defense will pursue the previous schedule as outlined; in the event of a disaster during the planning cycle, the schedule is subject to change. The Forum will be directed to meet as needed to guide in response and recovery efforts and respond to Hazard Mitigation Grant Program and Pre-Disaster Mitigation program requirements. The schedule may also be adjusted to accommodate changes in federal, state, and local administrations during this cycle.*

The outlined schedule will be reviewed, revised, and updated periodically to best serve the State of Hawaii's needs in implementing hazard mitigation practices and actions. The schedule will be shared in the secure server to ensure that the state hazard committees are coordinated and organized.

7.2 Monitoring, Evaluating and Updating

As discussed in Section 2, the 2018 HMP Update was led by the HI-EMA overseen by the SHMO, with the guidance and input from other state departments, the Forum, stakeholders and public. The 2018 HMP Update will be maintained on the HI-EMA website at http://dod.hawaii.gov/hiema/sert-resources/hazard-mitigation/. The SHMO will continue to lead the HMP maintenance throughout the plan's peformance period (2018 to 2023).

Through the coordination of the SHMO and/or Chair of the Forum, the Forum will continue to meet quarterly, as per their bylaws updated in August 2017 (Appendix X), throughout the 2018 HMP Update performance period to support implementation of, and discuss amendments to the SHMP. In addition to these meetings, the SHMO and Forum Chair may request the Forum meet following disaster events, to assure that procedures and resources are appropriate for plan maintenance and implementation. The SHMO may continue to invite additional stakeholders that were invited to Forum meetings during the 2018 HMP Update to ensure continuity of involvement and subject-matter expertise. The continuous review and evaluation of the HMP will help determine its overall effectiveness and ensure its ongoing relevance to the State's mitigation needs.

At a minimum of one Forum meeting per year, the SHMO will lead the HMP update discussion to evaluate the content of the plan. The framework and questions listed below will be asked. At the conclusion of these Forum meetings, the HI-EMA will capture the changes and progress discussed, and combine into an annual review report. The annual review report will be structured to align with the main sections of the 2018 HMP Update and be included in Appendix X. This will facilitate the incorporation of changes and progress made in the 2023 HMP Update. The SHMO will continue to host the current version of the 2018 HMP Update on the HI-EMA website and ensure the annual review reports are included in Appendix X and uploaded to the site.

- Planning Process
  - What milestones in plan integration have been made (e.g., updated State Strategic Plan and THIRA)?
  - Are there any changes needed to the Forum membership to ensure broad participation across all sectors?
- State Profile

- Have there been any significant changes to the State in terms of demographics, development, state assets or other?

- Capability Assessment
  - What changes in programs and policies have occurred at the local, state and federal levels?
  - As local HMPs are updated, integrate their updated local capabilities into the State capability assessment.
- Risk Assessment
  - Have the nature and magnitude of hazard risks and/or development changed?
  - Is there any updated climate science data to integrate into the plan?
  - Document new disaster declarations and impacts incurred.
- Mitigation Strategy
  - What progress has been made toward the HMP's goals?
  - Do the goals still address current and expected conditions?
  - Discuss any change in state priorities.
  - Report mitigation action implementation progress (discussed further below).
  - Review existing mitigation action items to determine appropriateness of funding.
  - Discuss changes in available funding sources, programs and their priorities.
  - Re-prioritize state-level potential mitigation projects, if needed, using the methodology described in the plan.

In addition to the annual review report on the HMP, a summary of the FEMA annual consultation will be included in the appendix as well. The 2017 FEMA annual consultation documentation has been included in Appendix X because it was completed as the HI-EMA commenced the 2018 HMP Update.

Table 7-2 outlines the updated plan maintenance strategy that the HI-EMA will implement over the next five years.

Table 7-2. Plan Maintenance Strategy for the 2018 HMP Update

Year	Implementation Milestone
October 2018	• FEMA-approval and State adoption of the 2018 HMP Update
2019 (Year 1)	• Continue Forum meetings • In August 2019, solicit Forum and stakeholder assistance to document mitigation action implementation progress to date using the BATool℠ • Evaluate the 2018 HMP Update utilizing the framework above • Develop the annual review report by the end of September 2019, include in Appendix X of the 2018 HMP Update, and update the HI-EMA website with the new information
2020 (Year 2)	• Continue Forum meetings • In August 2020, solicit Forum and stakeholder assistance to document mitigation action implementation progress over the past year using the BATool℠ • Evaluate the 2018 HMP Update using the framework above • Develop the annual review report by the end of September 2020, include in Appendix X and update the HI-EMA website with the new information
2021 (Year 3)	• Continue Forum Meetings • Apply for FEMA PDM planning grant to develop the 2023 HMP Update • In August 2021, solicit Forum and stakeholder assistance to document mitigation action implementation progress over the past year using the BATool℠ • Evaluate the 2018 HMP Update using the framework above

Year	Implementation Milestone
	• Develop annual review report by September 2021, include in Appendix X and update the HI-EMA website with the new information
2022 (Year 4)	• Continue Forum Meetings • Commence 2023 HMP Update • Request mitigation action progress by July 2022 • Develop annual review report by September 2022, include in Appendix X, and update the HI-EMA website with the new information
2023 (Year 5)	• Continue Forum Meetings • Continue preparation of the 2023 HMP Update • Submit updated HMP to FEMA by August 2023

Notes: *BATool^{SM} Baseline Assessment Tool*
FEMA Federal Emergency Management Agency
HI-EMA Hawai‘i Emergency Management Agency
HMP Hazard Mitigation Plan
PDM Pre-Disaster Mitigation

7.3 Tracking Progress

Tracking progress on state-level mitigation activities shall continue to be led by HI-EMA. To standardize and facilitate collection of progress data and information on the specific mitigation actions in the HMP, HI-EMA will utilize the BATool^{SM} plan review module, an on-line plan review service that will allow Forum members and other state agencies and stakeholders to login to a secure site and provide a status update to their mitigation actions. The service will be established and populated with HMP mitigation actions within the first six months of FEMA-approval of this plan. Once ready, the link, instructions and login credentials will be distributed prior to the next scheduled Forum meeting and a training session on the BATool^{SM} will be provided. The HI-EMA envisions collecting progress on an annual basis, and reporting progress in the annual review report appended to this plan to facilitate integration into the 2023 HMP Update. While tracking progress on documented actions, this will be an opportunity for the HI-EMA, Forum and stakeholders to identify modifications to existing actions, and add new mitigation actions to the State mitigation strategy; all of which can be accomplished in the BATool^{SM}.

Local mitigation projects funded by FEMA are administered through the HI-EMA and are tracked from initiation. Counties that receive project grant awards are required to submit progress reports on the status of their project(s). Currently, the HI-EMA is tracking the one HMGP award under DR-4201 and two PDM 2016 awards on their internal Access database. When FEMA awards the five projects under DR-4282, the HI-EMA will initially track on the same Access database, but will convert to the new BATool^{SM} once it is installed.

7.4 Documenting and Supporting Local Hazard Mitigation Plans

As each county’s expiration date on their current hazard mitigation plan approaches, the SHMO notifies each county regarding their status and advises to submit a FEMA HMA planning grant application to FEMA. The HI-EMA Mitigation Section provides technical assistance, when requested, to the four counties during their local mitigation plan development and update. Due to limited staffing at the HI-EMA Mitigation Section, technical assistance has been somewhat limited over the past five years. As the HI-EMA Mitigation Section capacity increases so will the technical assistance it can provide to the counties. A final plan review is made by the HI-EMA to ensure all requirements of the program have been met before forwarding the updated plan to FEMA for final review and approval.

During the period of performance of the 2013 HMP, limited resources were available to provide a linkage between the local plans and the HMP. It is the current SHMO's vision to get all four counties on the same local HMP update cycle. The 2018 HMP Update will serve as a trigger for all county HMPs to be updated. The HI-EMA envisions that this will allow for wise use of resources and better coordination of risk assessment and mitigation strategies among the counties and with the State. In addition, it is the intention of the HI-EMA to develop a standard operating procedure for state technical assistance program for local county hazard mitigation plans and mitigation activities, implement an annual review coordinated with and through the annual mitigation program consultation with FEMA Region IX. This is included as a new mitigation action led by the HI-EMA as documented in Section 6 (Mitigation Strategy) and Appendix (Mitigation Strategy). During this consultation methods and progress on linking the 2018 HMP Update and local HMPs will be discussed and evaluated.

APPENDIX A CAPABILITY ASSESSMENT

This appendix includes detailed information that supports the Capability Assessment discussion presented in Section 5 (Capability Assessment) of this document.

A.1 State Capability Assessment Detailed Tables

The following sections include the detailed capability assessment that is summarized in Section 5 (Capability Assessment) of the HMP. The reader should note that the goal of this assessment was not to identify all capabilities an agency may have, but only those that are currently used or could be used to support mitigation efforts. Capabilities are generally arranged by agency; however, in some instances, capabilities listed are closely associated with the agency/department, but do not fall under their explicit authority. Information is provided for each capability as appropriate:

- **Description**—Brief, succinct description of the capability
- **Notable changes**—Description of any significant changes that have impacted the capability since the 2013 HMP was developed. Changes include but are not limited to plan updates, change in staff/resources, change in administrative rules or amendment to law, etc.
- **Challenges**—Describes any issues with implementing the capability, capability effectiveness or any aspects of the capability that conflict with hazard mitigation goals. Challenges include but are not limited to a lack of staffing or funding for implementation, outdated information or protocols, etc.
- **Opportunities**—Describes identified opportunities to address challenges, integrate mitigation goals, or otherwise enhance capabilities
- **Hazards**—Lists the hazard(s) of concern that the capability addresses
- **Type of Hazard Management Capability**—Indicates whether the capability applies pre- or post-disaster
- **Effect on Loss Reduction**—Indicates if the capability supports, facilitates or conflicts with hazard mitigation goals.

A.1.1 Department of Accounting and General Services

Table A.1-1 includes information on hazard mitigation related capabilities for the Department of Accounting and General Services (DAGS). Table A.1-2 includes information on hazard mitigation related capabilities for the Structural Engineers Association of Hawaiʻi (SEAOH).

Table A.1-1. Department of Accounting and General Services Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *DAGS, is headed by the State Comptroller, who concurrently serves as the director of DAGS. The department is responsible for managing and supervising a wide range of State programs and activities.*								
State-owned Building Insurance	**Description:**	DAGS works with the insurance industry to make sure that the state-owned buildings and facilities (more than 7,500) have insurance in case of emergencies and hazards, and works with FEMA, Hawaiʻi Emergency Management Agency (HI-EMA), and the insurance industry during declared disasters to conduct damage assessments.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Dam Failure, Earthquake, Event-based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆		◆		
Land Acquisition Program	**Description:**	The Public Works Division of DAGS plans, coordinates, organizes, directs and controls a variety of engineering and architectural services for the State including land acquisition. Funds for land acquisition are appropriated by the legislature through the Capital Improvement Program. Land acquisition is conducted in partnership with the DLNR Land Division.						
	Notable Changes:	None identified.						
	Challenges:	DAGS does not have funding budgeted for this purpose, so all funding would need to come from the legislature.						
	Opportunities:	Properties that have experienced repetitive losses from hazard events could be acquired though willing seller programs.						
	Hazards:	Drought, Climate Change, Tsunami, Event-based flood		◆		◆		◆
Shelter Upgrade Program [b]	**Description:**	The Public Works Division of DAGS takes the lead in implementing sheltering upgrades for public facilities to withstand disasters. Funds for shelter upgrades are appropriated by the legislature through the Capital Improvement Program.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Hurricane	◆		◆	◆		◆
Damage Assessments [b]	**Description:**	The Public Works Division of DAGS has architectural and engineering staff capable of supporting damage assessments to buildings and structures damaged after an event.						
	Notable Changes:	None identified.						
	Challenges:	Staff workload would need to be managed for this additional task. Staff time would need to be reimbursed.						
	Opportunities:	None identified.						
	Hazards:	Earthquake, Hurricane		◆	◆	◆		
Building Code Council [c]	**Description:**	The State Building Code Council (the Council) which is administratively attached to the Department of Accounting and General Services and is authorized by Section 107-22, Hawai‘i Revised Statues. The purpose of the Council is to establish a state building code through the timely adaption of national building codes and would include the latest fire code as adopted by the State Fire Council, the latest edition of the International Building Code, the latest edition of the Uniform Plumbing Code, and Hawai‘i design standards to implement Act 5, Special Session Laws, 2005 as applicable to emergency shelters and essential government facilities. HAR §3-180 sets forth the State Building Code. Counties may make local amendments						
	Notable Changes:	None identified.						
	Challenges:	Work on the adoption and implementation of modern building codes for all counties is still ongoing. The 2012 IBC is still pending for some counties. The 2012 codes have some HI-specific amendments that are focused on wind that are important. DAGS has a mitigation grant to facilitate the adoption of amendments. Challenges have involved some changes in legislation that impact the logistical aspects of the adoption process. Adoption is expected to move forward in the short-term.						
	Opportunities:	The American Society of Civil Engineers (ASCE)’s 2016 edition of ASCE 7 Standard Minimum Design Loads and Associated Criteria for Buildings and Other Structures includes a unified set of analysis and design methodologies for tsunami forces and effects on critical and essential facilities, and tsunami evacuation centers for the states of Alaska, Washington, Oregon, California, and Hawai‘i. The standards can also be applied to other multi-story buildings, as determined by the local jurisdiction. The standard’s methods are consistent with state-of-the-art tsunami physics, and utilizes probabilistic hazard						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		analysis and structural target reliability analysis similar to the methods underlying earthquake design in ASCE 7. In addition to the standards, ASCE developed Tsunami Design Zone Maps which graphically depict the extent of inundation for up to a 1 in 2,500 annual chance Maximum Considered Tsunami (MCT) flooding for the coastlines of the five applicable states, including the State of Hawaiʻi (ASCE 2016). These maps provide the default design maps, which in turn should be produced in finer spatial resolution as local Hawaiʻi map amendments for application in state building codes (Chock, 2016). These provisions will be required in the State of Hawaiʻi by the next version of the Hawaiʻi State Building Code (Wei et al, 2017).						
	Hazards:	Earthquake, Event-based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.
c. Identified by a stakeholder group as presenting an opportunity to improve effectiveness at meeting hazard mitigation goals. In this instance, opportunity primarily lies with adoption and enforcement at the local level.

Table A.1-2. Structural Engineers Association Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *SEAOH is the Structural Engineers Association of Hawai`i, a charter member of the National Council of Structural Engineers Association (NCSEA). SEOAH is a non-profit, member-driven organization that pursues the common interests of practicing structural engineers and others sharing an interest in the activities of structural engineers (SEAOH, 2018).*								
Disaster Response Committee	**Description:**	The purpose of the SEAOH Disaster Response Committee (DRC) is to consider and coordinate activities the structural engineering community can do before and after disasters occur. The DRC maintains a list of SEAOH member volunteers who: (1) want to participate in Pre-disaster Organization and Training and (2) can be called upon to act as Post-Disaster Volunteer Engineers.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Opportunities:	None identified.						
	Hazards:	Dam Failure, Earthquake, Event-based flood, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆		◆		
Building Code Committee	**Description:**	One member of the State Building Code Council is a member of the SEAOH. The committee reviews the International Building Code and International Residential Code in support of this role.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Dam Failure, Earthquake, Event-based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.2 Department of Budget and Finance

Table A.1-3 includes information on hazard mitigation related capabilities for the Department of Budget and Finance (DBF).

Table A.1-3. Department of Budget and Finance Capabilities

Capability	Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *The Department of Budget and Finance (DBF), headed by the Director of Finance, administers the State budget, develops near- and long-term financial plans and strategies for the State, and provides programs for the improvement of management and financial management of State agencies.*						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Capital Improvements Budget	**Description:**	Project appropriation proposals submitted by state and county agencies are reviewed, prioritized, and evaluated to ensure conformity with statewide planning goals and objectives and executive priorities, and an estimate of the operational costs for each proposed capital improvement project is provided to the governor for consideration for possible inclusion in the executive capital improvement project budget that is to be presented to the legislature. The department also reviews, analyzes, and reports on state and county capital improvement project appropriation proposals that extend over wide geographical areas of the State and that have significant impacts upon economic development, land use, environmental quality, construction employment, and executive policy directions. Act 286 (HRS § 226-109) adopting Climate Change Adaptation Priority Guidelines as a policy of the Hawaiʻi State Planning Act (see Table A.1-7 below) mandates that all county and state agency actions consider climate change adaptation in capital improvement.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Projects identified in capital budgets can be submitted for consideration in federal grant programs. Opportunities to integrate hazard mitigation goals, should be included in capital project review and development. This source of funding may be used for mitigation, including: • Wildfire o nursery improvements needed to provide native plants for green breaks, which help shade out grass to break the grass fire cycle, by replacing non-native, invasive grasses and shrubs with mostly native plants and trees; and o development of water sources, including installation of water storage structures and improvements to existing water storage structures • Rockfall o Rockfall and slope stabilization projects are included in the capital budget.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, High Wind Storms, Hurricane, Landslide/ Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		◆

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.3 Department of Business, Economic Development and Tourism

The Department of Business, Economic Development and Tourism (DBEDT) is a large department with many mitigation-related capabilities. Table A.1-4 includes information on hazard mitigation related capabilities for the Hawaiʻi Community Development Authority (HCDA), Table A.1-5 includes information for the Hawaiʻi Tourism Authority (HTA), Table A.1-6 includes information for the Hawaiʻi State Energy Office, and Table A.1-7 includes information for the Office of Planning (OP).

Table A.1-4. Hawaiʻi Community Development Authority Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Hawaiʻi Community Development Authority (HCDA) is a public entity created by the Hawaiʻi State Legislature to establish community development plans in community development districts; determine community development programs; and cooperate with private enterprise and the various components of federal, state, and county governments to bring community development plans to fruition. The HCDA's work should result in economic and social opportunities and aim to meet the highest needs and aspirations of Hawaii's people.*								
Community Development District Program	**Description:**	At the time of this plan update there are three community development districts in the State: Kakaʻako, Kalaeloa and Heʻeia						
	Notable Changes:	None identified. Annual reports are available online at: http://dbedt.Hawaiʻi.gov/hcda/hcda-annual-reports/						
	Challenges:	None identified.						
	Opportunities:	As a community development planning agency, HCDA has the opportunity to integrate natural hazard mitigation goals and strategies into its development programs and districts.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-5. Hawaiʻi Tourism Authority Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Description: *HTA works closely with state and county safety and security agencies to ensure visitor safety remains a top priority. To accomplish this, HTA utilizes technology to reach and deliver safety messages directly to visitors in times of danger or potential danger. Visitor Assistance Programs (VAPs) in all four counties provide assistance with aloha to visitors in need.*								
GoHawaiʻi Mobile App	**Description:**	In 2016 HTA developed the GoHawaiʻi mobile app – the State of Hawaii's first destination app – which offers safety information available in English, Chinese, Korean, Japanese and German to educate visitors on enjoying the Hawaiian Islands safely. Additionally, the app's push notification capability enables HTA to send messages directly to users, alerting them of dangerous or hazardous situations (HTA, 2016).						
	Notable Changes:	This is a new capability.						
	Challenges:	None identified.						
	Opportunities:	Expand the GoHawaiʻi mobile app information to address all hazards of concern for Hawaiʻi.						
	Hazards:	Chronic Coastal Flooding, Earthquake, Event-based flood, Health Risks, Hurricane, Landslide/Rockfall, Tsunami,	◆	◆		◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-6. Hawaiʻi State Energy Office Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Description: *As the designated agency for energy, HSEO works closely with many government and industry emergency management and security partners to lower vulnerabilities, deter threats, minimize the consequences of energy disruptions, and enhance recovery of Hawaii's energy systems.*								
	Description:	Hawaii's Energy Assurance Program provides organizational and planning support for energy emergency management. The program aims to facilitate the rapid restoration of Hawaii's energy systems and mitigate the impact of energy shortages. The						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Energy Assurance Program		concept of operations for the program includes energy emergency preparedness; response and restoration; monitoring, reporting, and analysis; coordination and outreach; and energy assurance planning.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	HSEO has established relationships with private and public industry owners and operators of the state’s energy infrastructure, as well as state and county agencies. HSEO should consider looking for opportunities to partner with the private sector to reduce vulnerability of lifelines and other critical facilities and infrastructure, potentially, through FEMA mitigation grant programs.						
	Hazards:	Climate Change, Dam Failure, Earthquake, Event-based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆		◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-7. Office of Planning Capabilities

Capability	Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
STATE LAND USE LAW [d]						
Description: *The State Land Use Law (Chapter 205, Hawai`i Revised Statutes) was adopted in 1961, establishing a framework of land use management and regulation in which all lands in the State of Hawai`i are classified into one of four land use districts. The Land Use Division of the Office of Planning represents the state's interests as they pertain to District Boundary Amendments, Special Permits, and Important Agricultural Lands. Land Use Division staff ensure petitions for boundary amendments meet the land use commission decision-making criteria, address impacts to state infrastructure, and evaluate whether the proposed project complies with the Hawai‘i State Plan.*						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
Land Use Districts	**Description:**	All lands in Hawai‘i are classified in one of the four land use districts: urban, rural, agricultural and conservation. County government have regulatory authority over Urban District lands and shared authority over Agricultural and Rural District Lands. Conservation District lands are reserved for the State						
	Notable Changes:	Since 2013, statewide land use classifications have mostly remained static. A total of 261 acres statewide were reclassified from the Agricultural District to the Urban District (OP, 2017). Changes to rules include an allowance of solar farms on agricultural lands with B and C rated soils with a Special Permit.						
	Challenges:	Increasing use of agricultural lands for non-farming uses, expansion of permissible uses in Chapter 205 for non-farming uses, subdivision and use of condominium property regimes for residential developments without active farming, unclear definition of what constitutes bona fide farming and farm dwelling.						
	Opportunities:	Bona fide agricultural production task force formed under the Department of Agriculture, pending legislation designed to address challenges.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆			
Five-Year Boundary Review	**Description:**	Hawai‘i Revised Statutes § 205‑18 calls for the periodic “review of the classification and districting of all lands in the state.” Such reviews have been conducted in 1969, 1974, and 1990.						
	Notable Changes:	A five-year boundary review process was started in 2013. The review was expected to include two phases (1) conduct the periodic review without pursuing any boundary amendments and (2) Review the State Land Use District Boundary Amendment process and provide recommendations to the Land Use Commission, Governor and the Legislature to improve its efficiency and effectiveness without compromising the original intent of the law (Office of Planning, 2014b). The Five-Year Boundary Review report is nearing completion and should be published in 2018. Phase 2 of the project has been terminated as there is no consensus from an advisory group called by OP to move forward on amendments to the Land Use District Boundary Amendment process.						
	Challenges:	Review being done with in-house staff resources. Boundary amendments are precluded due to lack of resources to initiate petitions for district boundary amendments.						
	Opportunities:	Future Reviews can include issues such as sustainability and climate change issues.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Event-based flood, Landslide/Rockfall, Tsunami, Volcanic Hazards	◆		◆			
Land Use Commission	**Description:**	The Land Use Commission (LUC) administers the Land Use Law. The LUC is composed of nine members, one from each county and five members appointed at large. The Land Use Commission Rules outline standards for determining district boundaries, which include consideration of some natural hazards.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Event-based flood, Landslide/Rockfall, Tsunami, Volcanic Hazards	◆		◆			
COASTAL ZONE MANAGEMENT PROGRAM [c, d]								
Description: *The Hawaiʻi Coastal Zone Management Program (CZM Program) was approved in 1977 and is responsive to the Federal CZM Act of 1972. It serves as the State's resource management policy umbrella and the guiding perspective for the design and implementation of allowable land and water use activities throughout the state. All agencies must assure their statutes, ordinances, rules and actions comply with the CZM's ten objectives and related policies. The coastal zone in the State of Hawaiʻi consists of the entire State and the area extending seaward to the limit of the state's police power and management authority. The Office of Planning administers the Coastal Zone Management Law through the Coastal Zone Management Program and sub-programs; however, 14 agencies have responsibilities relating to marine and coastal zone management.*								
Hawaiʻi CZM Program Document	**Description:**	Approved by NOAA in 1990, the Hawaiʻi Coastal Zone Management Program document provides a description of the Hawaiʻi Coastal Zone Management Program including links between the Federal, State, and County governments, Hawaii's land use and environmental management systems, and special components of the Hawaiʻi CZM program (Office of State Planning, 1990). In 2011 a supplemental document describing the CZM program as it existed in 2011 was produced, but it is not intended to be a replacement for the 1990 program document. Reducing hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution is a stated objective of the program and four policies have been developed to support this objective (Office of Planning, 2011).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Expand coastal hazards to include explicit discussion of sea level rise.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆		◆			
Coastal Nonpoint Pollution Control Program (CNPCN)	**Description:**	The purpose of this program is "to develop and implement management measures for nonpoint source pollution to restore and protect coastal waters." Projects to address polluted runoff control are outlined in the Coastal Nonpoint Pollution Control Management Plan and Hawai'i Nonpoint Source Management Plan and are eligible for Clean Water Act section 319 funding. Hawaii's CNPCP is co-implemented by the Department of Health and is a requirement of the 1990 Coastal Zone Act Reauthorization Amendments (16 U.S.C. – 1455b).						
	Notable Changes:	Hawaii's Nonpoint Source Management Plan was updated over the performance period of the 2013 HMP and will next be updated in 2020. Updated Management Measures for Hawaii's CNPCP were last developed in 2010.						
	Challenges:	319 grant funding is limited with $167.9 million available in 2017 and projects must meet pollution reduction objectives						
	Opportunities:	While the focus of the program is on pollution control, some projects, such as those addressing urban stormwater runoff and water source protection, may also help meet mitigation goals and objectives. There may be an opportunity to align and leverage program objectives at the time of the next update.						
	Hazards:	Climate Change, Event-based flood, Health Risks	◆			◆		◆ (F)
Marine and Coastal Zone Advocacy Council (MACZAC)	**Description:**	MACZAC is a public advisory body to assist the Hawai'i CZM Program toward the implementation of an integrated and comprehensive management system for marine and coastal zone resources, consistent with the objectives and policies or the Hawai'i Coastal Zone Management Act. Comprised of twelve advisory members recruited from the islands of Kaua'i, O'ahu, Maui, Moloka'i, Lāna'i, and Hawai'i, MACZAC members have diverse backgrounds in business, environment, native Hawaiian practices, terrestrial and marine commerce, recreation, research, and tourism. The council's mission statement is "Advocate for a comprehensive management system which restores, preserves and protects Hawaii's marine and coastal environment."						
	Notable Changes:	None identified.						
	Challenges:	Capabilities are limited to the statutory role to advise and evaluate the CZM program.						
	Opportunities:	MACZAC may be a venue to have community discussion(s) on coastal hazards.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆			◆		
Special Management Area (SMA) Permits	**Description:**	The SMA permit is a management tool designed to assure that developments in the SMA are designed and carried out in compliance with the CZM objectives, policies, and SMA guidelines. The SMA permitting system regulates development within county designated SMAs extending from the shoreline inland (Office of Planning, 2012). OP plays a lead role in the administration and management of the program, oversees the consistency of the permit system, provides training sessions to county SMA personnel and the County Planning Commissions, provides SMA permit guidance, and conducts SMA use review and approval for development within the SMA of community development districts. SMA permits were established as part of the Shoreline Protection Act of 1975. County authorities administer SMA permits and may amend their boundaries as necessary; however, boundary contractions are subject to OP's review. Trainings are generally offered for Planning Commissions and City/County Councils, particularly when there are new members. Trainings are requested by the County Planning Department and are typically conducted as a portion of a public meeting and are, therefore, open to the public. In general, these trainings are requested once per year and focus on the SMA basics, including the review criteria regarding coastal hazards.						
	Notable Changes:	None identified.						
	Challenges:	Not all development in the SMA is required to obtain an SMA permit. SMA permitting excludes agriculture, inferior alterations or non-structural improvements, single family homes, and underground utilities.						
	Opportunities:	Hazard mitigation training can be integrated into SMA trainings offered by OP. County authorities may amend its county SMA boundaries as necessary; however, any contraction of the boundary is subject to OP's review and determination.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆		◆			
Federal Consistency	**Description:**	The State CZM Program reviews federal actions affecting any coastal use or resource to ensure that proposed activities are consistent with state enforceable policies. Specifically, actions are assessed for consistency with National Flood Insurance Program flood hazard requirements and maps and tsunami inundation areas and subsidence hazards are considered (State of Hawaiʻi, 2013). Federal consistency is required under the national Coastal Zone Management Act (CZMA), Section 307. Procedures and requirements are established in the Code of Federal Regulation, 15 CFR 930.						
	Notable Changes:	Annual, routine program change requests as well as a list of current federal license, permit, and financial assistance activities subject to federal consistency are available on the Office of Planning website.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Challenges:	None identified.						
	Opportunities:	The State CZM Program attempts to review statues and ordinances to ensure that they are enforceable policies so that they can be included as part of the CZM program and be considered during the federal consistency review.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆		◆			
Coastal Zone Enhancement Program	**Description:**	State CZM program changes addressing one or more enhancement areas (wetlands, coastal hazards, public access, marine debris, cumulative and secondary impacts, special area management planning, ocean/great lakes resources, energy and government facility siting, and aquaculture) are eligible for Section 309 funding once an approved Assessment and Strategy has been completed. Past projects included education and outreach materials developed for distribution at community fairs and other public events. In addition, a tsunami inundation modeling project for the Island of Hawaiʻi is ongoing at the time of this plan update.						
	Notable Changes:	The Assessment and Strategy was updated over the performance period of the plan for FY 2016-2020, approved on July 1, 2015. Strategies for implementation in the updated plan include Probabilistic Tsunami Design Zone Maps for the State of Hawaiʻi and Ocean Resources Management Planning (Hawaiʻi CZM Program, 2015).						
	Challenges:	This is a NOAA incentive program and is not administered by the State.						
	Opportunities:	An update of the Assessment and Strategy will be required during the performance period of the HMP. There will be an opportunity to identify additional strategies that meet both CZM and hazard mitigation goals and objectives.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆			◆		◆ (F)
Cumulative & Secondary Impact: Stormwater Impact Assessment	**Description:**	Document that provides easy to follow guidance on assessing stormwater impacts in the planning phase of project development and suggests the incorporation of appropriate mitigation strategies (Office of Planning, 2013).						
	Notable Changes:	This is a new capability – final document completed in May of 2013.						
	Challenges:	The guidance document does not impose any legally binding requirements on county, state or federal agencies.						
	Opportunities:	Document could be updated/amended to include guidance on how to incorporate expected/possible changes in stormwater impacts because of climate change.						
	Hazards:	Event-based flood	◆		◆			

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
Hawaiʻi Coastal and Estuarine Land Conservation Plan	**Description:**	The Hawaiʻi Coastal and Estuarine Land Conservation Plan (CELCP) serves as the initial action toward eligibility for the federal Coastal and Estuarine Land Program, which enables permanent protection of coastal and estuarine lands by providing matching funds for community based projects to acquire property from willing sellers through fee simple purchases or conservation easements.						
	Notable Changes:	The plan received final approval from NOAA in June 2014 during the performance period of the 2013 HMP.						
	Challenges:	President's budget has not funded CELCP program at the federal level for approximately four years straight.						
	Opportunities:	Although the focus on the program is on protecting resource value associated with ecological value, conservation value, cultural value, recreational value and aesthetic value, there may be overlap between these values and mitigation goals.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆		◆	◆		◆ (F)
Hawaiʻi Community Stewardship Directory	**Description:**	Developed as an implementation tool for the Hawaiʻi Ocean Resources Management Plan to help community groups and organizations connect with each other to share their experiences and lessons learned in natural and cultural resources management. The 2015 directory includes 95 organizations (Hawaiʻi CZM Program, 2015b).						
	Notable Changes:	The directory was updated over the performance period of the 2013 HMP in December of 2015. The number of organizations listed declined from 114 in the 2010 version.						
	Challenges:	Organizations in the Directory have no official capacity to address natural hazards in terms of emergency management.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆			
Low Impact Development: A Practitioner's Guide	**Description:**	This workbook provides information on better site design principles, along with best management practices (BMPs) for stormwater and wastewater management that minimize the impacts to environmental resources. The design requirements for stormwater BMPs are based on the climate and rainfall characteristics experienced in Hawaiʻi, taking into account the variability in rainfall with elevation and with the windward and leeward sides of the islands (Hawaiʻi CZM Program, 2006).						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Workbook could be amended/updated to incorporate design considerations for the likely impacts of climate change.						
	Hazards:	Drought, Event-based flood	◆		◆			
Shoreline Setback Area	**Description:**	Establishes minimum shoreline setbacks of 40 feet from the shoreline, with allowances to 20 feet under certain circumstances. Counties may expand the setback area beyond the minimum requirements. Established under HRS Section 205A-43						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Some counties have chosen to expand setback area requirements above the minimum set forth by the State. The State could consider expanding the minimum requirements Statewide.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆	◆		◆		
Ocean Resources Management Plan	**Description:**	Statewide plan that sets forth the State's ocean and coastal resources management priorities. The ORMP works by identifying eleven Management Priorities for the next five-year planning period, by identifying responsible agencies and resources, and by providing a method for performance measures and reporting. The ORMP is required under HRS Section 205A-62(1). The current plan was completed in July 2013 and includes coastal hazards, sea level rise, and coastal erosion as well as climate change adaptation: disaster preparedness and community resilience as pressures on the ocean and critical issues that need to be addressed (Hawaiʻi CZM Program, 2013).						
	Notable Changes:	The ORMP Dashboard was recently launched and provides information on the progress of implementing the ORMP. See the following sites: https://dashboard.Hawaiʻi.gov/stat/goals/25ji-kwv7/ http://planning.Hawaiʻi.gov/czm/ocean-resources-management-plan-ormp/ocean-resources-management-plan-dashboard/						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
	Opportunities:	The plan will be updated during the performance period of the 2018 HMP Update, which provides opportunity for continued plan integration.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆		◆			
Council on Ocean Resources	**Description:**	Established in 2013 by directors of state and county agencies, with unanimous support of federal and community partners, the Council facilitates greater coordination and implementation of the State's shared ocean and coastal resource management priorities (Hawaiʻi CZM Program, 2013b).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, Hurricane, Tsunami	◆			◆		
HAWAIʻI STATE PLANNING ACT								
Description: *All state agencies are guided by the Hawaiʻi State Planning Act, which is a broad policy document that sets the table for all activities, programs, and decisions made by local and state agencies. The Hawaiʻi State Planning Act was signed into law in 1978 to "improve the planning process in this state, to increase the effectiveness of government and private actions, to improve coordination among different agencies and levels of government, to provide for wise use of Hawaii's resources and to guide the future development of the state" (HRS § 226-1). The Act is codified under HRS Chapter 226. The State Plan is divided into three parts: Overall theme, goals, objectives and policies; planning coordination and implementation; and priority guidelines.*								
Statewide Planning System	**Description:**	Coordinates and guides all major state and county activities and implements 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.						
	Notable Changes:	The State has developed 17 functional plans. Of these only one has been developed and/or updated since 1991. The *Housing State Functional Plan* was completed in February 2017 (Hawaiʻi Housing Finance and Development Commission, 2017).						
	Challenges:	None identified.						
	Opportunities:	As functional plans are updated, they can be reviewed and enhanced to ensure consistency with hazard mitigation goals.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-	◆		◆			

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation [b]
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire						
Priority Guidelines	**Description:**	As art of the Statewide Planning System, the guidelines establish priorities to address areas of statewide concern: economic development, population growth and land resource management, affordable housing, crime and criminal justice, and quality education. Established in HRS § 226-59						
	Notable Changes:	During the performance period of the 2013 HMP, the priority guidelines were updated to include climate change adaptation.						
	Challenges:	Priority guidelines serve primarily as aspirational or advisory and do not have any clear enforcement mechanisms from which to derive authority.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆			
Hawaiʻi State Plan Update Phase I	**Description:**	A comprehensive review of the State Planning Act is underway. Phase 1 of the update involves inventorying and reviewing all state department plans, strategic plans, functional plans, and capital improvement plans; identifying common themes and policy directions; developing findings as to the overall status of the plans and preparing findings and recommendations for next steps in the update of the State Planning Act.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The update of the State Plan provides an opportunity to fully integrate the hazard mitigation plan with the State Plan.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆		◆		

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation [b]
HAWAIʻI STATEWIDE GEOGRAPHIC INFORMATION SYSTEM PROGRAM								
Hawaiʻi Statewide Geographic Information System Program	**Description:**	The program leads a multi-agency effort to establish and promote the use of GIS technology in State Government. A centralized database enables agencies to share information while reducing the development of redundant databases, helps standardize the information being analyzed by decision makers and serves as a means for collecting and distributing the best available databases. The program includes the Hawaiʻi Open Data Portal, map tools and applications, and other resources.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Map tools and applications can continue to be expanded to support statewide planning efforts as well as support hazard mitigation related education and outreach activities. Program capabilities could also be expanded to help support mitigation activities through projects such as maintaining the Hazus-MH model developed as a part of this plan update.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding
c. Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.
d. Identified by a stakeholder group as presenting an opportunity to improve effectiveness at meeting hazard mitigation goals.

A.1.4 Department of Commerce and Consumer Affairs

Table A.1-8 includes information on hazard mitigation related capabilities for the Department of Commerce and Consumer Affairs (CCA).

Table A.1-8. Department of Commerce and Consumer Affairs Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
HAWAI`I INSURANCE DIVISION								
Description: *The Insurance Division is responsible for overseeing the insurance industry in the State of Hawai`i , which includes insurance companies, insurance agents, self-insurers and captives. The division ensures that consumers are provided with insurance services meeting acceptable standards of quality, equity and dependability at fair rates by establishing and enforcing appropriate service standards.*								
Hawai`i Hurricane Relief Fund	**Description:**	Created in 1993, the fund is used to provide hurricane property insurance policies in Hawai`i in the event they are not available in the private market. Due to increased availability of hurricane property insurance coverage from the private sector, the fund ceased writing hurricane property insurance policies effective December 1, 2000. The HRS creating the Hawai`i Hurricane Relief Fund (HRS 431P) established a board of directors as the policy making body of the fund. If at any time the board determines that the private insurance market is not making property insurance reasonably available, the fund may offer policies of hurricane property insurance for sale in Hawai`i.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Hurricane		◆		◆		
REAL ESTATE BRANCH								
Description: *The Real Estate Branch, as part of the Professional and Vocational Licensing Division, assists the Real Estate Commission in carrying out its responsibility for the education, licensure and discipline of real estate licensees; registration of condominium projects, condominium associations, condominium managing agents, and condominium hotel operators; and intervening in court cases involving the real estate recovery fund.*								
Mandatory Seller Disclosures in Real Estate Transactions	**Description:**	Requires seller disclosures in residential real property sales including if the residential property lies within the boundary of a special flood hazard area and/or within the anticipated inundation areas designated on the department of emergency management tsunami inundation maps. (HRS §508D)						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Legislation could be amended to require mandatory disclosure of location in a sea level rise exposure area.						
	Hazards:	Event-based flood, Tsunami	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.5 Department of Hawaiian Home Lands

Table A.1-9 includes information on hazard mitigation related capabilities for the Department of Hawaiian Home Lands (DHHL).

Table A.1-9. Department of Hawaiian Home Lands Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The primary responsibilities of the Department of Hawaiian Home Lands (DHHL) are to serve its beneficiaries and manage its extensive land trust. The land trust consists of over 200,000 acres on the islands of Hawaiʻi, Maui, Molokaʻi, Lānaʻi, Oʻahu, and Kauaʻi. These lands are developed and distributed to native Hawaiian beneficiaries by way of residential, agricultural, and pastoral leases for 99-year terms with lease payments of $1.00 per year. Some parcels are designated for income-producing purposes and are general leased for industrial, retail, or other uses.*								
DHHL Land Trust	**Description:**	Much of the properties originally designated as Hawaiian Home Lands were in remote or otherwise undesirable locations, and prone to natural and man-made hazards. Therefore, during the planning and design of subdivisions, the department evaluates the potentials for hazards, (such as flooding, rockfalls, lava flows, contamination from prior agricultural uses, unexploded ordinance (UXO) from former military uses) and ensures that proper mitigation measures are taken before awarding leases. DHHL coordinates with other federal, state and county agencies to address problems that span beyond the boundaries of Hawaiian Home Lands. Examples are the Waianae Coast Emergency Access Road and Secondary Access Road; flooding in Mapunapuna, Oʻahu, and Kalamaula, Molokaʻi; reservoir and dam inspections and repairs in Anahola, Kauaʻi and elsewhere. DHHL is not subject to State Land Use Laws and County zoning regulations. Otherwise development complies with Federal, State, and County requirements – especially where health and safety are concerned.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.6 Department of Health

The Department of Health is a large department with many mitigation-related capabilities. Table A.1-10 includes information on hazard mitigation related capabilities for the Environmental Management Division (EMD), Table A.1-11 includes information for the Health Resources Administration (HRA), Table A.1-12 includes information for the Office of Environmental Quality Control.

Table A.1-10. Environmental Health Administration Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
ENVIRONMENTAL MANAGEMENT DIVISION								
Description: *EMD is responsible for implementing and maintaining statewide programs for controlling air and water pollution, for assuring safe drinking water, and for the proper management of solid and hazardous waste. The division also regulates the state's wastewater.*								
CLEAN WATER BRANCH								
Description: *The Clean Water Branch (CWB) protects the public health of residents and tourists who enjoy playing in and around Hawaii's coastal and inland water resources. The CWB also protects and restores inland and coastal waters for marine life and wildlife. This is accomplished through statewide coastal water surveillance and watershed-based environmental management through a combination of permit issuance, monitoring, enforcement, sponsorship of polluted runoff control projects, and public education.*								
NPDES Wastewater Discharge Permits	**Description**	Issues National Pollution Discharge Elimination System (NPDES) wastewater discharge permits for industries discharging wastewater/ process water to surface waters of the state to ensure compliance with state and federal water quality standards for environmental health and recreation purposes.						
	Notable Changes:	Office moved to 2827 Waimano Home Road, Pearl City, HI 96782.						
	Challenges:	Establish and fill vacant positions. Permits contested by permittees. Finish workplan commitments.						
	Opportunities:	Standardize procedures, process, requirements, and conditions; Factor in considerations of sea level rise and updated flood plain and storm surge maps into the development of permit conditions to reduce instances of illicit discharge of wastewater pollutants because of flooding.						
	Hazards:	Event-based flood, Hazardous Materials, Health Risks	◆			◆		
Clean Water Act Section 401 Water Quality Certifications	**Description**	Issues Clean Water Act Section 401 water quality certifications for federal permit for construction in nearshore and inland waters. Identifies sources of water pollution through area surveillance, routine inspections, and compliant investigations.						
	Notable Changes:	Notify public when beach fecal testing result exceeds 130 CFU/100ml by email, website update and posting sign.						
	Challenges:	Establish and fill vacant positions. Permits contested by permittees. Finish workplan commitments.						
	Opportunities:	None identified						
	Hazards:	Event-based flood, Hazardous Materials, Health Risks		◆	◆			

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Polluted Runoff Control Program	**Description:**	The Polluted Runoff Control Program's mission is to protect and improve the quality of Hawaii's water resources by preventing and reducing nonpoint source pollution. To achieve its mission, the PRC Program updates and implements Hawaii's Nonpoint Source Management Plan (2015-2020). Each year, the PRC Program uses Clean Water Act Section 319(h) funds to provide grants for polluted runoff projects in Hawai'i.						
	Notable Changes:	None identified.						
	Challenges:	Grant recipients must provide 25% matching funds or in-kind contributions from non-federal sources for the 319(h) grant program.						
	Opportunities:	Although primarily focused on water quality, runoff control projects may also aid in mitigation-related goals.						
	Hazards:	Drought, Event-based flood	◆			◆		◆ (F)
SOLID AND HAZARDOUS WASTE BRANCH								
Description: *The Solid and Hazardous Waste branch oversees several programs including the hazardous waste section and underground storage tank section.*								
Hazardous Waste Section Regulations	**Description:**	Regulates the generation, transportation, treatment, storage, and disposal of hazardous waste.						
	Notable Changes:	During the 2017 regular session, the Legislature passed Act 125, which bans all further permitting of cesspools and requires the replacement of all cesspools by 2050.						
	Challenges:	Legacy cesspools – State recently identified 88,000 cesspools across the state that pose a significant risk to safe drinking water quality standards and are impacting near shore marine ecosystems						
	Opportunities:	None identified.						
	Hazards:	Hazardous Materials	◆		◆			
Underground Storage Tank Section Regulations	**Description:**	Regulates underground storage tanks that store petroleum or hazardous substances.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Drought, Event-based flood	◆		◆			
SAFE DRINKING WATER BRANCH								
Description: *Assess and determine the integrity of drinking water supply and distribution system infrastructure, ensure drinking water supplies comply with safe drinking water quality standards, and identify alternative safe drinking water supplies if water quality is compromised.*								
Safe Drinking Water Emergency FAQs	**Description:**	Frequently asked questions pertaining to drinking water during emergencies.						
	Notable Changes:	Developed emergency-based FAQs and posted on the SDWB website back in July 2013 in response to numerous public inquiries during Hurricane Flossie. These FAQs are periodically updated.						
	Challenges:	During a large scale statewide disaster, limited technical staff (8 engineers+ 5 EHS, almost all staff (12/13) are on O'ahu.						
	Opportunities:	The SDWB has proactively developed disaster FAQs (coordinated with County water supply entities) relating to drinking water treatment, use of alternative supplies, and posted them on their website: http://health.Hawai'i.gov/sdwb/files/2014/08/DrinkWaterFAQinEmergency.pdf						
	Hazards:	Health Risks		◆		◆		
ENVIRONEMTRNAL HEALTHS SERVICES DIVISIONALTH SERVICES DIVISION (EHSD)								
Description: *EHSD is responsible for implementing and maintaining statewide programs to assure the safety of food and drugs, control noise and radiation, and improve indoor air quality. The division is also responsible for lead abatement, sanitation, and vector control (rats, mosquitoes, and other public health threats).*								

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
SANITATION BRANCH								
Description: *Protects and promotes the health and well-being of Hawaii's residents and visitor with professionalism, integrity and fairness through education and regulation in the areas of food safety, disease prevention, community sanitation and emergency response*								
Mass Feeding Operations	**Description:**	Ensure sanitation of food supply and handling for mass feeding operations as a function of emergency shelter support						
	Notable Changes:	All files for licensed food establishments in the state are now electronic as well as inspection results. All staff have surface PRO's, smart phones, and mobile hot spots. Public web-site/GIS mapping of food facilities live since 2014. Use of tech has allowed us to post inspection results to the public in real time. Food Safety staff has increased from 12 in 2013 to 31 at present due to 400% increase in revenue generated by the food safety program.						
	Challenges:	Procurement and HR systems need improvement and no improvements have been made since 2013.						
	Opportunities:	Opportunities may present themselves as political climates change.						
	Hazards:	Health Risks		◆		◆		
INDOOR AND RADIOLOGICAL HEALTH BRANCH								
Description: *The Indoor and Radiological Health Branch is responsible for the implementation of diverse, statewide programs in community noise, radiation control, air-conditioning/ventilation, indoor air quality, asbestos, and lead-based paint."*								
Radiation Section-Radiation Assessment Team (RAT)	**Description:**	Radiological emergency response, WMD/CBRNE emergency response and rapid assessment of radiation exposure and environmental contamination. Assist in radiological decontamination.						
	Notable Changes:	In process of developing radiological response public health emergency response annex to the Department of Health's All-Hazards Emergency Response Plan						
	Challenges:	None identified						
	Opportunities:	None identified						
	Hazards:	Hazardous Materials, Health Risks (Radiological exposure and contamination)		◆	◆			
VECTOR CONTROL BRANCH								
Vector Control Program	**Description:**	Strategically aims to lessen risks of arboviral and vector borne diseases by suppressing vector populations (organisms capable of transmitting disease or parasites from one animal to another)						
	Notable Changes:	Since the State's response to the 2015 Dengue outbreak on the Big Island, HDOH has created a total of 30 new positions statewide to restore the capabilities of the Vector Control Program that had been substantially impacted by budget cuts in 2008. The program has additionally upgraded its inventory of pesticidal abatement products and various types of equipment used for vector control. Additionally, the program has expanded its preventative measures to include routine larval breeding source reduction and surveillance at ports of entry, vector suppression activities in weeks preceding major events that attract large and international crowds, door-to-door public education, and mosquito suppression activities in areas of high concentrations of elderly populations and around schools.						
	Challenges:	Public perception and resistance to pesticide applications utilized in vector control efforts; Conflicts of interest with organic farmers						
	Opportunities:	Increased availability of pesticides for mosquito abatement that meet organic certification requirements						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Hazards:	Health Risks (Vector borne diseases)	◆	◆	◆	◆		
HAZARD EVALUATION AND EMERGENCY RESPONSE OFFICE (HEER)								
Description: *The HEER Office is responsible for responding to releases, threats of releases, or discoveries of hazardous substances, including oil, that present a substantial endangerment to public health or the environment. Maintains environmental response programs for planning for, responding to, and preventing releases of hazardous substances into the environment*								
Hawai`i Emergency Planning and Community Right to Know Act (HEPCRA)	**Description:**	HEPCRA establishes requirements for State, local and industry regarding emergency planning and "Community Right-to-Know" reporting required on hazardous and toxic chemicals. There are four major provisions: Emergency Response Planning, Emergency Release Reporting, Hazardous Chemical Storage and Tier II Reporting, and Toxic Release Inventory Reporting. The HEPCRA establishes the Hawai`i State Emergency Response Commission and the Local Emergency Planning Committees.						
	Notable Changes:	None identified						
	Challenges:	None identified						
	Opportunities:	None identified						
	Hazards:	Hazardous Materials	◆	◆	◆	◆		

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b. (F) = Federal grant funding supports in full or in part

Table A.1-11. Health Resource Administration Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
DISEASE OUTBREAK CONTROL DIVISION								
Description: *The Disease Outbreak Control Division (DOCD) comprises the Disease Investigation Branch, Immunization Branch, and Public Health Preparedness Branch. These programs work together to monitor, investigate, prevent, and control infectious diseases in Hawai`i, especially those preventable through immunizations, and to ensure Hawaii's ability to respond to emergencies that threaten the public's health. Toward these goals, DOCD works to strengthen the relationships between the Department of Health and other partners including laboratories, hospitals, schools, emergency response agencies, private organizations, and the military.*								
Hospital Preparedness Program (HPP)	**Description:**	Supports the continuity of healthcare system operations during emergencies that exceed the day-to-day capacity of health and emergency response systems through the development and sustainment of a regional health care coalition that incentivizes healthcare organizations to work together to maintain essential capabilities of statewide healthcare services.						
	Notable Changes:	None identified						
	Challenges:	Unstable federal funding – 2018 Presidential Budget Proposal considering zeroing out Hawaii's HPP funding allocation						
	Opportunities:	None identified						
	Hazards:	Health Risks	◆	◆		◆		◆ (F)

Capability			Type of Hazard Management Capability Pre-Disaster	 Post-Disaster	Effect on Loss Reduction[a] Support	 Facilitate	 Conflict	Provides Funding for Mitigation
Laboratory Preparedness and Response Program	**Description:**	Conducts analysis in support of laboratory preparedness programs for bioterrorism and chemical terrorism, environmental health and communicable disease monitoring and control activities and investigations						
	Notable Changes:	None identified						
	Challenges:	Aging physical infrastructure						
	Opportunities:	None identified						
	Hazards:	Hazardous Materials and Health Risks (Bioterrorism, chemical terrorism, infectious disease, and environmental health risks)	◆	◆		◆		
DISEASE INVESTIGATION BRANCH								
Epidemiological Surveillance	**Description:**	Conducts surveillance monitoring, investigation, and control of infectious diseases and potential acts of terrorism throughout the State (conducted jointly with the CDC)						
	Notable Changes:	• Implementation of Meaningful use stage 2 and initiation of stage 3 • Continued improvement of the Hawaiʻi Electronic Disease Surveillance System (HI-EDSS/Maven) • Continued improvement of the Hawaiʻi Electronic Laboratory Reporting System (ELR) • Establishment of a federally-funded Healthcare Associated Infections Collaborative Coordinator position • Establishment of a federally-funded Antimicrobial Resistance Surveillance Coordinator position • Establishment of a federally-funded Arbovirus Disease Surveillance Coordinator position • Establishment of a federally-funded Entomology Specialist position • Establishment of a federally-funded Arbovirus Information Technology Specialist position • Establishment of a federally-funded Arbovirus Health Educator position (0.5 FTE)						
	Challenges:	• Position vacancies • Fluctuations in federal funding • Lack of adequate fiscal/administrative support personnel • Lack of adequate investigative personnel • Competing priorities of disease outbreaks						
	Opportunities:	• State funding for key personnel currently federally-funded - e.g., surveillance coordinators, information technology specialists, biostatistician • State funding for additional fiscal/administrative support personnel • State funding for additional investigative personnel • State funding for maintenance, support, and improvements to information technology systems - e.g., HI-EDSS, ELR						
	Hazards:	Health Risks (Infectious Diseases)	◆		◆			
PUBLIC HEALTH PREPAREDNESS BRANCH								
Description: *Responsible for coordinating the department's all-hazards emergency preparedness and response planning efforts; facilitating training and exercising for the entire department to ensure the department's ability to respond to and support recovery from public health emergencies.*								

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Department of Health All-Hazards Training and Exercise Program	**Description:**	Facilitates training and exercises for the entire department to ensure the department's ability to respond to and support recovery from public health emergencies						
	Notable Changes:	None identified						
	Challenges:	Staffing vacancies, unstable funding						
	Opportunities:	Public Health Preparedness Branch is internally being reorganized as an office under the Director of Health						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆	◆		◆
Medical Countermeasure (MCM) Points of Distribution (PODs)	**Description:**	HDOH Public Health Preparedness Branch manages the receipt and distribution of the Strategic National Stockpile (SNS), a repository of antibiotics, vaccines, chemical antidotes, antitoxins, and other critical medical equipment necessary for a public health emergency (e.g. infectious disease outbreak or chemical attack)						
	Notable Changes:	HDOH has increased the number of partnerships with key business sectors and industries across the state to provide Closed Points of Distribution (PODs) to enhance the efficiency of prophylaxis distribution, reduce volume of population reliant upon Open PODs operated by the state, and increase the continuity and resilience of key businesses and sectors during a public health emergency (i.e. infectious disease outbreak)						
	Challenges:	Limited HDOH staff resources available for rapid distribution and staffing of PODs						
	Opportunities:	Continue to build partnerships and establish Closed PODs for major industries and sectors necessary to maintain critical functions of government and commerce necessary for emergency response and recovery efforts. Expand inventory of locations capable of supporting Open PODs and agreements with other agencies for staffing.						
	Hazards:	Health Risks (Infectious disease/ chemical-biological attack response)		◆	◆			
IMMUNIZATIONS BRANCH								
Description: *Promotes immunization of public, both adults and children, against vaccine preventable diseases.*								
Immunization Programs	**Description:**	Facilitates access to vaccines for protection of persons not able to pay for vaccines. Conducts annual Stop Flu at School campaign to prevent the spread of influenza within grade schools across the state.						
	Notable Changes:	The annual Stop Flu at School program has been scaled back. It is no longer offered to all schools statewide. Selected schools have been chosen based on students with the greatest need for assistance, which allowed us to maximize the benefit to the public while utilizing the limited funds and resources available.						
	Challenges:	Unstable funding – 2018 Presidential Budget Proposal reduces/removes funding allocations for the Prevention and Public Health Fund (PPHF), which is a significant funding source in the Immunization Grant (approximately 47.7% for FY2017 grant award). Competing priorities with huge outbreaks of vaccine-preventable diseases, such as hepatitis A and mumps, which divert staff resources to concentrate on the outbreak leaving little time to concentrate fully on other immunization activities.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Opportunities:	The Immunization Branch is working with the Maternal and Child Health Branch to expand immunization education to pregnant women enrolled in the Home Visiting Services Unit. A key strategy for this program is to reduce preterm births and promote healthy pregnancies. Providing immunization education to the mother will reinforce the importance of the mother receiving her vaccinations to provide her protection, but to also provide protection through maternal antibodies for her baby against vaccine-preventable diseases. In addition, once the baby is born, the immunization education provided to the mother will hopefully have her vaccinate her baby to ensure protection against vaccine-preventable diseases.						
	Hazards:	Health Risks (Infectious diseases)	◆			◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-12. Office of Environmental Quality Control Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Hawai`i Environmental Policy Act (HEPA)	**Description:**	Requires an environmental review process for state agency actions. This review process includes consideration of sensitive areas (such as floodplains and geologically hazardous areas).						
	Notable Changes:	None identified						
	Challenges:	None identified						
	Opportunities:	None identified						
	Hazards:	Chronic Coastal Flooding, Earthquake, Event-based flood, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.7 Department of Labor and Industrial Relations

The Tables below includes information on hazard mitigation related capabilities for the Department of Labor and Industrial Relations (DLIR). Table A.1-13 includes information for the Office of Community Services (OCS) and Table A.1-14 includes information for the State Fire Council (SFC).

Table A.1-13. Office of Community Services Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Weatherization Assistance Program	**Description:**	The OCS administers the Weatherization Assistance Program (WAP) under a grant from the U.S. Department of Energy (DOE). WAP helps low-income families and individuals reduce their energy bill by installing weatherization measures into their homes and by providing education to the participants and community about energy efficiency.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Low-flow showerheads and faucet aerators are pre-approved on the Hawaii's Weatherization Assistance Program Priority List for Single-Family Homes.						
	Hazards:	Drought	◆		◆	◆		◆ (F)

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part

Table A.1-14. State Fire Council Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
State Fire Council	**Description:**	The State Fire Council (SFC) s an administrative agency attached to the State of Hawaiʻi, Department of Labor and Industrial Relations and recognized, for all intents and purposes, as Hawaii's equivalent of the State Fire Marshal's Office. Comprised of the four county Fire Chiefs and an administrative support staff, the SFC's primary mission is to develop and support a comprehensive fire service emergency management network for the protection of life, property, and the environment for the State. Through a collaborative and unified approach, the SFC promotes the standardization of fire service reporting, training, sharing of technology, resources, and best practices. In accordance with Hawaiʻi Revised Statutes (HRS) §132, the SFC is tasked with the adoption of the State Fire Code and the support and assistance with federal grant programs for the fire service in Hawaiʻi. The SFC may advise and assist the county fire departments where appropriate; prescribe standard procedures and forms related to inspections, investigations, and reporting of fires; and advise the Governor and State Legislature on issues relating to fire prevention and protection, life safety, and other functions or activities of the various county fire departments.						
	Notable Changes:	None identified						
	Challenges:	None identified						
	Opportunities:	The SFC has identified several continuous improvement initiatives including several that are particularly relevant for hazard mitigation:						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		• Develop or adopt a Statewide Interagency Wildfire Mitigation Plan, which may include mutual aid agreements, hazard identification and monitoring systems, training, and public awareness/education programs • Develop or update as needed mutual aid plans and agreements to assist the fire service during statewide technological and/or natural disasters.						
	Hazards:	Wildfire	◆	◆	◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.8 Department of Land and Natural Resources

The Department of Land and Natural Resources is a large department with many mitigation-related capabilities. Table A.1-15 includes information on hazard mitigation related capabilities for the Commission on Water Resource Management (CWRM), Table A.1-16 includes information for the Division of Forestry and Wildlife, Table A.1-17 includes information for the Engineering Division, Table A.1-18 includes information for the Historic Preservation Division (SHPD) , Table A.1-19 includes information on the Land Division, Table A.1-20 includes information on the Office of Conservation and Coastal Lands, and Table A.1-21 includes information on the State Board of Land and Natural Resources.

Table A.1-15. Commission on Water Resources Management Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Commission on Water Resources Management	**Description:**	The CWRM works to preserve and enhance water resources. It provides staffing and technical support for the Hawai'i Drought Council and its various task forces and committees and works with the Board of Water Supply, the counties, and the DOFAW to develop drought and wildland fire response, preparedness, and mitigation plans.						
	Notable Changes:	The Hawai'i Drought Plan was updated in 2017						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Drought, Wildfire	◆	◆	◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-16. Division of Forestry and Wildlife

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *The mission of DLNR’s Division of Forestry and Wildlife is to responsibly manage and protect watersheds, native ecosystems, and cultural resources and provide outdoor recreation and sustainable forest products opportunities, while facilitating partnerships, community involvement and education. Mālama i ka ʻāina.*								
FORESTRY PROGRAM								
Forest Reserve System (FRS)	**Description:**	The Forest Reserve System (FRS) was created by the Territorial Government of Hawai’i through Act 44 on April 25, 1903. It accounts for more than 678,612 acres of state management land. The Division of Forestry and Wildlife (DOFAW) provides recreational and hunting opportunities; aesthetic benefits; watershed restoration; native, threatened, and endangered species habitat protection and management; cultural resources; and fire protection among many other things. Freshwater replenishment is a key component of the FRS.						
	Notable Changes:	Growth in FRS through acquisitions of private lands.						
	Challenges:	Nearly half of Hawaii’s native forests have been lost due to invasive species (DOFAW 2017). Forest loss continues due to conversion to other uses and/or impact by grazing animals.						
	Opportunities:	Carbon sequestration for climate change mitigation. Protection of watersheds						
	Hazards:	Climate Change, Drought, Hurricane, Wildfire	◆		◆			
Hawaiʻi Forest Action Plan	**Description:**	The DLNR-DOFAW is the lead agency in the development of the Hawaiʻi Forest Action Plan. The plan identifies nine priority areas for Hawaii’s forests that include: water quality and quantity; forest health, invasive species, insects and disease; wildfire; urban and community forestry; climate change and sea level rise; conservation of native biodiversity; hunting, nature-based recreation, and tourism; forest products and carbon sequestration; and US tropical island state and territorial issues (DOFAW, 2016).						
	Notable Changes:	The Hawaiʻi Statewide Assessment of Forest Conditions and Trends (2010) was updated and renamed the Hawai’i Forest Action Plan (2016)						
	Challenges:	Data gaps						
	Opportunities:	Plan will be revisited in 2021.						
	Hazards:	Climate Change, Drought, Event-based flood, Hurricane, Landslide/Rockfall, Tsunami, Wildfire	◆		◆			
Conservation Reserve Enhancement Programs (CREP)	**Description:**	The Conservation Reserve Enhancement Program (CREP) is a federal-state natural resources conservation program that addresses state and nationally significant agricultural related environmental concerns. Through CREP, program participants receive financial incentives from U.S. Department of Agriculture (USDA) and the State to voluntarily enroll in the Conservation Reserve Enhancement Program in contracts of 15 years. Participants are asked to convert degraded lands to native trees, shrubs, and grasses. The primary goals of the project are to enhance wildlife habitat and control invasive species, as well as improve water quality and quantity, increase groundwater recharge, improve near shore coral reef health and diversity by filtering agricultural runoff and increasing water condensation in the uplands.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Notable Changes:	The program seeks to enroll 15,000 acres of eligible land in 15-year agreements within the following counties: Hawaiʻi, Maui, Kauaʻi, and City and County of Honolulu. As of January 2017, 1,168 acres of land have been enrolled in the program.						
	Challenges:	Flooding, landslides, climate change						
	Opportunities:	Agricultural diversification, climate mitigation through carbon sequestration						
	Hazards:	Drought, Event-based flood, Wildfire	◆			◆		◆ (F)
Hawai'i Forest Legacy Program	**Description:**	Protects private forestlands from being converted to non-forest uses via a federal grant program. This program provides willing private landowners the opportunity to sell fee simple property, or conservation easement use-rights on their land to the State of Hawaiʻi for the purpose of preserving or restoring uniquely forested areas. The Forest Legacy Program targets forest land as identified in the Assessment of Needs (AON).						
	Notable Changes:	The AON was first established in 1994, amended in 2004 and again in 2017 and is in the final draft form at the time of the hazard mitigation plan update (DOFAW, 2017b).						
	Challenges:	Volunteer program, competing land uses, funding						
	Opportunities:	Preservation of threatened forest land from conversion						
	Hazards:	Climate Change, Wildfire	◆			◆		◆ (F)
Kaulunai Urban & Community Forestry Program	**Description:**	Focuses on improving the health and viability of trees in Hawaiʻi communities through educational programs; financial support in the form of cost-share grants; technical training; Arbor Day promotions and public/private partnerships. Funding comes from the State and Private Forestry Branch of the USDA Forest Service. Since its inception in Hawaiʻi as of 1992, Kaulunani has awarded more than $2.6 million to more than 400 organizations across the state, in the form of cost-share grants that were matched with $7.1 million in cash and in-kind contributions. The program is guided by the Forest Action Plan.						
	Notable Changes:	The Forest Action Plan details all of the notable changes in program strategies (Issue 4 pg 128-155) including discussion on wildland-urban interface, emergency management and response, hazards, climate change.						
	Challenges:	Green Infrastructure and trees are often not considered in preparations for emergency response or during emergency response; significant loss of urban tree cover in the City and County of Honolulu in the past 4 years (approximately 5% loss)						
	Opportunities:	An urban Forestry Emergency operations Planning Guide for Storm Response if Available and could be used to develop emergency response plans/procedures in Hawaiʻi - http://www.smarttreespacific.org/urban-forestry-emergency-operations-planning-guide/ Urban Tree Canopy Assessment was completed in May of 2012 - http://www.smarttreespacific.org/projects/honolulu-urban-tree-canopy-assessment/						
	Hazards:	Climate Change, Drought, High Wind Storms, Tsunami, Wildfire	◆		◆	◆		◆ (F)
Forest Stewardship Program (FSP)	**Description:**	Hawaii's Forest Stewardship Program (FSP), administered by the Department of Land and Natural Resources, Division of Forestry and Wildlife (DLNR-DOFAW), provides technical and financial assistance to owners of nonindustrial private forest land that are interested in conservation, restoration, and/or timber production. Management objectives include fire pre-suppression, watershed, riparian, and/or wetland protection and improvement, windbreaks, among others.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		The Forest Stewardship Program leverages from $80,000 to $200,000 per year in U.S. Forest Service funding support to administer the program. Further, since 1990 State funds for this program have leveraged a total of $6,639,847 in private funds as a direct match spent on sustainable forest management.						
	Notable Changes:	In Fiscal year 2017, the State, through support by the Hawai‘i Association of Conservation Districts, received a contribution agreement award from NRCS to continue the existing Hawai‘i CREP Planner position. The Hawai‘i CREP Planner position was created as a solution to address the need for dedicated positions to alleviate the backlog of potential projects, engage landowners, and increase participation in the program.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Drought, Event-based flood, High Wind Storms, Wildfire	◆			◆		◆ (F)
FIRE PROGRAM								
Fire Management Program	**Description:**	DLNR-DOFAW is statutorily mandated by the Land Fire Protection Law, Chapter 185, Hawai‘i Revised Statutes, to take measures for the prevention, control, and extinguishment of wildfires on lands managed by DOFAW, which accounts for 26% of the land statewide. DOFAW is also required to cooperate for these purposes with county fire departments and federal agencies to an additional 32% which is determined by Mutual Aid Agreements and Memoranda of Agreement or Understanding. DOFAW supports prevention, presuppression, and suppression activities, including mitigation, such as maintaining fire and fuel breaks/access roads, reducing and/or converting hazard fuels through the green breaks, living breaks, managed grazing, and as necessary, prescribed burns. DOFAW is also the State Liaison to the Firewise USA program, which encourages residents to work with neighbors to reduce home ignition potential and increase home survivability leading to the prevention of wildfire disasters. DOFAW staff also participates in: • Wildfire outreach and education events; • CWPP development; and • WUI Grant Program administration • The maintenance of 25 Remote Automated Weather Stations (RAWS) for fire weather reporting						
	Notable Changes:	• Water storage structures including portable catchment tanks, reservoirs and dip tanks have been installed since 2013. • See other sections for notable changes related to community risk reduction.						
	Challenges:	• Limited funds and staff capacity - although Chapter 185, HRS, mandates DLNR-DOFAW to prevent, control, and extinguish wildfires, DOFAW personnel are primarily natural resource managers, foresters, biologists, and technicians and do not focus solely on fire management activities, including mitigation. There is no permanent Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector, interagency mitigation actions. • Six water storage structures are needed for County of Maui.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		• There may be a need to analyze prescribed fire liability laws in other states to determine if it would be appropriate to amend HRS. • Some agencies lack prescribed fire training. • Rainfall and mild temperatures that occur throughout the year contribute to a year-round growing season, thus requiring continual maintenance. • Native ecosystems in Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants. • There has also been an increase in the amount of fallow agricultural land. Abandoned agricultural land is susceptible to invasive, fire prone grasses and shrubs, thereby increasing fire risk to nearby communities and conservation land. • Preventing ignitions through effective public education (nearly all fires in the State of Hawaiʻi are human caused).						
	Opportunities:	• Establish DLNR-DOFAW fire crews at each district to focus solely on fire management activities, including mitigation. • Establish a Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector, interagency mitigation actions. • Federal funding for fuel mitigation is available.						
	Hazards:	Drought, Wildfire	◆		◆	◆		◆
Wildfire Related Public Education and Outreach Events	**Description:**	A number of wildfire-related public outreach events are conducted on a regular basis including: • An all-agency, unified wildfire and drought awareness campaign was launched in 2016. • An annual unified multi-agency Wildfire LOOKOUT! campaign was launched the following year to raise awareness about the threat of wildfire to Hawaii's natural resources and to private and public property. Over two dozen state, county, and federal agencies have committed to this effort to educate and inform residents about the threat of wildfires in Hawaiʻi. • Elected officials, government agencies, NGOs, and the public participate in the National Fire Protection Association's (NFPA) national initiative to better prepare communities for wildfires by holding multiple Wildfire Community Preparedness Day events throughout the State, including a photo contest. • Wildfire risk reduction workshops, trainings, and field tours are offered locally through the National Fire Academy, NFPA, HWMO, PFX, Hawaiʻi Conservation Conference, and Pacific Risk Management ʻOhana Conference for government agencies, large landowners, and the public. • DLNR-DOFAW features wildfire prevention information at Fire Prevention Week events alongside county and federal agencies. • DLNR-DOFAW sponsors Smoky Bear visits and HWMO sponsored Kaleo the Pueo visits at schools.						
	Notable Changes:	• Most of these public education and outreach efforts are offered regularly, but the all-agency, unified wildfire and drought awareness campaign was launched in 2016, and the following year, that campaign turned into the unified						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		multi-agency Wildfire LOOKOUT! campaign. Participation in the Wildfire Community Preparedness Day events started after 2013. Also, most wildfire risk reduction workshops, trainings, and field tours started after 2013. • The vacant DLNR-DOFAW State Information and Education Specialist position was filled during the performance period of the 2013 HMP.						
	Challenges:	Limited funds and staff capacity. • Some DLNR-DOFAW District Offices lack permanent Outreach and Education Specialists for the entire Division. • Over 98% of wildfires in Hawaiʻi are human caused, which means many are preventable. Preventable wildfires cause losses which exceed the cost of prevention education. There is no permanent Wildfire Prevention Specialist at the state level to focus on prevention education. • While under-publicized, the percentage of land area burned per year in Hawaiʻi exceeds the national average, and some years surpasses the western states.						
	Opportunities:	The US Forest Service can provide technical assistance in creating a statewide wildfire prevention plan. [d]						
	Hazards:	Drought, Wildfire	◆		◆			
Community Wildfire Protection Plans (CWPPs)	**Description:**	CWPPs help communities address wildfire response, hazard mitigation, and community preparedness as well as identify hazard reduction priorities. Newly established CWPPs have made additional lands eligible for funds available through the Wildland Urban Interface (WUI) Grant Program. There are 13 CWPPs established throughout the State of Hawaiʻi, which cover over half of the State. Each county has at least one CWPP.						
	Notable Changes:	One new plan (Western Maui) was completed in 2015 (1 in County of Maui), 6 new plans (Kauaʻi, Western Oʻahu, Molokaʻi, South Maui, Upcountry Maui, and North Kona) were completed in 2016 (1 covering County of Kauaʻi, 1 in the City and County of Honolulu, 3 in County of Maui, and 1 in Hawaiʻi County), 5 plans (Northwest Hawaiʻi Island, South Kona, Ocean View, Kau, and Volcano) were updated in 2016 (5 in Hawaiʻi County), and 1 plan (Kahikinui) was slated to be updated during 2017/2018 (1 in County of Maui).						
	Challenges:	There is no permanent funding to develop CWPPs. HWMO has updated plans and created new plans with WUI grant funding.						
	Opportunities:	By establishing CWPPs to cover additional lands, those lands will be eligible for funds available through the WUI Grant Program.						
	Hazards:	Drought, Wildfire	◆		◆			
Firewise USA™	**Description:**	Firewise USA™ 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.						
	Notable Changes:	There are 11 Firewise USA recognized sites in Hawaiʻi County and County of Maui. The State's first community was recognized by Firewise in 2004, and 10 more communities have gained recognition since 2013 thereby increasing risk reduction investments by $554,402.09 in the home ignition zone.						
	Challenges:	There is no permanent funding to promote this program and establish new Firewise USA recognized sites. HWMO has increased the number of Firewise USA recognized communities with WUI grant funding. There is no permanent Wildfire						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector, interagency mitigation actions.						
	Opportunities:	The City and County of Honolulu and Kauaʻi County both have multiple prospects for recognition as Firewise USA sites. These communities are projected to be recognized in 2018 at the earliest, which would establish recognized Firewise USA sites in all counties. Additional prospects have been identified for County of Maui and Hawaiʻi County.						
	Hazards:	Wildfire	◆		◆			
Wildland Urban Interface (WUI) Grant Program [d]	**Description:**	U.S. Forest Service funds to mitigate risk from wildland fire within the WUI are available and awarded annually through a competitive process with emphasis on (1) hazardous fuel reduction in the WUI; (2) information and education; and (3) planning. In Hawaiʻi, funding is delivered through DOFAW to communities, organizations, and agencies to implement WUI risk reduction projects.						
	Notable Changes:	WUI funds were allocated for: • FY14 to HWMO for $114,000 to create five new and one updated CWPPs in addition to six related community-led hazard reduction projects based on CWPP priorities; • FY15 to: o HWMO for $300,000 to establish recognition for 10 new Firewise USA communities with 10 related community-led hazard reduction projects, provide 24 Ready, Set, Go! workshops/events, and implement West Maui and Leeward Haleakala fuels reduction projects; and o County of Maui Department of Fire and Public Safety for $22,137.50 to implement a firebreak in West Maui. • FY17 to: o HWMO for $300,000 to provide six public service announcements, hold a two-day fire workshop, provide 16 Ready, Set, Go! workshops/events, establish recognition for four new Firewise USA communities, purchase and install 10 phenocams, and implement fuel breaks in West Hawaiʻi and West Maui; o DOFAW Kauaʻi Branch for $155,100 to implement a Kokee fuel reduction project and to hold two Ready, Set, Go! workshops conducted by HWMO; and o Heleakala Ranch for $82,600 to install firebreaks in Maui.						
	Challenges:	• Applications must be covered by a CWPP. • There is no permanent Wildfire Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to promote, write, review, and manages these grants. • State funds must be available to match these grants. • Hawaiʻi competes against the western states for these funds.						
	Opportunities:	Multi-sectors are eligible for this grant program.						
	Hazards:	Wildfire	◆		◆	◆		◆ (F)
	Description:	Remote automated weather stations (RAWS) ensure that microclimate data is captured to help rate fire danger and monitor fuels. They also provide DOFAW with up to date data that can be used to close areas in event of hazardous						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Remote Automated Weather Stations (RAWS)		weather conditions. RAWS are maintained on an ongoing basis. There are 66 RAWS statewide maintained by federal and state agencies, including 25 operated by DOFAW, 16 operated by the Department of Defense, 16 operated by the National Park Service, 6 operated by US Fish and Wildlife Service, 1 operated by Bureau of Land Management, and 2 operated by unidentified agencies.						
	Notable Changes:	None identified.						
	Challenges:	Some RAWS are located in remote area, which may make maintenance challenging.						
	Opportunities:	Six RAWS are needed for County of Maui; further data analysis						
	Hazards:	Drought, Hurricane, Wildfire	◆		◆			
NATIVE ECOSYSTEMS AND MANAGEMENT								
Legacy Lands Conservation Program	**Description:**	The State of Hawaiʻi dedicates a portion of its annual revenue from real estate conveyance taxes to the Land Conservation Fund. Each year the State Legislature provides the Legacy Land Conservation Program with some of the money held in the Fund. The Legacy Land Conservation Program distributes this money through a competitive grants process–for purchasing land and conservation easements and for paying the debt service on state financial instruments (such as bonds)–for the protection of land that shelters exceptional, unique, threatened, and endangered resources.						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	This program can prevent development in hazard-prone areas.						
	Hazards:	Climate Change, Drought, Event-based flood, Hurricane, Wildfire	◆		◆			◆
Watershed Partnership Program	**Description:**	The Watershed Partnerships Program provides technical and financial support for the implementation of watershed management plans. The Watershed Partnerships Program is funded by the Natural Area Reserve Special Fund, established by HRS §195-9. These funds come from a portion of the conveyance tax, which is levied each time real estate property is bought or sold. The mission of the program is to "increase the effective management and protection of mauka watershed areas by raising the capacity of watershed partnerships, facilitating sharing of watershed management expertise, building public support for protecting watershed values, and developing sustainable funding sources." Watershed protection measures relevant to mitigation goals include recharging water supplies, controlling erosion and runoff, mitigating flooding, and mitigating the impacts of climate change (DOFAW, no date).						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawaiʻi has the						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	By protecting forests, additional moisture is captured, preventing drought. Forest also absorb carbon, reducing climate change. Forests hold the soil, reducing erosion and flooding. The Governor's Hawaiʻi Sustainable Initiative aims to protect 30% of priority watersheds by 2030.						
	Hazards:	Climate Change, Drought, Event-based flood, Hurricanes, Wildfires	◆		◆			◆
Natural Area Partnership Program	**Description:**	The Natural Area Partnership Program (NAPP) was established in 1991 by the state Legislature and the Governor authorizing the Department of Land & Natural Resources (DLNR) to "provide state funds for the management of private lands that are dedicated to conservation." Lands and waters that might qualify include areas with intact native Hawaiian ecosystems, essential habitat for endangered species, and areas within the protective (P) subzone of the Conservation District.						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	By protecting forests, additional moisture is captured, preventing drought. Forest also absorb carbon, reducing climate change. Forests hold the soil, reducing erosion and flooding. This is a program that helps private landowners mitigate hazards.						
	Hazards:	Climate Change, Drought, Event-based flood, Hurricane, Wildfire	◆		◆	◆		◆
Natural Area Reserves System (NARS)	**Description:**	The statewide NARS was established to preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaiʻi. The system presently consists of 21 reserves on five islands, encompassing 123,810 acres of the State's most unique ecosystems. The Strategic Plan for Hawaii's Natural Area Reserves System (2008) includes objectives and sub-objectives that support mitigation goals, such as "employ appropriate fire management strategies" (DOFAW NARS Program, 2008).						
	Notable Changes:	None identified.						
	Challenges:	Natural resources can be damaged by hazards, such as wildfires. Native ecosystems in Hawaiʻi evolved with little or no fire. Wildfire is a threat to native forests, including watersheds and threatened and endangered species. Hawaiʻi has the highest number of species listed as threatened and endangered in the U.S. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.						
	Opportunities:	By protecting forests, additional moisture is captured, preventing drought. Forest also absorb carbon, reducing climate change. Forests hold the soil, reducing erosion and flooding.						
	Hazards:	Climate Change, Drought, Event-based flood, Hurricane, Wildfire	◆		◆			◆

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part
c. HWMO provides Ready Set Go!, preparedness, or hazard reduction workshops (6-12 workshops per island per year each on Oʻahu and Kauaʻi, 12-15 in County of Maui, and 20+ across Hawaiʻi Island. Total: 44-59 workshops a year on average the last couple of years).
d. Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.

Table A.1-17. Engineering Division Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
DAM SAFETY PROGRAM								
Description: *The objectives of the dam safety program include encouraging high safety standards and regulations in the practices and procedures for dam site investigation, design, construction, operation and maintenance and emergency preparedness; maintaining updated and accurate inventory of dams, physical conditions, and potential hazard classifications; promoting a continuous, dynamic process where guidelines, practices, and procedures are examined periodically and updated; cooperating with all public and private agencies involved in dam safety activities including owner training and dissemination of information to the public, and emergency preparedness.*								
Emergency Action Plans (EAP)	**Description:**	HRS 179D-30 requires the owners of State-regulated high and significant hazard potential dams and reservoirs to establish an EAP to assist the local community in effectively responding to a dam safety emergency. Owners are required to have established protocols for flood warning. The Dam Safety program works with owners to develop or update their EAPs. The program's website includes an EZ-EAP instructional video, EAP development guidelines, EAP template, and internet quick links (DLNR Engineering, 2017).						
	Notable Changes:	None identified.						
	Challenges:	There are federal, state, county, and privately-owned dams in Hawaiʻi.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Opportunities:	None identified.						
	Hazards:	Dam Failure	◆		◆	◆		
Dam Safety Permits	**Description:**	The DLNR Engineering Division administers the State Dam and Reservoir Program as authorized under HRS Chapter 179D and HAR Title 13, Sub-Title 7, Chapter 190.1. A permit must be obtained from the program for the construction, enlargement, repair, alteration or removal of dams (DLNR Engineering, 2016).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Dam Failure	◆		◆	◆		
Certificate of Approval to Impound (CAI)	**Description:**	Requirements for obtaining a CAI for the impoundment of water at a dam or reservoir in the State of Hawaiʻi are outlined in HAR, Title 13, Sub-Title 7, Chapter 190.1. Completed applications are submitted to the Dam Safety Program (DLNR Engineering, 2013).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Dam Failure	◆		◆	◆		
Training Events and Materials	**Description:**	The Dam Safety program offers training events and materials including overview workshops and technical seminars on dam evaluation and rehabilitation, and operation and maintenance training.						
	Notable Changes:	Training topics are decided internally and are generally provided on a rotating basis. Three one-day overview workshops and one two-day technical seminar on dam evaluation and rehabilitation training were offered in March and April 2017; EAP training was offered in 2015; Dam safety Inspection training was offered in 2014 and operation and maintenance training was offered in 2012. A dam safety grant is used to hire contractor to do a training for selected topics. Maui and Kauaʻi have most dams and dam owners						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Opportunities:	Incorporate information from the hazard mitigation planning risk assessment into future trainings.						
	Hazards:	Dam Failure	◆		◆			
Dam Inundation and Evacuation Maps	**Description:**	DLNR in partnership with the US Army Corps and the PDC engaged in the development of dam failure inundation maps and individual assessment reports for 140 dams within the State of Hawai'i. These inundation maps and reports were then released for the development of dam evacuation plans by the counties.						
	Notable Changes:	According to the 2013 HMP, eight evacuation maps had not yet been completed. These were completed over the performance period of the 2018 plan and information on evacuation is available on the Flood Hazard Awareness Tool (FHAT).						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Dam Failure	◆		◆	◆		
NATIONAL FLOOD INSURANCE PROGRAM (NFIP)								
Description: *DLNR has been designated as the State Coordinating Agency responsible for assisting the coordination of the NFIP between the Federal and County agencies in Hawai'i*								
Flood Hazard Assessment Tool (FHAT)	**Description:**	The FHAT is an online map viewer where residents can view effective digital flood insurance rate map (DFIRM) information, historic FIRM and DFIRM information, obtain information on letter of map changes, and auto generate from fields for a FEMA elevation certificate. In addition, a report can be printed that provides parcel-specific flood hazard information as well as tsunami and dam evacuation zone information.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The FHAT could be expanded to include information on other hazards.						
	Hazards:	Dam failure, Event-based flood, Tsunami	◆		◆			
Wai Halana	**Description:**	Wai Halana is a Hawai'i Flood newsletter published several times a year by the DLNR Engineering division. It is available on the department's website and emailed to a listserv. The newsletter contains information on flood and flood related hazards including topics such as flood insurance, emergency warning information, and tips on hurricane season.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Challenges:	None identified.						
	Opportunities:	Wai Halana could be used as a component in a state-wide Community Rating System program for public information. Public outreach could be conducted to expand the number of recipients.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Event-based flood, Hurricane	◆		◆			
Maintenance of channels, streambeds, streambanks, and drainageways	**Description:**	HRS § 46-11.5 stipulates that it is “the responsibility of the county to maintain all channels, streambeds, streambanks, and drainageways unless such channels, streambeds, streambanks, and drainageways are privately owned or owned by the State, in which event such channels, streambeds, streambanks, and drainageways shall be maintained by their respective owners.” County responsibility accounts for the vast majority of this maintenance and counties also bear responsibility for enforcement. If maintenance is needed on State owned land, the appropriate department is identified and the maintenance is conducted.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Event-based flood	◆	◆	◆	◆		
Flood control and flood water conservation statutes	**Description:**	HRS § 179 sets forth flood control and flood water conservation statutes, the purpose of which is to “provide for the coordination by the State of all federal and state flood control projects undertaken in Hawaiʻi and for such technical or financial assistance to its political subdivisions as may be desirable or necessary to assure maximum benefits to the people of the State from the expenditure of state funds for flood control purposes.” These statutes designate the BLNR as the implementation authority for flood control and water conservation.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Drought, Event-based flood	◆			◆		

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Community Assistance Program – State Support Services Element (CAP-SSSE) [c]	**Description:**	This program provides funding to states to provide technical assistance to communities in the National Flood Insurance Program (NFIP) and to evaluate community performance in implementing NFIP floodplain management activities. DLNR participates in this program and conducts an array of activities to support the mission of the program including: • Conduct Community Compliance Audits (a.k.a. CAVs) • Conduct Training Workshops and Public Outreach • Attend National and Regional NFIP related conferences • Publish a quarterly newsletter (Wai Halana) • Provide Technical Assistance to community officials and the public • Conduct V zone properties audits • Maintain an Internet Website dedicated to NFIP awareness Monitoring compliance with NFIP is accomplished, in part, by requiring FEMA Elevation Certificates (pre- and post-construction submittals), which help assures buildings within SFHA are constructed in compliance with laws; reviewing applications for subdivisions and related construction plans, building permits and grading/grubbing permits for compliance; responding to complaints, and taking appropriate actions to correct noncompliance. This includes reviewing, approving, preparing, and submitting to FEMA and maintaining a Letter of Map Changes, which are used to update FEMA's FIRMs.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Dam Failure, Event-based flood, Hurricane, Tsunami	◆		◆	◆		◆ (F)
State General Flood Control Plan (SGFCP)	**Description:**	The SGFCP was developed in 1983 to coordinate floodplain management initiatives. The goal of the State General Flood Control Plan (SGFCP) is to assist the State in decision-making regarding flood hazards and prioritize areas to best focus limited resources. The last Statewide inventory of flood history and flood studies was performed in 1994. HRS 179 outlines the purpose, mandates and mission of the SGFCP.						
	Notable Changes:	The State General Flood Control Plan is currently being updated and will utilize digital database and website technologies to provide educational information and public awareness tools on flood risks, flood histories, hydrologic data, mitigation initiatives, a library for flood studies and post-flood reports, and other related information. In addition, through the update DLNR is interested in identifying building footprints within floodplains throughout the entire State.						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Post-Disaster	Effect on Loss Reduction: Support	Facilitate	Conflict	Provides Funding for Mitigation
	Opportunities:	The SGFCP update will also implement geospatial and internet technologies that will allow partner agencies to share, communicate, and utilize collected information.						
	Hazards:	Event-based flood	◆		◆	◆		
RISK MAP								
Risk Mapping, Assessment, and Planning Program (Risk MAP)	**Description:**	FEMA is working with federal, state, tribal and local partners across the nation to identify flood risk and promote informed planning and development practices to help reduce that risk through the Risk MAP program. Risk MAP provides high quality flood maps and information, tools to better assess the risk from flooding and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk. Each Risk MAP flood risk project is tailored to the needs of each community and may involve different products and services.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Event-based flood, Hurricane, Tsunami	◆		◆	◆		◆ (F)
SILVER JACKETS								
Description: *Silver Jackets teams in states across the country bring together multiple state, federal, and sometimes tribal and local agencies to learn from one another and apply their knowledge to reduce the risk of flooding and other natural disasters in the United States and enhance response and recovery efforts when such events do occur (Silver Jackets, 2018). Silver Jackets are supported by the USACE Flood Risk Management Program.*								
Silver Jackets Interagency Projects	**Description:**	A competitive process through the Silver Jackets program where multiple Federal agencies are involved in contributing towards a shared outcome. No specific cost-share or funding limit, although there is an expectation that the non-Federal sponsor will contribute either cash or work in-kind. Submittal deadlines are typically in the spring, around February-March.						
	Notable Changes:	This is a new capability. State of Hawaiʻi Silver Jackets Program Coordination Meetings began in November 2017. The Hawaiʻi State DLNR will be leading meeting efforts.						
	Challenges:	None identified.						
	Opportunities:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Event-based flood, Hurricane, Tsunami	◆	◆	◆	◆		◆ (F)

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part
c. Identified by a stakeholder group as presenting an opportunity to improve effectiveness at meeting hazard mitigation goals.

Table A.1-18. Historic Preservation Division Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Description: *The Historic Preservation Division works to preserve and sustain reminders of earlier times which link the past to the present. SHPD's three branches, History and Culture, Archaeology, and Architecture, strive to accomplish this goal through many different activities.*								
Historic Preservation	**Description:**	The division's work includes maintaining the Hawaiʻi Register of Historic Places and coordinating nomination procedures for the National Register of Historic Places. The division's statewide Inventory of Historic Properties contains information on more than 38,000 historic sites in Hawai`i. The National Register contains more than 350 places in Hawaiʻi.						
	Notable Changes:	None identified.						
	Challenges:	Historic preservation objectives can conflict with mitigation goals as a historic designation may exempt structures from certain building requirements, such as local flood damage prevention ordinance requirements. In recent years there have been efforts to preserve the historic integrity of structures, while also incorporating mitigation strategies such as elevating or floodproofing structures in floodplains and conducting seismic retrofits.						
	Opportunities:	Federal tax incentives are available for mitigation of historic places in some instances.						
	Hazards:	N/A	◆				◆	

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part

Table A.1-19. Land Division Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Description: *The Land Division is responsible for the management of State-owned lands in ways that will promote the well-being of Hawaii's people and insure that these lands are used in accordance with the goals, policies and plans of the State. Lands that are not set aside for use by other government agencies come within the direct purview of the division.*								
Shoreline Certification	**Description:**	Applications for shoreline certification are submitted to the land division. Shoreline is defined as "the upper reaches of the wash of the waves, other than storm or seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves" in HAR §13-10. The certified shoreline establishes jurisdictional authority between the state and the county governments and establishes the line from which shoreline setbacks are established.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Dynamic shoreline certification may provide a mechanism through which to address some of the impacts of sea level rise.						
	Hazards:	Chronic Coastal Flooding, Climate Change	◆	◆	◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part

Table A.1-20. Office of Conservation and Coastal Lands Capabilities

Capability	Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
COASTAL LANDS PROGRAM						
Description: *OCCL is responsible for management of coastal resources including beaches, dunes, and rocky shorelines seaward of county jurisdictions and/or within the State Conservation District. The Program supports the complementary long-term goals of conserving coastal resources and mitigating risks from natural and human-induced hazards*						

Capability			Type of Hazard Management Capability: Pre-Disaster	Post-Disaster	Effect on Loss Reduction: Support	Facilitate	Conflict	Provides Funding for Mitigation
for coastal communities. The Program develops and implements innovative shoreline management techniques, including alternatives for coastal erosion management through a long-standing cooperative relationship with the University of Hawai‘i (UH) Sea Grant College Program.								
Coastal Erosion Management Program	**Description:**	The Coastal Lands Program supports sustainable alternatives for coastal erosion management including programs for beach and dune restoration and guidelines for other "soft" approaches to shoreline protection through the DLNR Coastal Erosion Management Plan (COEMAP), which identifies 7 broad goals, 20 recommendations and 21 implementing actions for improving the erosion management system in Hawai‘i. The Program works closely with coastal communities, resource management and regulatory agencies, and university researchers to improve management of coastal areas through science-based decision making. The Program also conducts public education, and outreach and distributes information and guidelines on best management practices, erosion control and construction practices for Hawai‘i ’s coastal areas in partnership with UH Sea Grant and other organizations.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding	◆			◆		
Small Scale Beach Nourishment (SSBN) Program	**Description:**	The SSBN program is intended to provide a viable alternative to shoreline hardening through development and enhancement of beach restoration programs – encouraging landowners to consider beach restoration over hard shoreline armoring. The SSBN program provides a streamlined application process for beach restoration projects within the DLNR under a programmatic Conservation District Use Permit and Environmental Assessment. SSBN authorizations allow placement of compatible beach sand within the State Conservation District and may be submitted under one of two Categories: SSBN Category I – (up to 500 cubic yards of sand), or SSBN Category II – (up to 10,000 cubic yards).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	OCCL is developing an updated statewide programmatic environmental assessment for SSBN and exploring the possibility of an agreement with the U.S. Army Corps of Engineers, Department of Health, and Coastal Zone Management Program to re-establish a streamlined inter-agency programmatic permitting process for SSBN projects. This is anticipated to take place over the next couple years.						
	Hazards	Chronic Coastal Flooding, Hurricane	◆	◆	◆	◆		

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
CLIMATE 21C								
Description: *The Hawai'i Climate Adaptation Initiative Act of 2014 (Act 83; House Bill 1714) is designed to address the effects of climate change through 2050 to protect the State's economy, health, environment, and way of life. The initial focus of the Initiative will be on the effects of sea level rise on the islands.*								
Hawai'i Climate Adaptation Portal	**Description:**	A website that includes a vast wealth of information on climate change and how it is impacting Hawai'i and other coastal states and locations around the world as well as all things related to the Hawai'i Climate Change Mitigation & Adaptation Commission. The website includes links to the Hawai'i Sea Level Rise Vulnerability and Adaptation Report, Hawai'i Sea Level Rise Viewer, and announcements and archives of meetings for the State Interagency Climate Mitigation and Adaption Commission.						
	Notable Changes:	This is a new capability. The website was established in 2015.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Climate Change	◆		◆			
Hawai'i Climate Change Mitigation & Adaptation Commission (Climate Commission)	**Description:**	It is anticipated that the Climate Commission will provide direction, facilitation, coordination and planning among state and county agencies, federal agencies, and other partners about climate change mitigation (reduction of greenhouse gases) and climate change resiliency strategies, including but not limited to, sea level rise adaptation, water and agricultural security, and natural resource conservation.						
	Notable Changes:	This is a new capability. The Climate Commission was established under HRS § 225P in 2014. In 2017 the name of the Commission was changed from the Interagency Climate Adaptation Commission to the current name of Hawai'i Climate Change Mitigation & Adaptation Commission.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Climate Change	◆		◆			
Hawai'i Sea Level Rise Vulnerability and Adaptation Report	**Description:**	The Sea Level Rise Vulnerability and Adaptation Report (SLR Report) provides the first state-wide assessment of Hawai'i 's vulnerability to sea level rise and recommendations to reduce exposure and sensitivity to sea level rise and increase the capacity to adapt.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Notable Changes:	This is a new capability. The SLR Report was adopted by the Climate Commission in December 2017 (Hawaiʻi Climate Change Mitigation and Adaptation Commission, 2017).						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change	◆		◆	◆		
Hawaiʻi Sea Level Rise Viewer	**Description:**	The Hawaiʻi Sea Level Rise Viewer was developed by through a partnership between UH Sea Grant, PacIOOS, and DLNR. The Hawaiʻi Sea Level Rise Viewer is intended to provide an online atlas to support the Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report. The Viewer provides map data depicting projections for future hazard exposure and assessing economic and other vulnerabilities due to rising sea levels.						
	Notable Changes:	Made publicly available in December 2017 with the Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, dam Failure	◆		◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part

Table A.1-21. State Board of Land and Natural Resources Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Shoreline Determination Rules	**Description:**	The BLNR is authorized by HRS §205A to adopt rules for determining the shoreline and appeals of shoreline determination and to enforce the established rules.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
and Enforcement Rules	**Challenges:**	None identified.						
	Opportunities:	Shoreline certification rules and procedures may present an opportunity to address some aspects of sea level rise.						
	Hazards:	Chronic Coastal Flooding, Climate Change	◆	◆		◆		
Conservation District	**Description:**	The Board of Land and Natural Resources has adopted and administered land use regulations for the Conservation District pursuant to the State Land Use Law (Act 187) of 1961. The Conservation District has five subzones: Protective, Limited, Resource, General and Special. The first four subzones are arranged in a hierarchy of environmental sensitivity, ranging from the most environmentally sensitive (Protective) to least sensitive (General). The Special subzones defines a unique land use on a specific site. The use of Conservation District lands is regulated by Title 13 Chapter 5 of the HARs and Chapter 183C of the HRS.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Drought, Event-based flood	◆		◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part

A.1.9 Department of Transportation

Table A.1-22 includes information on hazard mitigation related capabilities for the Department of Transportation (DOT). Table A.1-23 includes information on hazard mitigation related capabilities for the O‘ahu Metropolitan Planning Organization (OahuMPO).

Table A.1-22. Department of Transportation Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Hawai‘i Department of Transportation (HDOT) is responsible to plan, design, construct, operate, and maintain State facilities in all modes of transportation, including air, water, and land. Coordination with other State, County, and Federal programs is maintained to achieve these objectives.*								
Roadside Fuel Reduction Program	**Description:**	HDOT has a program to reduce or convert fuel load along roadsides and community open areas.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Wildfire	◆		◆	◆		
Hazardous Materials Risk Management Program	**Description:**	Information on unintentional releases of hazardous materials and the consequences are collected and analyzed.						
	Notable Changes:	None identified.						
	Challenges:	Identifying low probability, high consequence events (which may not be apparent from incident data) and providing appropriate levels of protection are among the more demanding aspects of this risk management program. A further challenge is to strike a proper balance between levels of safety and costs that result from regulations, special permits, and approvals.						
	Opportunities:	None identified.						
	Hazards:	Hazardous Materials	◆		◆			
Bridge Inspection Program	**Description:**	The bridge inspection program creates reports on the conditions of all HDOT bridges every two years.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Dam failure, earthquake, event-based flood, landslide/rockfall, tsunami	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-23. O‘ahu Metropolitan Planning Organization Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *OahuMPO is responsible for coordinating transportation planning on O‘ahu. Although OahuMPO serves as the metropolitan planning organization for the two urbanized areas on O‘ahu (Honolulu and Kailua-Kaneohe), OahuMPO coordinates transportation planning for the entire island.*								
Transportation Asset Climate Change Risk Assessment Project	**Description:**	OahuMPO was selected by the Federal Highway Administration (FHWA) as one of five pilots nationwide to perform and evaluate a risk assessment of climate change on important transportation assets. Inventory assets were integrated with climate information and vulnerability was determined in two dimensions: the impact to the asset itself and, importantly, the socioeconomic consequences of that impact (SSFM, 2011). While the report focuses on only several essential components of the Island of O‘ahu’s transportation infrastructure, the workshops, field work, and assessment looked at a far broader range of both transportation assets as well as climate change factors. Those assets selected for the report were deemed by those senior engineers, senior planners, and climate change experts, involved in the study to be the most at risk in 2011.						
	Notable Changes:	Climate change science has advanced since the assessment. Near-term risks to assets should now be assumed to be understated by the project. The study focused primarily on shoreline transportation assets and later advancements make it clear that the effects of climate change in the Hawaiian Islands are not limited to the shoreline.						
	Challenges:	Climate change science has advanced since the assessment and near-term risks to assets may now be understated by the project.						
	Opportunities:	Updated sea level rise information is available to reevaluate and plan for near and long-term risks not only to those assets identified in the study, but a broader range of effects that will result from temperature and rainfall (rockfall hazards), the need to address not only harbor infrastructure (Honolulu Harbor gantries) but also wastewater systems, oil refinery, and visitor industry assets, all of which are currently at shoreline.						
	Hazards:	Climate change and other factors	◆		◆			

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.1.10 Hawaiʻi Emergency Management Agency

Table A.1-24 includes information on hazard mitigation related capabilities for the Hawaiʻi Emergency Management Agency (HI-EMA).

Table A.1-24. Hawaiʻi Emergency Management Agency Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The Hawaiʻi Emergency Management Agency (HI-EMA) is the emergency management agency for the State of Hawaiʻi. HI-EMA serves as the coordinating agency between the four county emergency management agencies (County of Hawaiʻi Civil Defense, County of Maui Emergency Management Agency, City and County of Honolulu Department of Emergency Management, and Kauaʻi Emergency Management Agency) and as State Warning Point. The five core capabilities that guide HI-EMA are Prevention, Protection, Mitigation, Response, and Recovery. The branches in the HI-EMA organization address these capabilities: Preparedness, Operations, Telecommunications, Logistics, and Finance/Administration.*								
Hawaiʻi Earthquake & Tsunami Advisory Committee (HETAC)[b]	**Description:**	HETAC is a volunteer peer group of scientists who has served as an advisory body to HI-EMA for over 25 years (est. September 1990). HETAC meets quarterly to promote activities such as research, project development and management, and mitigation (HI-EMA, 2014). HETAC also supports the Pacific Tsunami Museum in their public outreach efforts.						
	Notable Changes:	No significant changes over reporting period						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Earthquake, Tsunami	◆		◆			◆ (F)
Western States Seismic Policy Council (WSSPC)	**Description:**	Hawaiʻi is a member of the WSSPC, which develops seismic policies and shares information to promote programs intended to reduce earthquake related losses. WSSPC also hosts a Tsunami Center.						
	Notable Changes:	WSSPC continues to support several mitigation initiatives in Hawaiʻi including HHARP, printing 3,000 copies of the Natural Hazards Preparedness Wheel, and general outreach initiatives.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Earthquake, Tsunami	◆		◆	◆		◆

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Hawaiʻi Advisory Council on Emergency Management (HACEM)	**Description:**	Hawaiʻi Revised Statutes §127A-4 authorizes HACEM. Originally established in 1951, the Advisory Council was known as the Civil Defense Advisory Council until July 1, 2014 when HRS 127A became effective. The council consists of seven members nominated by the Governor and serves as a resource to the Governor and the Director of the Emergency Management Agency.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆	◆		
Get Ready Website	**Description:**	This website is a key outreach tool that provides links and information to county-specific Get Ready Hawaiʻi websites; information on preparing for hurricane, tsunami, flash flood, earthquake, and wildfire; and tips for preparing your family, home, and business.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	Expand website to provide information on all hazards addressed by the hazard mitigation plan.						
	Hazards:	Earthquake, Event-based flood, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆			◆		
Hawaiʻi Hazards Awareness and Resilience Program (HHARP)[b]	**Description:**	The aim of 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.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Notable Changes:	This was established in 2014. As of December 2017, six communities have reached recognition level in the program and another six communities are on the verge of program recognition. This program won the *2016 National Award in Excellence for Educational Outreach to the General Public* from WSSPC.						
	Challenges:	None identified.						
	Opportunities:	Engage more communities to participate in and complete the program.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆			◆		
State of Hawaiʻi Emergency Operations Plan (HI-EOP)	**Description:**	The HI-EOP establishes the shared framework for the state's response to, and initial recovery from emergencies and disasters. It outlines the state's hazard vulnerabilities and planning assumptions, and establishes the authorities, responsibilities, operational priorities and general strategies for state emergency operations that apply regardless of the specific type of emergency or disaster.						
	Notable Changes:	The HI-EOP base plan was last updated in May 2017 (HI-EMA, 2017c). HI-EMA currently is updating the Emergency Support Function (ESF) Annexes						
	Challenges:	None identified.						
	Opportunities:	The hazard mitigation plan is considered the hazard assessment section of the HI-EOP. The information on Hawaii's hazard profile can be updated once the 2018 HMP Update is completed.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆			

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Hawaiʻi Catastrophic Hurricane Plan	**Description:**	The 2015 Hawaiʻi Catastrophic Hurricane Plan/FEMA Region IX Hawaiʻi outlines scalable and coordinated strategies to execute a joint state and federal response to catastrophic damage before, during, and following a catastrophic hurricane event (HI-EMA and FEMA Region IX, 2015).						
	Notable Changes:	This is a new capability. The plan was developed in 2015.						
	Challenges:	None identified.						
	Opportunities:	The Cat Plan provides the basis for the development of other operational plans (e.g. Critical Systems Vulnerability Assessment) that highlight mitigation opportunities.						
	Hazards:	Hurricane	◆		◆			
Training & Exercise Plan (TEP)	**Description:**	The TEP is updated annually. It is the product of the Training and Exercise Planning Workshop (TEPW), which is hosted by HI-EMA and attended by stakeholders from all levels of government, the non-profit and private sectors. The TEP is informed by the input provided by this diverse group of agencies and is the roadmap for Hawaiʻi to accomplish the training, exercise and planning priorities described within this document.						
	Notable Changes:	This is capability aligns with the Emergency Management Performance Grant and Homeland Security Grant Program guidance. The following have been identified as the state's program priorities for the 2016 to 2018 training cycle: mass care; planning and operations; logistics; cybersecurity; physical protective measures; and risk assessment.						
	Challenges:	None identified.						
	Opportunities:	The annual hurricane (Makani Pahili) exercise hot-wash provide an opportunity to discuss mitigation opportunities of identified vulnerabilities						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆			
Department Emergency	**Description:**	Each state department is required to have a Department Emergency Operations Plan that is consistent with the state plan. A template is provided by HI-EMA.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Operations Plan Template	**Challenges:**	Significant out-reach required for Departments that do not regularly participate in emergency exercises and events.						
	Opportunities:	Out-reach provides opportunity to discuss mitigation actions						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆			
Department Operations Center (DOC) Planning Guidance and Resources	**Description:**	Every state department should have a DOC, which is the location where their key personnel will gather in an emergency to coordinate support requested by the State Emergency Operations Center, and to address impacts to critical agency functions. This document provides guidance on supplies and back-up communications assets a DOC should be equipped with and contains templates that can be used to organize operations when the DOC is activated.						
	Notable Changes:	This is an operations/response plan.						
	Challenges:	None identified.						
	Opportunities:	Post-event Hot-wash provides an opportunity to discuss mitigation opportunities of identified vulnerabilities.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆	◆		
Hawai‘i Weather Impacts Advisory Committee	**Description:**	N/A						
	Notable Changes:	This committee is no longer active. Some duties have been absorbed by HETAC.						
	Challenges:	N/A						
	Opportunities:	N/A						
	Hazards:	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
State Mitigation Forum (Forum)	**Description:**	The Hawaiʻi State Hazard Mitigation Forum was formerly established in 1998. The forum serves in an advisory capacity relative to the incorporation of hazard mitigation in policy in Hawaiʻi. Forum members (17 in total) come from a broad spectrum of State and County agencies, and the private sector. The Forum also includes ex officio representatives from all four County Emergency Management Agencies, and FEMA. Two of the most important Forum duties are to assist in the development of the State Hazard Mitigation Plan, and to make mitigation project recommendations to the Emergency Management Agency Director. Two committees of the forum have been established: education and emergency shelter criteria. The Form bylaws can be found in Appendix X (State Hazard Mitigation Forum Bylaws).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆	◆		
Critical Systems Vulnerability Assessment	**Description:**	The Critical Systems Vulnerability Assessment is a holistic systems evaluation (rather than component by component) of the implications of a large natural disaster on key systems (e.g. ports, food & water, power). The gap analysis leads to a 9-step resiliency strategy, that lead to response, recovery and mitigation actions strengthen those systems and reduce response/recovery times						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Earthquake, Hurricane, Tsunami	◆		◆	◆		
Natural Disaster Economic Recovery Strategy	**Description:**	This Hawaiʻi 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 Hawaii'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						

Capability			Type of Hazard Management Capability: Pre-Disaster	Post-Disaster	Effect on Loss Reduction: Support	Facilitate	Conflict	Provides Funding for Mitigation
		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 (Office of Planning, 2014).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆			
Threat Hazard Identification and Risk Assessment	**Description:**	The THIRA process helps communities identify capability targets and resource requirements necessary to address anticipated and unanticipated risks.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	The HI-EMA will be conducting a comprehensive update to the State THIRA in 2018						
	Hazards:	Earthquake, Event-based flood, Health Risks, Hurricane, Tsunami, Volcanic Hazards	◆		◆	◆		
HAWAIʻI WING CIVIL AIR PATROL								
Description: *Hawaiʻi Wing Civil Air Patrol (CAP) has three primary missions: emergency services, cadet programs, and aerospace education. Hawaiʻi Wing Units are located on Oʻahu, Hawaiʻi, Kauaʻi, and Maui.*								
Aircraft Alert System	**Description:**	CAP aircraft are capable of night flights with instrument-rated pilots equipped with speakers and sirens on the islands of Kauaʻi, Oʻahu, Maui, and Hawaiʻi are deployed to alert areas where any land-based sirens have malfunctioned. CAP has eleven aircrafts.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Tsunami	◆			◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*
b. *Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.*
c. *(F) = Federal grant funding supports in full or in part; HETAC tsunami work is funded by NOAA*

A.1.11 Hawai‘i State Legislature

Table A.1-25 includes information on hazard mitigation related capabilities for the Hawai‘i State Legislature

Table A.1-25. Hawai‘i State Legislature Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Hawai‘i State Legislature Grant-in-Aid (GIA) Program	**Description:**	Pursuant to Chapter 42F, Hawai‘i Revised Statutes (HRS), the Legislature may award state funds on an annual basis as a grant by an appropriation to a specified recipient, to support the activities of the recipient and permit the community to benefit from those activities. These activities may include hazard mitigation. An appropriation for a grant shall be disbursed by a contract between the state agency designated the expending agency for the appropriation by the legislature, and the recipient of the grant. During the Regular Legislative Session of 2016, the Hawai‘i State Legislature appropriated $158,000 as a grant to Hawai‘i Wildfire Management Organization (HWMO) to support wildfire prevention and hazardous fuel reduction measures, including: • Create all-agency unified wildfire prevention messaging, related materials, and a public awareness campaign to maximize public protection and preparedness; and • Develop cross-boundary fuel reduction priorities, maps, and projects for all four counties in Hawai‘i. DLNR-DOFAW was the designated expending agency for the grant to HWMO.						
	Notable Changes:	Funds were appropriated to HWMO as a grant pursuant to Chapter 42F, HRS, during the Regular Legislative Session of 2016. A contract was executed and funds were encumbered in 2017. The contract is currently open and the Statewide initiative is ongoing. This grant was used to distribute wildfire outreach materials endorsed by all fire agencies to schools on all islands						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
		and help to coordinate the annual unified multi-agency Wildfire LOOKOUT! campaign to raise awareness about the threat of wildfire to Hawaii's natural resources and to private and public property. This grant will also fund HWMO to develop cross-boundary fuel reduction priorities, maps, and projects for all four counties in the State of Hawaiʻi. HWMO has started holding workshops on County of Maui and County of Hawaiʻi to develop these fuel reduction priorities, maps, and projects. There may be other grants pursuant to Chapter 42F, HRS, that are funding other hazard mitigation projects with other state agencies designated as expending agencies.						
	Challenges:	The Hawaiʻi State Legislature decides on which recipients and the type of activities to fund as long as the grants support the activities of the recipient and permit the community to benefit from those activities.						
	Opportunities:	This is a funding source for mitigation activities performed by the non-governmental sector						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire (As long as the grant supports the activities of the recipient and permit the community to benefit from those activities)	◆	◆	◆			◆

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. (F) = Federal grant funding supports in full or in part

A.1.12 University of Hawaiʻi

Table A.1-26 includes information on hazard mitigation related capabilities for the University of Hawaiʻi (UH). The Pacific Disaster Center (PDC) is managed under a Cooperative Agreement with the Office of the Undersecretary of Defense and its capabilities are included in Table A.1-27. Table A.1-28 includes information on the Pacific Regional Integrated Sciences and Assessments (Pacific RISA) program. Table A.1-29 includes information on the Pacific Risk Management ʻOhana (PRiMO).

Table A.1-26. University of Hawaiʻi Capabilities

Capability		Type of Hazard Management Capability: Pre-Disaster	Post-Disaster	Effect on Loss Reduction: Support	Facilitate	Conflict	Provides Funding for Mitigation
SCHOOL OF OCEAN AND EARTH SCIENCE TECHNOLOGY							
Description: *The School of Ocean and Earth Science and Technology (SOEST) at the University of Hawaiʻi at Mānoa is a world-class research and academic institution focused on informing solutions to some of the world's most vexing problems. Through an integrated, comprehensive, and sustained system of Earth and planetary observations, research, and education, SOEST staff work to transform the way people live on Earth by enabling a healthy public, economy, and planet.*							
SOEST Public Resources	**Description:**	SOEST's website includes a number of publicly available resources including a video archive, publications, K-12 resources, and a data access portal. Among the programs generating hazard related information are: • Mauna Kea Weather Center provides realtime data, model output, and forecasts for Mauna Kea including blizzard conditions and high winds at the summits. The model output covers the <u>state</u> at a 900 meter resolution and provides 2-day forecast output of clouds, winds, and storm conditions, including hurricanes and kona lows, etc. • VMAP, a weather modeling program provides 2-day web-based ongoing forecasts of atmospheric concentrations of sulfur dioxide and sulfate aerosols using initial conditions from the Flyspec Array developed by Keith Horton of SOEST and maintained by the USGS. • The Hawaiʻi Beach Safety website was developed by Dr. Fletcher. Using current weather, surf, public safety alerts and beach conditions we calculate hazard levels at thirty-three Oʻahu beaches. Hazard ratings may vary between nearshore and offshore. • Pacific Islands Ocean Observing System (PacIOOS) empowers ocean users and stakeholders in the Pacific Islands by providing web-based and on-demand accurate and reliable coastal and ocean information, tools, and services that are easy to access and use, including products wave hazard, currents, shoreline impacts, water characteristics, and weather. (see details below) • The Department of Meteorology maintains the Weather Server (Department of Meteorology, 2017), which provides real time weather observations and forecasts for Hawaiʻi, the central Pacific region and the US Mainland.					
	Notable Changes:	None identified.					
	Challenges:	Supported internally and through grant funds; subject to availability of agency funding					
	Opportunities:	None identified.					

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
	Hazards:	Chronic Coastal Flooding, Climate Change, Event-based flood, High Wind Storms, Hurricane, Volcanic Hazards	◆		◆	◆		
SOEST Research	**Description:**	SOEST faculty and staff are recognized as international leaders in research, innovation, and education on topics as varied as renewable energy, oceanography, coral reef ecology, volcanology, remote sensing, cosmochemistry, tropical meteorology and climate modeling, and projection of future climate change for Hawaiʻi. SOEST faculty work with community groups and agencies at local, state, and federal levels, to perform the fundamental research that underlies policy development in water quality, renewable energy, natural hazard management, natural hazards and climate variability (e.g., El Niño, Pacific Decadal Oscillation), climate change impacts, and sustainable ecosystems. SOEST includes several research centers, labs, programs and groups. Particularly relevant for hazard mitigation goals include: • The Sea Level Center • The Coastal Geology Group • The State Climatologist • The Department of Ocean and Resources Engineering maintains tsunami modeling capabilities for determination of tsunami inundation and run-up projections as well as for modeling ocean and harbor currents and water levels over the course of tsunami events. • The Department of Geology and Geophysics maintains research programs on public risk perception, volcano hazards management and training programs for crisis response.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Drought, Event-based flood, High Wind Storms, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		
Sea Grant	**Description:**	Hawai'i Sea Grant supports an innovative program of research, extension, education, and communication services directed to the improved understanding and stewardship of coastal and marine resources. Realizing the necessity of collaboration to address coastal resource issues, Hawai'i Sea Grant also provides links between academia, federal, state, and local government agencies, industries, and local community members. Hawaiʻi Sea Grant has five focus areas: (1) sustainable coastal development, (2) hazard resilience in coastal communities (3) sustainable coastal tourism (4) indigenous cultural heritage (5) water resource sustainability; and six centers of excellence: (1) smart building and						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
		community design (2) sustainable coastal tourism (3) marine science education (4) coastal and climate science and resilience (5) integrated science, knowledge, and culture; and (6) water resource sustainability. With capacity and concentration working in these focal areas for more than 10 years, the Center for Coastal and Climate Science and Resilience (CCCSR) was formally established in 2016 to increase support for collaborative and transdisciplinary coastal and climate research, outreach, and education in the service of communities and decision-makers to understand and address impacts of coastal hazards, climate change, and sea-level rise in Hawaiʻi and the Pacific region. University of Hawaiʻi researchers and Hawaiʻi Sea Grant extension faculty working through the CCCSR significantly amplify project impacts and outcomes through increased collaboration and involvement of multidisciplinary center faculty. The CCCSR engages a broad range of regional stakeholders involved in coastal community resilience and coastal ecosystem management to inform the CCCSR's research agenda, advise decision-makers on potential impacts of climate change and the implementation of adaptation measures, and improve sustainable management of public coastal resources and shoreline land use.						
	Notable Changes:	Projects particularly relevant for hazard mitigation initiated over the performance period of the 2013 HMP include: Hawaiʻi and Pacific Island King Tides Project; Hawaiian Islands Sentinel Site Cooperative Project; Building Resilience to Coastal Hazards and Climate Change in Hawaiʻi Project including the Hawaiʻi Sea Level Rise Viewer, and contributions to the Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report; Maui based project Post-disaster Reconstruction Guidelines and Protocols for the Conservation of Coastal Resources and Protection of Coastal Communities; and the following publications: Third edition of *Homeowner's Handbook to Prepare for Natural Hazards* (Sea Grant, 2017; Hwang and Okimoto, 2014), *Climate Change Impacts in Hawaiʻi, Kauaʻi Climate Change and Coastal Hazards Assessment*. Additional publications that support hazard mitigation goals include: *Natural Hazard Considerations for Purchasing Coastal Real Estate in Hawaiʻi: A Practical Guide of Common Questions and Answers* (Eversole and Norcross-Nuʻu, 2006) and *Hawaiʻi Coastal Hazard Mitigation Guidebook* (Hwang, 2003).						
	Challenges:	None identified.						
	Opportunities:	Partnerships leveraged between counties, state departments (e.g. DLNR) and the University to support staff in county planning agencies that participate directly in hazard mitigation activities and planning.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Earthquake, Event-based flood, Hurricane, Tsunami	◆	◆	◆	◆		
	Description:	The Pacific Islands Ocean Observing System (PacIOOS) provides coastal and ocean data and information to promote a safe, healthy and productive ocean and resilient coastal zone. PacIOOS collects real-time data on ocean conditions, forecasts future events, and develops user-friendly tools to access this information. Based within the School of Ocean						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Pacific Islands Ocean Observing System (PacIOOS)		and Earth Science and Technology (SOEST) at the University of Hawaiʻi at Mānoa, PacIOOS is part of the U.S. Integrated Ocean Observing System (IOOS).						
	Notable Changes:	• Installed a number of wave buoys around the islands; 10 wave buoy locations now maintained by PacIOOS around Kauaʻi, Oʻahu, Maui, Lānaʻi, and Hawaiʻi Islands. • Provides six-day High Sea Level forecasts for six harbors in the islands. • Provides two 6-day wave run-up forecasts provided: for Waikiki and North Shore, Oʻahu. • Provides the Haleiwa Harbor Surge Forecast. • Provides high resolution wave and wind forecasts for the islands. • Developed and hosts the Hawaiʻi Sea Level Rise Viewer as the online atlas to support the Hawaiʻi Sea Level Rise Vulnerability and Adaptation report. • Developed and now hosts a map viewer for Honolulu Sea Level Rise Inundation Risk, which illustrates risk of inundation from a Hurricane and/or Tsunami with 1-meter of sea level rise. • Developed the Hawaiʻi Shoreline Change tool, which displays scenarios of sea level rise, historical shorelines, and erosion rates by parcel.						
	Challenges:	PacIOOS is mostly federally funded, and while funding has been fairly level for the past decade, it is insufficient to address all the needs expressed by stakeholders.						
	Opportunities:	Advancements in the wave run-up forecast are currently being made with funding from multiple agencies and organizations.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Earthquake, Event-based flood, High Wind Storms, Hurricane, Tsunami High Surf, Wave Run-up, High Water Levels, High Winds; Tools provided via PacIOOS (e.g., PacIOOS data portal: Voyager) also address Tsunami, Sea Level Rise, and Earthquakes	◆		◆			
THE CENTER FOR THE STUDY OF ACTIVE VOLCANOES								
Description: *The Center for the Study of Active Volcanoes (CSAV) operates out of the University of Hawaiʻi at Hilo. The Center is a training and outreach program founded by Robert W. Decker. CSAV's mission is to provide information on volcanic and natural hazards that occur in Hawaiʻi and worldwide. CSAV has been operating since 1989, and is a cooperative program of the University of Hawaiʻi at Hilo, the Hawaiian Volcano Observatory (HVO), and the Hawaiʻi Institute of Geophysics and Planetology at the University of Hawaiʻi at Mānoa (UHM).*								

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
CSAV Public Education and Outreach Program on Natural Hazards	**Description:**	Includes website with information on natural hazards, YouTube and Vimeo channels, Facebook page, Visiting Schools Program, Public Seminar, Community Association Visits, and Teacher Training Workshops						
	Notable Changes:	None identified.						
	Challenges:	Outreach program is funded on an annual basis and will vary according to agency funding available in a given year.						
	Opportunities:	There is a significant need for comprehensive, web-based on-demand hazard mitigation guidance that could be met with University capabilities if resources were available for their development.						
	Hazards:	Earthquake, Event-based flood, Hurricane, Tsunami, Volcanic Hazards	◆		◆			
CSAV Cooperative Research Program	**Description:**	Includes monitoring and assessment of volcanoes, internship program, deformation studies, seismic analysis, volcanic hazards and society, geotechnical monitoring, geology and mapping, and public outreach						
	Notable Changes:	None identified.						
	Challenges:	Funded annually and subject to resource availability from funding agency.						
	Opportunities:	None identified.						
	Hazards:	Volcanic Hazards	◆		◆	◆		
GEOGRAPHY DEPARTMENT								
Hawaiʻi Climate Data Websites	**Description:**	Hosts a family of websites that provides data on the climate of Hawaiʻi including: Rainfall Atlas, Evapotranspiration, Solar Radiation and Climate (Geography Department, 2014).						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards	Event-based flood	◆		◆			
HAWAIʻI INSTITUTE OF GEOPHYSICS AND PLANETOLOGY								

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
Description: *The Hawaiʻi Institute of Geophysics and Planetology is a research institute within the School of Ocean and Earth Sciences and Technology specializing in basic and applied research in earth and space sciences*								
HIGP Research	**Description:**	Research faculty conduct research in a variety of technologies related to natural and technological hazards including: • Satellite remote sensing and quantification of volcanic and trace gases and aerosols • Multispectral remote sensing of lava flows • Geodetic modeling and tsunami detection • Remote sensing and spectroscopy of contaminants in the atmosphere and oceanic environment • Infrasound (acoustic) monitoring of volcanic events and nuclear testing for nuclear test ban treaty verification • Engineering and development of satellite instrumentation for remote sensing of earth and atmospheric processes.						
	Notable Changes:	None identified.						
	Challenges:	Supported extramurally through grant funds; subject to availability of agency funding						
	Opportunities:	None identified.						
	Hazards:	Tsunami, Volcanic Hazards, Technological (nuclear and chemical) hazards	◆		◆			
State Climatologist	**Description:**	Research focus on the impact of climate variability and climate change on natural hazards such as hurricane, flood, drought, vog, and wild fire in Hawaiʻi. Use a high-resolution regional climate model and advanced statistical methods for studying future changes in natural hazards. • Hurricane risk assessment • Hurricane intensity forecasts • Seasonal hurricane frequency forecasts • El Niño, La Niña, and rainfall changes in Hawaiʻi • A high resolution numerical model for assessing current and future weather hazards in Hawaiʻi • Projection of future flooding and drought events for Hawaiʻi using dynamical and statistical downscaling approaches • Estimating return levels of extreme precipitation using an extreme value theory • Long-term changes in trade winds over the Hawaiian Islands and their impact on society • Vog dispersion under various weather systems using numerical models						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction: Support	Effect on Loss Reduction: Facilitate	Effect on Loss Reduction: Conflict	Provides Funding for Mitigation
		• Seasonal and monthly prediction of temperature and precipitation using the Bayesian inference • Seasonal prediction of wildland fire activity for Hawaiʻi • Sea level forecasting						
	Notable Changes:	None identified.						
	Challenges:	Funded internally but need extramural funds to carry out the tasks outlined in Description; subject to availability of agency funding						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Event-based flood, Health Risks, High Wind Storms, Hurricane, Volcanic Hazards	◆		◆			
NATIONAL DISASTER PREPAREDNESS TRAINING CENTER (NDPTC)								
Description: *The NDPTC is a member of the National Domestic Preparedness Consortium (NDPC), which was expanded in 2007 to address all-hazards capabilities by the addition of the University of Hawai`i. The NDPTC is authorized to develop and deliver training and educational programs related to homeland security and disaster management, with a specific focus on natural hazards, coastal communities, and the special needs and opportunities of islands and territories. The NDPTC actively engages internally with FEMA and the University of Hawai`i, as well as with external partners across the region to integrate the delivery of its trainings, products, and services.*								
NDPTC Training Programs	**Description:**	The Center has trained more than 35,000 first responders across the nation. In addition to emergency managers and first responders, the Center works closely with urban planners and transportation agencies. The Center has built a nationwide network of subject matter experts, instructors, and training support personnel to facilitate training and adoption of new technologies.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	are						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane,	◆	◆	◆	◆		

Capability			Type of Hazard Management Capability		Effect on Loss Reduction			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
		Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire						

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

Table A.1-27. Pacific Disaster Center Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *PDC provides the most powerful, global decision support technology, as well as risk and vulnerability assessments, preparedness expertise, training and exercise support, and response capabilities. Our early warning and decision support technology, DisasterAWARE, is being used by decision makers and disaster management practitioners in Hawaiʻi and worldwide for disaster risk reduction, planning and preparedness, operational response, and recovery.* PDC provides a number of technical capabilities described below.								
DisasterAWARE™ [b]	**Description:**	Through DisasterAWARE, practitioners have access to PDC's vast data holdings and tools, in a single platform, including: ▪ Customizable early warning notifications and real-time hazard updates ▪ Mapping and visualizations for at-a-glance decision making ▪ Impact, damage, and needs assessment ▪ Risk and vulnerability analysis ▪ Civilian/Military/Interagency sharing and collaboration capabilities ▪ Hundreds of Hawaiʻi-specific data layers and thousands globally (e.g. hazard risk areas, critical infrastructure, vulnerable populations, observations and forecasts, etc.) ▪ Historical hazard impact information Custom version for disaster management and humanitarian assistance practitioners: https://emops.pdc.org/emops/ Version accessible to the public: https://disasteralert.pdc.org/disasteralert/						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆			
Risk and Vulnerability Assessment [b]	**Description:**	PDC's RVA enhances the ability of decision makers to anticipate and characterize potential risk and shocks by making visible the socioeconomic, political, cultural, and environmental factors that contribute to risk and resilience. Our RVA methodology is hazard independent and can be run for any hazard type.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆		◆			
Training and Exercise Support [b]	**Description:**	PDC provides DisasterAWARE™ training and exercise support to help disaster managers coordinate and test complex networks of response activities—simulating real-world events to ensure stakeholders respond effectively under high-pressure circumstances. We support scenario-based training, tabletop exercises, functional exercises, and full-scale exercises. Exercise capabilities include: ▪ Scenario development, design, and simulation ▪ Event scripting and data integration ▪ Communications and information sharing through DisasterAWARE™ ▪ Subject matter expertise (e.g. best practices, hazard risk, etc.)						
	Notable Changes:	None identified.						
	Challenges:	None identified.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆		◆			
Response Support [b]	**Description:**	With a global mission, PDC supports disaster managers in Hawaiʻi and worldwide with timely and accurate hazard information. Through custom products, PDC can assess potential impact and needs allowing communities to quickly mobilize the right resources to protect lives and reduce losses. Response capabilities include: ▪ Early warning notification (Email & SMS) ▪ Decision support (DisasterAWARE™) ▪ Custom mapping and products ▪ Hazard modeling ▪ Pre-impact needs assessments ▪ Interagency and civilian/military information sharing ▪ Subject matter expertise (SME; e.g. Comprehensive Disaster Management (CDM), Risk and Vulnerability Assessment (RVA), and Global health hazard evaluation) Decision makers and disaster management practitioners may request PDC response support at response@pdc.org.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆			

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Pre- and post-impact modeling[b]	**Description:**	Access modeled data through DisasterAWARE™ layers and analytical reports, including pre- and post-impact data, estimated losses and needs estimates for a variety of hazards including but not limited to: tsunami travel times, earthquake shaking and intensity, tropical cyclone storm surge, rainfall, and wind impacts, and volcanic ash cloud impacts. PDC's Hazus modeling expertise includes earthquakes, hurricane, flood inundation, and tsunami events. Our capabilities include Hazus modeling for damage and loss estimates, impacts to infrastructure and population, and direct economic losses. We also leverage Hawaiʻi-specific data for Hazus earthquake modeling that incorporates information about the state's unique built environment.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Earthquake, Event-based flood, Hurricane, Tsunami, Volcanic Hazards, Wildfire	◆	◆	◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.
b. Identified by the department/agency as one of the most effective capabilities for achieving mitigation goals.

Table A.1-28. Pacific Regional Integrated Sciences and Assessments Capabilities

Capability			Type of Hazard Management Capability		Effect on Loss Reduction[a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
Description: *The RISA program created in 1995 to pioneer innovative mechanisms for enhancing the value of climate information and products for understanding and responding to a variety of challenges associated with climate variability and change at the regional scale. The Pacific RISA program supports Pacific island and coastal communities in adapting to the impacts of climate variability and change. We strive to enhance Pacific communities' abilities to understand, plan for, and respond to changing climate conditions. Our work is conducted through interdisciplinary research and partnerships with local, national, and regional stakeholders.*								
Pacific RISA Projects	**Description:**	Pacific RISA is engaged in many projects to support mitigation goals including but not limited to work on regional climate projections, human dimensions of drought, and integrating climate and disaster risk assessments.						
	Notable Changes:	None identified.						

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Climate Change, Drought	◆		◆			
Pacific RISA Education & Outreach	**Description:**	The Pacific RISA website includes a number of education and outreach materials including case studies, “documoments,” and a newsletter.						
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Climate Change, Drought, Wildfire	◆		◆			

a. Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.

Table A.1-29. Pacific Risk Management ‘Ohana Capabilities

Capability			Type of Hazard Management Capability: Pre-Disaster	Type of Hazard Management Capability: Post-Disaster	Effect on Loss Reduction[a]: Support	Effect on Loss Reduction[a]: Facilitate	Effect on Loss Reduction[a]: Conflict	Provides Funding for Mitigation
Description: *PRiMO began in 2003 as an effort to explore opportunities to enhance communication and collaboration among the ‘’Ohana, or family, of local, national, and regional organizations involved in risk management. PRiMO has since transformed into a true collaborative effort governed by a coordinating council of navigators. These key representatives from the region provide leadership, resources, and policy guidance to PRiMO as well as seek institutional support for PRiMO from within their respective organizations.*								
Hui	**Description:**	Hui members are experts in their field and together the members bridge the information gaps between science and service providers, decisions makers and other stakeholders. These working groups represent the heart of the PRIMO effort, where the various organizations come together to develop and implement actions plans that improve the resilience of the Pacific region. Hui include: Communications, Health Security, Indigenous Knowledge and the Environment, Information Access and Geospatial technology, Risk Assessment and Planning, and Training and Education.						

Capability			Type of Hazard Management Capability		Effect on Loss Reduction [a]			Provides Funding for Mitigation
			Pre-Disaster	Post-Disaster	Support	Facilitate	Conflict	
	Notable Changes:	None identified.						
	Challenges:	None identified.						
	Opportunities:	None identified.						
	Hazards:	Chronic Coastal Flooding, Climate Change, Dam Failure, Drought, Earthquake, Event-based flood, Hazardous Materials, Health Risks, High Wind Storms, Hurricane, Landslide/Rockfall, Tsunami, Volcanic Hazards, Wildfire	◆		◆	◆		

a. *Support is defined as programs, plans, policies, regulations, funding, or practices that help the implementation of mitigation actions, while facilitate is defined as programs, plans, policies, regulations, funding, or practices that make implementing actions easier.*

A.2 State Funding Capabilities Detailed Tables

The following sections provide detailed information for discussions presented in Section 5 (Capability Assessment) of the 2018 HMP Update.

A.2.1 Projects Submitted for FEMA Funding

Table 5-A.2-1 shows projects submitted for funding during the performance period of the 2013 HMP. It should be noted that those projects whose status is listed as "withdrawn" or "submitted" are not included in the totals shown in Section 5 (Capability Assessment).

Table 5-A.2-1. Projects Submitted for Funding during Performance Period of 2013 HMP

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
HMGP	1743	County of Hawai'i Critical Facility Retrofit-Waiakea High Gym	Department of Education	Retrofit	Closed	$430,523
HMGP	1743	State Management Costs 1743	HI-EMA	Management Costs	Closed	$22,385
HMGP	1967	Facility Exterior Hardening-Community Clinic of Maui	Community Clinic of Maui	Facility Exterior Hardening	Closed	$45,306
HMGP	1967	Harden State Civil Defense Warehouse Phase II[a]	HI-EMA	Hardening	Closed	$730,000
HMGP	1967	Siren Upgrade Project-5% [a]	HI-EMA	Warning Systems	Closed	$59,980
HMGP	1967	State Management Costs	HI-EMA	Management Costs	Closed	$40,801
PDM	2014	Hawai'i State Civil Defense PDM Management Costs	HI-EMA	Management Costs	Closed	$0.00
PDM	2014	County of Hawai'i Multihazard Mitigation Plan	County of Hawai'i Civil Defense	Local Mitigation Planning	Closed	$81,000
PDM	2016	State Hazard Mitigation Plan Update	HI-EMA	State Mitigation Planning	Ongoing	$267,000
PDM	2016	City and County of Honolulu Mitigation Plan Update	C&C Department of Emergency Management	Local Mitigation Planning	Ongoing	$200,000
PDM	2016	State Management Costs PDM 2016 ()	HI-EMA	Management Costs	Ongoing	$16,600

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
HMGP	4062	State Mgmt. Costs 4062	HI-EMA	Management Costs	Closed	$34,575
HMGP	4062	Hawaiʻi SCD Tsunami Hazard Maps	HI-EMA	State Mitigation Planning	Closed	$50,000
HMGP	4062	County of Kauaʻi Local Wind Amendments for Adoption (5%)	County of Kauaʻi	Local Mitigation Planning	Closed	$36,000
HMGP	4201	Hawaiʻi State Building Code Administrative Rules to Implement Updated Standards for Hurricane Mitigation – 7%	Department of Accounting and General Services	State Mitigation Planning	Ongoing	$100,000
HMGP	4201	University of Hawaiʻi System-Wide Multi-Hazard Mitigation Plan Update	University of Hawaiʻi	University Mitigation Planning	Withdrawn	$196,000
HMGP	4201	Maui Food Bank Generator Installation	Maui Food Bank	Generator	Withdrawn	$40,000
HMGP	4282	C&C Board of Water Supply Generator- Barbers Point Booster	C&C Board of Water Supply	Generator	Submitted	$300,000
HMGP	4282	Maui Dept. of Public Works Baseyard Generator	Maui Department of Public Works	Generator	Submitted	$150,000
HMGP	4282	Hardening of Waikiki Fire Station #7- Doors	Honolulu Fire Department	Hardening/ Retrofit	Submitted	$105,000
HMGP	4282	Generator Hook-Ups for Hawi, Piihonua #3, Honokohau, and Panaewa Wells	Hawaiʻi Department of Water Supply	Generator Hook-Ups	Submitted	$300,000
HMGP	4282	Hanakapiai Stream Gage-Warning	County of Kauaʻi	Stream Gage-Warning	Submitted	$37,500
HMGP	4282	Hardening of the Kauaʻi War Memorial Convention Hall-Hurricane Sheltering	County of Kauaʻi	Hardening for Hurricane Sheltering	Submitted	$200,000
PDM	2017	Update of County of Maui Mitigation Plan	Maui Emergency Management Agency	Local Mitigation Planning	Submitted	$75,000
PDM	2017	Update of County of Kauaʻi Mitigation Plan	Kauaʻi Emergency Management Agency	Local Mitigation Planning	Submitted	$100,000

Grant	DR# or Fiscal Year	Project Name	Subapplicant	Activity Type	Status	Total Project Cost
PDM	2017	Update of County of Hawaiʻi Mitigation Plan	Hawaiʻi Civil Defense Agency	Local Mitigation Planning	Submitted	$153,000
PDM	2017	State Management Costs	HI-EMA	Management Costs	Submitted	$31,500
PDM	2017	Hardening of the Olomana Fire Station	Honolulu Fire Department	Generator	Submitted	$70,000
PDM	2017	Hardening of the Wilcox Medical Center	HI-EMA	Generator	Submitted	$12,816,075

a. CIP Funding provided local match for project

A.2.2 Federal Pre- and Post-Disaster Funding Resources

Table A.2-2 shows the evaluation of federal funding resources that the state has access to or is eligible to use to fund mitigation efforts.

Table A.2-2. Evaluation of Funding Resources for Mitigation Efforts

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Hazard Mitigation Grant Program (HMGP)	FEMA		◆
	Description: *To provide funds to states, territories, Indian tribal governments, and communities to significantly reduce or permanently eliminate future risk to lives and property from natural hazards. HMGP funds projects in accordance with priorities identified in state or local hazard mitigation plans, and enables mitigation measures to be implemented during the recovery from a disaster.*		
Pre-Disaster Mitigation Grant (PDM)	FEMA	◆	
	Description: *To provide funds to states, territories, tribal governments, and communities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.*		
Flood Mitigation Assistance Grant (FMA)	FEMA	◆	
	Description: *To implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP).*		
Post-Disaster Economic Recovery Grants and Assistance	Economic Development Administration		◆
	Description: *Grant funding to assist with the long-term economic recovery of communities, industries, and firms adversely impacted by disasters.*		
U.S. Small Business Administration Loan Programs	Small Business Administration		◆
	Description: *Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, economic injury, machinery and equipment, and inventory and business assets. Funding: Homeowners may apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners may borrow up to $40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances – damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations.*		
Public Assistance Grants	FEMA		◆
	Description: *Grants for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private nonprofit organizations. Mitigation funding is available for work related to damaged components of eligible buildings/structures.*		
Community Development Block Grants Program (Non-entitled Counties)	U.S. HUD	◆	
	Description: *In* Hawaiʻi, *three counties qualify for this program -* Hawaiʻi, *Kauaʻi, and Maui. Funds are allocated using a formula based on population, poverty, and housing overcrowding, with the poverty factor carrying a double weight. CDBG funds may be used for activities which include, but are not limited to:* ▪ Acquisition of real property ▪ Relocation and demolition ▪ Rehabilitation of residential and non-residential structures		

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
	▪ Construction of public facilities and improvements, such as water and sewer facilities, streets, neighborhood centers, and the conversion of school buildings for eligible purposes ▪ Public services, within certain limits ▪ Activities relating to energy conservation and renewable energy resources ▪ Provision of assistance to nonprofit and profit-motivated businesses to carry out economic development and job creation/retention activities *Each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available*		
Community Development Block Grants/ Entitlement Grants	U.S. HUD	◆	
	Description: *The City and County of Honolulu qualifies for this program. Grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, suitable living environments, expanded economic opportunities), principally for low- and moderate-income persons. Activities as the same as for the non-entitled counties.*		
Community Development Block Grant Disaster Recovery Program	U.S. HUD		◆
	Description: *HUD provides flexible grants to help cities, counties, and States recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. In response to Presidentially declared disasters, Congress may appropriate additional funding for the Community Development Block Grant (CDBG) Program as Disaster Recovery grants to rebuild the affected areas and provide crucial seed money to start the recovery process.*		
Public Housing Capital Fund Emergency/Natural Disaster Funding	U.S. HUD		◆
	Description: *Funding to public housing agencies that confront an emergency situation or a natural disaster.*		
Single Family Housing Repair Loans and Grants (Section 504 Rural Housing Loans and Grants)	U.S. Department of Agriculture	◆	◆
	Description: *Repair loans, grants, and technical assistance for very low-income homeowners living in rural areas to repair their homes and remove health and safety hazards.*		
Guaranteed Single Family Housing Loans (Section 502 Rural Housing Loans)	U.S. Department of Agriculture	◆	
	Description: *Also known as the Section 502 Direct Loan Program, this program assists low- and very-low-income applicants obtain decent, safe and sanitary housing in eligible rural areas by providing payment assistance to increase an applicant's repayment ability.*		
Farm Ownership Loans	U.S. Department of Agriculture	◆	
	Description: *Direct loans, guaranteed/insured loans, and technical assistance to farmers to develop, construct, improve, or repair farm homes, farms, and service buildings and to make other necessary improvements.*		
HOME Investment Partnerships Program	U.S. HUD	◆	
	Description: *Grants to states, local government, and consortia for permanent and transitional housing (including support for property acquisition, improvements, demolition, and relocation) for very low and low-income persons.*		
Rural Development Assistance—Housing	U.S. Department of Agriculture		◆
	Description: *Grants, loans, and technical assistance for addressing rehabilitation and health and safety needs in primarily low-income rural areas. Declaration of major disaster necessary.*		

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Rural Development Assistance—Utilities	U.S. Department of Agriculture	◆	
	Description: *Direct and guaranteed rural economic loans and business enterprise grants to address utility issues and development needs.*		
Assistance—Community Facility Direct Loans/Grants	U.S. Department of Agriculture	◆	
	Description: *Grants, direct and guaranteed loans, and technical assistance to construct, enlarge, or improve community facilities for healthcare, public safety, and public services in primarily low-income rural areas.*		
Community Development Block Grant—Section 108 Loan Guarantees	U.S. HUD	◆	
	Description: *Loan guarantees to public entities for economic development, housing rehabilitation, public facilities, and large-scale physical development projects (including mitigation measures).*		
Homeland Security Grant Program	FEMA	◆	
	Description: *Grants to enhance the ability of states, territories, and urban areas to prepare for, prevent, and respond to terrorist attacks and other major disasters. Includes State Homeland Security Program, Urban Areas Security Initiative, Law Enforcement Terrorism Prevention Program, Metropolitan Medical Response System, and Citizen Corps Program grant programs.*		
Infrastructure Protection Program	FEMA	◆	
	Description: *Grants to strengthen the nation's ability to protect critical infrastructure facilities and systems. Includes Transit Security Grant Program, Port Security Grant Program, Intercity Bus Security Grant Program, Trucking Security Program, and Buffer Zone Protection Program grant programs.*		
Assistance to Firefighters Grant Program	FEMA	◆	
	Description: *Grants to local fire departments to protect citizens and firefighters against the effects of fire and fire-related incidents*		
Fire Prevention and Safety Grant Program	FEMA	◆	
	Description: *Grants for projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to target high-risk populations and mitigate high incidences of death and injury.*		
Fire Management Assistance Grant Program	FEMA		◆
	Description: *Grants for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster.*		
Hazardous Materials Emergency Preparedness Program	U.S. Department of Transportation	◆	
	Description: *Project grants and technical assistance to enhance hazardous materials emergency planning and training*		
Nonstructural Alternatives to Structural Rehabilitation of Damaged Flood Control Works	U.S. Army Corps of Engineers		◆
	Description: *Direct planning and construction grants for nonstructural alternatives to the structural rehabilitation of flood control works damaged in floods or coastal storms.*		
Reimbursement for Firefighting on Federal Property	U.S. Fish and Wildlife Service		◆
	Description: *Provides reimbursement only for direct costs and losses over and above normal operating costs.*		
National Dam Safety Program	FEMA	◆	
	Description: *National Dam Safety Program (NDSP). The NDSP, which is led by FEMA, is a partnership of the states, federal agencies, and other stakeholders to encourage individual and community responsibility*		

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
	for dam safety. Grant assistance to the States: Provides vital support for the improvement of the State dam safety programs that regulate most of the dams in the United States.		
Land and Water Conservation Fund	Land and Water Conservation Fund	◆	
	Description: *Funding to states for outdoor recreational development, renovation, land acquisition, and planning. Funding: The fund is authorized at $900 million annually, a level that has been met only twice during the program's 40-year history. The program is divided into two distinct funding pots: state grants and federal acquisition funds.*		
The Forest Legacy Program	U.S. Forest Service	◆	
	Description: *Federal program in partnership with states supports efforts to protect environmentally sensitive forest lands. Designed to encourage the protection of privately owned forest lands, Forest Legacy is an entirely voluntary program. To maximize the public benefits it achieves, the program focuses on the acquisition of partial interests in privately owned forest lands. Forest Legacy helps states develop and carry out their forest conservation plans. It encourages and supports acquisition of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another, without removing the property from private ownership. Most Forest Legacy Program conservation easements restrict development, require sustainable forestry practices, and protect other values. Funding: To qualify, landowners are required to prepare a multiple resource management plan as part of the conservation easement acquisition. The federal government may fund up to 75% of project costs, with at least 25% coming from private, state, or local sources. In addition to gains associated with the sale or donation of property rights, many landowners also benefit from reduced taxes associated with limits placed on land use.*		
Transportation Trust Fund	Federal Highway Administration	◆	
	Description: *Transportation Trust Fund funds grants through a competitive application-based process administered by the Local Aid District Offices. County Aid Program- Administer the County Aid Program for road and bridge infrastructure improvements under county jurisdiction. Each County receives an annual formula based allotment that takes into consideration county road lane mileage and population. The County Aid Program is funded through the Transportation Trust Fund and provides funding for eligible costs of projects included in the county's approved Annual Transportation Program.*		
Department of Homeland Security Grant Program (HSGP)	Department of Homeland Security	◆	
	Description: The Homeland Security Grant Program (HSGP) plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. HSGP is composed of three interconnected grant programs including the State Homeland Security Program (SHSP), Urban Areas Security Initiative (UASI), and the Operation Stonegarden (OPSG). Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration.		
Emergency Management Performance Grand Program (EMPG)	Department of Homeland Security	◆	
	Description: Grants are available to State, local, territorial, and tribal governments in preparing for all hazards. The Federal Government, through the EMPG Program, provides necessary direction, coordination and guidance, and provides necessary assistance, as authorized so that a comprehensive emergency preparedness system exists at all levels for all hazards.		
Coastal Resilience Grants	NOAA	◆	
	Description: The NOAA Coastal Resilience Grants program supports projects that increase coastal resilience and restore habitat.		

Funding Program	Funding Agency	Pre-Disaster	Post-Disaster
Small Civil Works Projects; Continuing Authorities Program (CAP)	U.S. Army Corps of Engineers	◆	
	Description: The Secretary of the Army has been delegated the authority to plan, design, and construct certain types of water resource and environmental restoration projects without specific Congressional authorization. Each authority has its own requirements and strict limits on responsibilities and financial contributions of the federal partners: (Section 14—Emergency Streambank and Shoreline Erosion; (2) Section 103—Hurricane and Storm Damage Reduction; (3) Section 107—Small Navigation Improvements; (4) Section 111—Shore Damage Attributable to Federal Navigation Projects; (5) Section 204—Regional Sediment Management & Beneficial Uses of Dredges Materials; (6) Section 205—Small Flood Damage Reduction Projects; (7) Section 206—Aquatic Ecosystem Restoration; (8) Section 208—Snagging and Clearing for Flood Control; (9) Section 1135—Project Modification for Improvement of the Environment (USACE, no date). Submittal deadlines are typically in May-June. Cost shares are typically 50% for feasibility and 65% for construction. Most projects are less than $15,000,000.		
Cooperative Forestry State Fire Assistance	US Forest Service	◆	
	Description: The Cooperative Forestry program manages a number of programs including The Forest Stewardship Program, The Forest Legacy Program, The Community Forest Program, The Urban and Community Forestry Program, Ecosystem Services and Markets, and Wood Innovations		
Floodplain Management Services	U.S. Army Corps of Engineers, Honolulu District (USACE)	◆	
	Description: Modeling, delineation and mapping of floodplains. There is no limit on funding although typical projects are $100,000 or less. Submittal deadlines are typically in June-July. There are no state or local cost shares.		

A.3 State Pre- and Post-Disaster Capabilities and Core Mitigation Capabilities

The National Preparedness Goal (FEMA, 2015) identifies seven core capabilities for the mitigation mission area:

- **Threats & Hazard Identification**—Identify the threats and hazards that occur in the geographic area; determine the frequency and magnitude; and incorporate this into analysis and planning processes so as to clearly understand the needs of a community or entity (FEMA, 2016)
- **Risk & Disaster Resilient Assessment**—Assess risk and disaster resilience so that decision makers, responders, and community members can take informed action to reduce their entity's risk and increase their resilience (FEMA, 2016)
- **Planning**—Conduct a systematic process engaging the whole community as appropriate in the development of executable strategic, operational, and/or tactical-level approaches to meet defined objectives (FEMA, 2016)
- **Community Resilience**—Enable the recognition, understanding, communication of, and planning for risk and empower individuals and communities to make informed risk management decisions necessary to adapt to, withstand, and quickly recover from future incidents (FEMA, 2016)
- **Public Information & Warning** —Deliver coordinated, prompt, reliable, and actionable information to the whole community through the use of clear, consistent, accessible, and culturally and linguistically

appropriate methods to effectively relay information regarding any threat or hazard and, as appropriate, the actions being taken and the assistance being made available (FEMA, 2016)

- **Long-term Vulnerability Reduction**—Build and sustain resilient systems, communities, and critical infrastructure and key resources lifelines so as to reduce their vulnerability to natural, technological, and human-caused threats and hazards by lessening the likelihood, severity, and duration of the adverse consequences (FEMA, 2016)
- **Operational Coordination**—Establish and maintain a unified and coordinated operational structure and process that appropriately integrates all critical stakeholders and supports the execution of core capabilities (FEMA, 2016).

Table A.3-1 shows the State of Hawaiʻi mitigation capabilities and the mitigation mission area core capability that they support. This information is included to support the development and enhancement of the State of Hawaiʻi THIRA and State Preparedness Report.

Table A.3-1. State of Hawaiʻi Mitigation Capabilities by Mitigation Mission Area Core Capability

Capability [a]	Mitigation Core Capabilities [c]						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Aircraft Alert System (HI-EMA)					◆		
Building Code Committee (SEAOH)						◆	
Building Code Council (DAGS)						◆	◆
Capital Improvements Budget (DBF)			◆			◆	
Clean Water Act Section 401 Water Quality Certifications (DOH EHA)					◆		
Climate 21C (OCCL)	◆	◆	◆	◆	◆	◆	
Coastal Lands Program (OCCL)		◆		◆		◆	
Coastal Zone Management Program (OP)	◆		◆	◆		◆	
Commission on Water Resources Management (CWRM)	◆	◆	◆			◆	◆
Community Development District Program (HCDA)			◆				
Critical Systems Vulnerability Assessment (HI-EMA)	◆	◆	◆			◆	
Dam Safety Program (Engineering)		◆	◆		◆	◆	
Damage Assessments (DAGS)		◆		◆			
Department Emergency Operations Plan Template (HI-EMA)			◆				
Department of Hawaiian Home Lands Land Trust (DHHL)	◆		◆	◆			

Capability [a]	Mitigation Core Capabilities [c]						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Department of Health All-Hazards Training and Exercise Program (DOH HRA)	◆	◆					◆
Department Operations Center (HI-EMA) Planning Guidance and Resources (HI-EMA)			◆				
Disaster Response Committee (SEAOH)		◆		◆			
Energy Assurance Program (HSEO)	◆	◆	◆			◆	
Epidemiological Surveillance (DOH HRA)	◆	◆					◆
Fire Program (DOFAW)	◆	◆	◆	◆	◆	◆	
Forestry Program (DOFAW)	◆	◆	◆	◆		◆	
Geography Department (UH)	◆				◆		
Get Ready Website (HI-EMA)				◆	◆		
GoHawai'i Mobile App (HTA)					◆		
Hawai`i Environmental Policy Act (DOH OEQC)			◆			◆	
Hawai`i Hurricane Relief Fund (DCCA)				◆			
Hawai`i Emergency Planning and Community Right to Know Act (DOH EHA)				◆	◆		
Hawai'i Advisory Council on Emergency Management (HI-EMA)	◆	◆					◆
Hawai'i Catastrophic Hurricane Plan (HI-EMA)			◆				◆

Capability [a]	Mitigation Core Capabilities [c]						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Hawaiʻi Earthquake & Tsunami Advisory Committee (HI-EMA)		◆				◆	◆
Hawaiʻi Hazards Awareness and Resilience Program (HI-EMA)		◆	◆	◆	◆		
Hawai'i Institute of Geophysics and Planetology (UH)	◆	◆			◆		
Hawai'i State Legislature Grant-in-Aid Program (HSL)		◆	◆	◆		◆	
Hawai'i State Planning Act (OP)			◆	◆		◆	◆
Hawai'i Statewide Geographic Information System Program (OP)	◆	◆	◆				◆
Hazardous Materials Risk Management Program (DOT)					◆		
Hazardous Waste Section Regulations (DOH EHA)	◆						◆
Hospital Preparedness Program (DOH HRA)		◆	◆				◆
Immunization Programs (DOH HRA)				◆	◆		
Laboratory Preparedness and Response Program (DOH HRA)		◆	◆				◆
Land Acquisition Program (DAGS)						◆	
Mandatory Seller Disclosures in Real Estate Transactions (DCCA)	◆				◆		
Mass Feeding Operations (DOH EHA)							◆

Capability [a]	Mitigation Core Capabilities [c]						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Medical Countermeasure Points of Distribution (DOH HRA)			◆				◆
National Disaster Preparedness Training Center (UH)				◆			◆
National Flood Insurance Program (Engineering)	◆	◆	◆	◆		◆	◆
Native Ecosystems and Management (DOFAW)				◆		◆	
Natural Disaster Economic Recovery Strategy (HI-EMA)		◆	◆	◆			
NPDES Wastewater Discharge Permits (DOH EHA)						◆	
Pacific Disaster Center Technical Capabilities (PDC)	◆	◆	◆	◆			
Pacific RISA (Pacific RISA)	◆	◆			◆		
Polluted Runoff Control Program (DOH EHA)						◆	
PRiMO (PRiMO)	◆	◆	◆	◆		◆	
Radiation Section- Radiation Assessment Team (DOH EHA)		◆					
Risk MAP (Engineering)	◆	◆	◆			◆	
Roadside Fuel Reduction Program (DOT)				◆			
Safe Drinking Water Emergency FAQs (DOH EHA)					◆		

Capability [a]	Mitigation Core Capabilities [c]						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
School of Ocean and Earth Science Technology (UH)	◆	◆	◆	◆	◆		
Shelter Upgrade Program (DAGS)				◆			
Shoreline Certification (Land Division)						◆	
Silver Jackets (Engineering)			◆				◆
State Board of Land and Natural Resources (BLNR)						◆	
State Fire Council (SFC)	◆					◆	◆
State Land Use Law (OP)			◆			◆	
State Mitigation Forum (HI-EMA)		◆	◆			◆	◆
State of Hawai‘i Emergency Operations Plan (HI-EMA)			◆				◆
State-owned Building Insurance (DAGS)				◆			
The Center for the Study of Active Volcanoes (UH)	◆				◆		
Threat Hazard Identification and Risk Assessment (HI-EMA)	◆		◆				
Training & Exercise Plan (HI-EMA)			◆		◆		◆
Transportation Asset Climate Change Risk Assessment Project (O’ahuMPO)			◆				
Underground Storage Tank Section Regulations (DOH EHA)	◆						
Vector Control Program (DOH EHA)		◆					

Capability [a]	Mitigation Core Capabilities [c]						
	Threats & Hazard Identification	Risk & Disaster Resilient Assessment	Planning	Community Resilience	Public Information & Warning	Long-term Vulnerability Reduction	Operational Coordination
Weatherization Assistance Program (OCS)				◆	◆		
Western States Seismic Policy Council (HI-EMA)		◆				◆	

Acronym in parenthesis refers to the state department detail table under which the capability is discussed (see Section A.1 (State Capability Assessment Detailed Tables). Listing under a particular department or agency should not be construed to imply that the department is the sole administrator of the capability. Additionally, in some instances the capability is associated with the duties of the department but the department does not have administrative authority over the capability.

A.4 Criteria for Prioritizing Planning and Project Grants

The following criteria are used by the State Hazard Mitigation Forum (Forum) to rank planning and project proposals for FEMA mitigation grant funding programs. Past practices of the State have been to give the highest priority for funding for HMGP opportunities to the county where the event occurred and to give additional weight to those projects that propose a higher contribution of cost-share. All counties are considered to be equal priorities for other mitigation grant programs and projects are evaluated on their individual merits.

It should be noted that, at the time of the update of the 2018 HMP Update, the HI-EMA was working on revisions to the ranking protocol and criteria described below. It should also be noted the HI-EMA Director has the final authority on those projects that submitted for grant funding after the Forum review and ranking. See Section 5 (Capability Assessment) for more details.

Projects are assigned a numeric value from 1 to 5, where 1 is the lowest and 5 is the highest, for the following ranking criteria:

- **Environmental/Historic Preservation**—Must be environmentally sound and in conformance with Floodplain Management, Historical Preservation, and Protection of Wetlands and Endangered Species laws and regulations.
- **Resolve Significant Problems**—Addresses a problem that has been repetitive or a problem that poses a significant risk to public health and safety if left unresolved.
- **Long-range**—Solution should be long-range.
- **Cost-effective**—Be cost-effective and substantially reduce the risk of future damage, loss, hardship, or suffering from a major disaster.
- **Priority in State Plan**—Types of projects which have been determined high priority for the State of Hawaiʻi
    - Hardening or retrofit of essential facilities such as fire station, EOCs, communications facilities, schools, shelters, hospitals, etc.
    - Public awareness/education
    - Flood control
    - Development and/or improvement of warning systems.

A.5 Local Capability Assessment Detailed Table

County policies, programs, funding, and other capabilities are used to support and accomplish hazard mitigation goals and objectives. A list of foundational capabilities for hazard mitigation was developed based on FEMA local mitigation planning guidance, professional judgement, and suggestions from the State Hazard Mitigation Forum. This list was not intended to be inclusive of every capability discussed in the local HMPs or every capability that may be used to support hazard mitigation at the local level.

Table A.5-1 includes a summary of foundational capabilities relevant for hazard mitigation in the State and if these capabilities were identified and discussed in the County local HMPs. It is important to note that the absence of a capability does not mean that the capability does not exist in the county. It simply means that no discussion was found describing or identifying the capability in the local HMP. This suggests that the capability may not be being used to its full potential to support mitigation within the County or it may suggest that the department or agency responsible for implementing the capability may not have been fully involved in the local HMP planning process. In addition, it is important to note that codes, regulations, and/or plans may have been updated since the time of their publication. Notes are provided below the table on some such updates.

Table A.5-1 - Foundational Capabilities as Identified and Reflected in County Local Hazard Mitigation Plans

Foundational Capability	County of Kauaʻi	City and County of Honolulu [a]	County of Kauaʻi	County of Maui	County of Hawaiʻi
Building Code [b]	**Yes** 2006 IBC	**Yes** Indicates that the 2003 IBC with wind maps was adopted over the performance period of the 2004 plan	**Yes** 2006 IBC	**Yes** 2006 IBC and IRC as amended	**Yes** Updating of the County Building Code in accordance with HRS Chapter 107 is identified as a county priority
Capital Improvement Program	**Yes** Considering ways to leverage resources for improving facilities and to partner for improving communication systems in the county	**Yes** Discusses including hazard mitigation projects in CIP	**Yes** Considering ways to leverage resources for improving facilities and to partner for improving communication systems in the county	**Yes** Discusses County of Maui and State CIP and includes an action to include hazard mitigation initiatives in the CIP	**Yes** Discusses including hazard mitigation projects in CIP
Climate Action/Resilience Plan	**Yes** County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan (2015); Hanalei Watershed Hui Community Disaster Resilience Plan	**No**	**Yes** County of Kauaʻi Multi-Hazard Mitigation and Resilience Plan (2015); Hanalei Watershed Hui Community Disaster Resilience Plan	**No**	**No**
Community Development Plans	**Yes** Climate change and coastal hazards assessment to be incorporated into three community development plans	**Yes** Natural hazard policies for Community Development Plans	**Yes** Climate change and coastal hazards assessment to be incorporated into three community development plans	**Yes** Risk assessment results presented at Community Plan level so that information can be integrated as appropriate	**Yes** Incorporation of the local HMP into Community Development Plans to make all natural hazards explicit factors for planning is identified as a county priority
Community Wildfire Protection Plan [c]	**Yes** Community Wildfire Protection Plan for Kauaʻi County (2009); Updates ongoing at time of plan development	**Yes** Limited details provided in Volume I	**Yes** Community Wildfire Protection Plan for Kauaʻi County (2009); Updates ongoing at time of plan development	**Yes** West Maui Community Wildfire Protection Plan, June 2014; Upcountry/Central Maui	**Yes** Indicated there are plans for Kaʻu and South Kona, Ocean View, and Hawaiʻi Volcanoes National Park

Foundational Capability	County of Kaua‘i	City and County of Honolulu [a]	County of Kaua‘i	County of Maui	County of Hawai‘i
				and South Maui plans in development	
Comprehensive Emergency Management Plan/ Emergency Operations Plan	**Yes** County of Kaua‘i Emergency Operations Plan-Basic Plan (2007); Kaua‘i County Hurricane Response Logistics Concept of Operations (CONOPS) 2013	**Yes** City & County Emergency Operations Plan (2007)	**Yes** County of Kaua‘i Emergency Operations Plan-Basic Plan (2007); Kaua‘i County Hurricane Response Logistics Concept of Operations (CONOPS) 2013	**Yes** County of Maui Emergency Operations Plan (2009)	**Yes** County of Hawai‘i Emergency Operations Plan (1989)
Continuity of Operations Plan	**Yes** Trainings offered to Kaua‘i Visitor and Business Industry, considering training for county agency being considered	**No**	**Yes** Trainings offered to Kaua‘i Visitor and Business Industry, considering training for county agency being considered	**No** Discusses encouraging critical facility owners to create or enhance continuity of operations plans based on information included in risk assessment	**No**
County Owned Building Insurance	**No**	**No**	**No**	**No**	**No**
Economic Development Plan	**Yes** Kaua‘i Economic Development Plan 2005-2015: Kauai’s Comprehensive Economic Development Strategy (Ceds) Report (2004)	**No** Aspects of economic development are discussed in the context of the General Plan	**Yes** Kaua‘i Economic Development Plan 2005-2015: Kauai’s Comprehensive Economic Development Strategy (Ceds) Report (2004)	**Yes** Maui General Plan 2030, Economic Development Elements; Hawai‘i Comprehensive Economic Development Strategy, 2010	**No** Aspects of economic development are discussed in the context of the General Plan
Firewise [d]	**No** State Firewise Coordinator mentioned	**No** Mentioned but does not describe participation	**No** State Firewise Coordinator mentioned	**Yes** Not currently participating; however, an action was included to revitalize the program	**Yes**
Flood Damage Prevention Ordinance	**Yes** Includes higher standards	**Yes**	**Yes** Includes higher standards	**Yes** Participates in CRS	**Yes**

Foundational Capability	County of Kauaʻi	City and County of Honolulu [a]	County of Kauaʻi	County of Maui	County of Hawaiʻi
		Includes discussion on some compliance challenges			Includes higher standards; Participates in CRS
General Plan	**Yes** County of Kauaʻi General Plan 2015 technical information used to inform the local HMP and hazard mitigation will be incorporated into the General Plan update	**Yes** Natural hazard policies for General Plan	**Yes** County of Kauaʻi General Plan 2015 technical information used to inform the local HMP and hazard mitigation will be incorporated into the General Plan update	**Yes** Discusses integration of hazard mitigation into General Plan	**Yes** Discusses integration of hazard mitigation into General Plan
Get Ready Website	**No**	**No**	**No**	**No**	**No**
Hawaiʻi Hazards Awareness and Resilience Program	**No**	**No**	**No**	**Yes** Includes action to promote participation	**No**
Hawaiʻi State Legislature Grant-in-Aid (GIA) Program	**No**	**No**	**No**	**Yes** Only the capital improvement project portion is discussed	**No**
Legacy Lands Conservation Program	**No**	**No**	**No**	**No**	**No**
Land Acquisition Plan / Willing Seller Program	**No**	**Yes** Kahuku Flood Control Project through acquisition	**No**	**Yes** Action identified to develop a flood acquisition/elevation plan	**No** Discussed generally, but No existing plan or program
Post-Disaster Recovery	**Yes** Post-Disaster Recovery Plan development identified as ongoing action; County of Kauaʻi Disaster Debris Action Manual (2001)	**No**	**Yes** Post-Disaster Recovery Plan development identified as ongoing action; County of Kauaʻi Disaster Debris Action Manual (2001)	**Yes** Post-Disaster Reconstruction Guidelines and Protocols for Conservation of Coastal Resources and Protection of Coastal Communities; Natural Disaster Economic	**Yes** Discussed in the Emergency Operations Plan and County of Hawaiʻi Disaster Debris Action Manual (2001)

Foundational Capability	County of Kauaʻi	City and County of Honolulu [a]	County of Kauaʻi	County of Maui	County of Hawaiʻi
				Recovery Strategy, December 2014	
Public Health Preparedness Plan [e]	**Yes** State of Hawai`i Health Risk and Vulnerability Assessment (2014)	**No**	**Yes** State of Hawai`i Health Risk and Vulnerability Assessment (2014)	**No**	**Yes** Discussed in terms of hazardous materials
Real Estate Disclosure [f]	**Yes**	**Yes** Real Estate Transactions Act	**Yes**	**Yes** Special Flood Hazard Area and Tsunami Inundation Area Exposure	**No**
Risk MAP Program	**No**	**No**	**No**	**No**	**No**
Sea Level Rise Study/Plan	**Yes** A technical study on sea level rise scenarios was commissioned to inform the General Plan and Community Development Plans; Kauaʻi Climate Change and Coastal Hazard Assessment Sea Grant Publication	**No** Discussed generally	**Yes** A technical study on sea level rise scenarios was commissioned to inform the General Plan and Community Development Plans; Kauaʻi Climate Change and Coastal Hazard Assessment Sea Grant Publication	**Yes** Sea level rise exposure assessment conducted as part of planning process; action identified to conduct community vulnerability assessments	**No** Discussed generally
Shoreline Setbacks	**Yes** Action identified to plan for variable setbacks and to update the Coastal Erosion Mitigation Plan; Erosion-based shoreline building setback ordinance has been adopted since plan development	**Yes** 60-foot setback for new subdivisions, which may not be adequate for increased erosion rates or longer lifespan facilities	**Yes** Action identified to plan for variable setbacks and to update the Coastal Erosion Mitigation Plan; Erosion-based shoreline building setback ordinance has been adopted since plan development	**Yes** Maui has erosion based setbacks that exceed minimum requirements	**Yes** Standard 40-foot setback is required, suggestion that this may not be sufficient in some areas
Site Plan Review	**No**	**Yes** Site Development Division	**No**	**Yes** County of Maui Code Title 12 and Title 16	**No**

Foundational Capability	County of Kauaʻi	City and County of Honolulu [a]	County of Kauaʻi	County of Maui	County of Hawaiʻi
Special Management Area Permits [g]	**Yes** Erosion planning and management activities through administration of the SMA	**Yes** Erosion planning and management activities through administration of SMA; Discussion of required permitting at different stage of development	**Yes** Erosion planning and management activities through administration of the SMA	**No** Discusses coastal zone management act generally	**Yes** Very limited discussion
State Hazard Mitigation Forum	**Yes** Extended into the Kauaʻi Disaster Management Committee	**Yes**	**Yes** Extended into the Kauaʻi Disaster Management Committee	**Yes** Mentioned as an existing program	**No**
Storm Ready/ Tsunami Ready [h]	**No**	**No**	**No**	**Yes** Mentions StormReady and TsunamiReady designations	**No**
Stormwater Management / Low Impact Development	**No** Drainage systems discussed in limited fashion	**Yes** Drainage systems approaches discussed	**No** Drainage systems discussed in limited fashion	**Yes** County of Maui Code Title 18 and Title 16; Maui Storm Water Management Program Plan	**Yes** Hilo Drainage and Flood Control Report; Drainage Master Plan for the County of Hawaiʻi (1971); Current drainage standards are based on a 10-year storm
Subdivision Requirements [i]	**Yes**	**Yes** Site Development Division; Uniform Land Sales Practices Act	**Yes**	**Yes** County of Maui Code Title 18	**Yes** Notes that Subdivision Chapter needs to be revised to include requirements for subdivisions within SFHAs
Threat & Hazard Identification & Risk Assessment (THIRA) [j]	**No**	**No**	**No**	**Yes** County of Maui THIRA	**No**
Water Management Plan	**Yes**	**Yes**	**Yes**	**No**	**Yes**

Foundational Capability	County of Kaua‘i	City and County of Honolulu [a]	County of Kaua‘i	County of Maui	County of Hawai‘i
	County of Kaua`i Drought Mitigation Strategies document (2004)	Honolulu Board of Water Supply	County of Kaua`i Drought Mitigation Strategies document (2004)	Discussion included on Water Conservation and Watershed Management Education	County of Hawai‘i Drought Mitigation strategies (2004); Indicates this document is being updated pending funding
Zoning Code or Land Use Ordinance [k]	**Yes**	**Yes** Last update was 2004	**Yes**	**Yes** County of Maui Code Title 19	**Yes** Existing mechanisms within the General Plan and Zoning Code allow the County to direct new development proposals away from known natural hazard locations

Note: Yes =Capability discussed in hazard mitigation plan, No = capability not discussed in hazard mitigation plan; Information presented in this table reflects information as it is presented in the County hazard mitigation plans unless otherwise noted. Codes, regulations, and/or plans may have been updated since the time of their publication.

a. An interim City and County of Honolulu HMP was developed and approved in 2017; however, this update included only limited information. Volume 1 of the 2012 local HMP was reviewed for this assessment.

b. The State Building Code is included in HAR §3-180 State Building Code; Counties may make local amendments; At the time of the 2018 HMP Update, not all counties have adopted the current version of the State Building Code, which includes provisions related to the special wind hazard in the State (See Section 4.9 [High Wind Storms] for additional discussion on wind hazards in the state. It should also be noted that the County of Kaua'i implemented a HMGP 5% initiative project to develop and adopt local wind amendments.

c. Progress on the development of Community Wildfire Protection Plans has occurred since the last updates of the County hazard mitigation plans. One new plan (Western Maui) was completed in 2015 (1 in County of Maui), 6 new plans (Kaua'i, Western O'ahu, Moloka'i, South Maui, Upcountry Maui, and North Kona) were completed in 2016 (1 covering County of Kaua'i, 1 in the City and County of Honolulu, 3 in County of Maui, and 1 in County of Hawai'i), 5 plans (Northwest Hawai'i Island, South Kona, Ocean View, Kau, and Volcano) were updated in 2016 (5 in County of Hawai'i), and 1 plan (Kahikinui) was slated to be updated during 2017/2018 (1 in County of Maui).

d. As of March 2018 there are 11 Firewise USA recognized sites in County of Hawai'i (8) and County of Maui (3).

e. There are no county equivalent public health agencies within the state; however, plans have been developed for all counties either directly by the Department of Health (for O'ahu) or via the District Health Offices of the Neighbor Islands (County of Kaua'i, County of Maui, and County of Hawai'i). In addition, the State of Hawai'i Health Risk and Vulnerability Assessment (2014) pertains to the entire state.

f. Disclosure of hazard risk is required in some real estate transactions by the State Uniform Land Sales Practices Act.

g. Special Management Area Permits are part of the State Coastal Zone Management Program and are administered at the County level

h. All four counties are Storm Ready and Tsunami Ready.

i. Required as part of the Uniform Land Sales Practices Act

j. County representatives have participated in the development of the State THIRA.

k. County government have regulatory authority over Urban District lands and shared authority over Agricultural and Rural District Lands. Conservation District lands are reserved for the State.

APPENDIX B MITIGATION STRATEGY

This appendix includes detailed information that supports the Mitigation Strategy discussion presented in Section 6 (Mitigation Strategy) of this document.

B.1 2013 HMP Progress Report

A comprehensive review and evaluation of the 2013 HMP actions is presented below.
Placeholder

B.2 Summary of Obstacles, Challenges and Opportunities

Placeholder

B.3 Local HMP Mitigation Strategy Roll-Up

Placeholder

B.4 2018 State Action Plan

B.4.1 2018 Mitigation Actions by Hazard

Placeholder

B.4.2 Action Plan Prioritization

Placeholder

B.4.3 Mitigation Action Worksheets

As discussed in Section 6 (Mitigation Strategy) the updated mitigation strategy was developed utilizing the four primary sources listed below:

- 2013 HMP Mitigation Strategy
- Risk Assessment
- Capability Assessment
- County Actions

The SHMO's vision was to ensure the updated mitigation strategy contained more detailed and 'actionable' mitigation actions to support implementation. The Forum, State agencies and stakeholders were provided capture tools (Mitigation Action Worksheets) to further assist in assessing the risk, evaluating potential actions/projects (qualitative alternatives analysis), and identifying new actions for implementation. Where applicable, mitigation projects have been documented with an action worksheet. The following presents the updated mitigation actions and prioritization in further detail that supplement the updated State mitigation action plan summarized in Tables 6.4.1 and 6.4-2, and high priority county actions summarized in Table 6.5-1.

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-001

Mitigation Action Title: Conduct non-structural retrofits of schools and hospitals in Hawaiʻi and Maui County

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☒Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Schools and hospitals built before current codes are at risk for non-structural damage that would render facilities inoperable even if there was no structural damage.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Demo and rebuild to the current code 3. Non-structural retrofit
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Assess and prioritize schools and hospitals 2. Prepare work plans 3. Procure funding 4. Implement
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Evacuation planning
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA / HETAC / DOE (Schools) / HAH (Hospitals)
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other: Retrofit related to building code
Potential Funding Sources	State DOE and DOH budgets; FEMA; PDM; HMGP

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short Term
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	3		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	3		EQ High Wind
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	3		
Is there an Agency/Department Local Champion for the action?	4		HIEMA - HETAC
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	54		
Priority: Low = <35 Medium = 35-49 High = >50	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-002

Mitigation Action Title: Multi-hazard, Non-Structural Retrofit of Hawaii & Maui County Hospitals and Schools

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☒Lānaʻi ☒Molokaʻi ☒Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	After the 2006 Kiholo Bay EQ several schools and hospitals were identified as potentially at risk for non-structural damage from earthquakes, hurricanes and flooding. (limited) emergency storage capacity, especially to those with special needs. An assessment is necessary to determine what actions are required to mitigation the potential damage and to provide the information necessary for a complete Hazard Mitigation Assistance application.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Rebuild at-risk schools and hospitals 3. Assess and prioritize schools and hospitals for non-structural retro fits.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Engage FEMA in a Cooperating Technical Partnership (CTP) to acquire technical assistance to assess the Hawaii & Maui County hospitals and schools for possible seismic, high wind and flooding non-structural vulnerabilities. The study would prioritize the hospitals and schools, prioritize non-structural actions, develop information for funding applications and develop documentation for benefit-cost analysis.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, HETAC
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Mitigation Grants, NEHRP,

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1 – 5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4 x 2 = 8	
Will the action result in <u>Property Protection</u>?	3	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	3	
Will the action have a positive impact on the natural <u>Environment</u>?	2	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department <u>Local Champion</u> for the action?	4	HETAC
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3	
Total	55	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	HI-EMA	**Mitigation Action #:**	2018-003
Mitigation Action Title:	Retrofit Of Kalaheo Gym-Emergency Sheltering		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Mass care, especially tropical cyclone evacuation shelters, is a top priority for the County of Kauai. There is a definite need to increase safe shelter spaces within the county. On going surveys estimate that about 27% of the population will seek shelter spaces during a hurricane.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do Nothing 2. Build a New Gym (Too Costly) 3. Build a Shelter (Too Costly)
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Facility is currently being renovated and the county desires to upgrade the structural integrity of the building, especially the roof. In consultation with HIEMA, additional funds of $450,000 from the State will be added to the scope of work to upgrade the gym to a Type A shelter which will be able to withstand Category 2 hurricane winds. This will add 924 shelter spaces to the West side of the island which is faced with a serious deficiency of shelter spaces.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, County of Kauai Department of Public Works
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	State CIP

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1-5 years
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Planning and Engineering Analysis Completed

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4 | x 2 = 8	
Will the action result in Property Protection?	4	
Will the action be Cost-Effective? (future benefits exceed cost)	4	
Is the action Technically feasible	4	
Is the action Politically acceptable?	4	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	4	
Will the action have a positive impact on the natural Environment?	3	
Is the action Socially acceptable?	4	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department Local Champion for the action?	4	County of Kauai Public Works
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3	
Total	58	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-004

Mitigation Action Title: Additional Mitigation Staffing

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	HI-EMA has been chronically understaffed for several years and as a result has missed several opportunities to advance numerous Mitigation opportunities, including project development and implementation, public outreach and education, and technical assistance to county and state partners.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Use EMAC at especially critical, disaster-related junctures 3. Advocate for State funding for three additional Mitigation positions at HI-EMA.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Document current shortfalls in implementing recent Mitigation opportunities, prepare justification for three additional positions, a Mitigation Planner to engage in the on-going State Hazard Mitigation Plan maintenance and provide technical assistance to up-coming Local Mitigation Plan updates, and a Mitigation Outreach Specialist to engage with other Emergency Management Programs and the PIO to provide better coordination, public education and technical assistance to County EMAs, and a Mitigation Technician with some engineering background to support the Shelter program and to engage with the Public Assistance staff on 406 Mitigation
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other:
Potential Funding Sources	State funding to DOD HI-EMA

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	5 + years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	3 x 2 = 6	
Will the action result in <u>Property Protection</u>?	3	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	3	
Will the action have a positive impact on the natural <u>Environment</u>?	2	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	3	
Is there an Agency/Department <u>Local Champion</u> for the action?	4	HIEMA
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3	
Total	49	
Priority: Low = <35 Medium = 35-49 High = >50	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HETAC / HIEMA **Mitigation Action #:** 2018-005

Mitigation Action Title: Earthquake Mitigation Training

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☒ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Live training in earthquake mitigation design professionals and public officials.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Web-based training 2. Generalized outreach 3. No action
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Working with the public and private sections to determine specific training needs.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Evacuation planning
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HETAC / HIEMA
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☒Other: Retrofit related to building code
Potential Funding Sources	HIEMA

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	2		
Will the action have a positive impact on the natural <u>Environment</u>?	4		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	58		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High (marked as medium)		

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Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-006

Mitigation Action Title: Implement Actions from Natural Disaster Economic Recovery Strategy

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	In 2014 the Hawaii Office of Planning, Department of Business, Economic Development & Tourism developed a Natural Disaster Economic Recovery Strategy for pre-disaster business continuity planning and post-disaster recovery actions for both public and private sector, with a focus on small business. The NDERS culminated in forty-nine recommendations which for the most part remain to be implemented.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action: HDERS remains an un-implemented strategy. 2. Redo the planning process to develop a new strategy. 3. Re-engage with the NDERS stakeholders to begin implementing strategies.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Coordinate with the Office of Planning to re-engage with the NDERS stakeholders 2. Review prioritize recommendations with a focus on implementation 3. Identify strategy “champions” and potential funding sources 4. Provide logistical support to champions and support agencies 5. Schedule regular follow up stakeholder meetings track progress and identify gaps and solution
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Education and outreach
Potential Funding Sources	FEMA, EDA, Static Funding

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	2	x 2 = 4	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	3		
Is the action Technically feasible	3		
Is the action Politically acceptable?	3		
Does the jurisdiction have the Legal authority to implement?	3		
Is Funding available for the action?	3		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	3		
Does the jurisdiction have the Administrative capability to execute the action?	3		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	3		
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	46		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-007

Mitigation Action Title: Enhance coordination between HI-EMA and DLNR on Flood Mitigation Projects

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☐Drought ☐Earthquake ☒ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The State of Hawaii is vulnerable to the flood hazards. Recent events have highlighted the vulnerability as evidenced by the 2018 event (DR-4062) due to severe storms, flooding and landslides. Impacts have been to roads, bridges and structures. The HI-EMA is committed to reduce the number of repetitive and severe repetitive loss properties in the State as outlined in Section 6 (Mitigation Strategy).
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing – not preferred flood vulnerability continues and may get worse based on changing future conditions 2. Increase coordination with DLNR to leverage FEMA mitigation funding (PDM, FMA and HMGP) to implement flood mitigation projects throughout the State – preferred and selected project 3. Entities operate separately to mitigate flood losses – not preferred; increased coordination and collaboration is needed to fully maximize State capabilities
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	The HI-EMA will continue to work with DLNR to identify flood vulnerability, identify flood mitigation projects and provide technical assistance to secure grant funding to implement the mitigation projects to reduce flood losses in the State. Mitigation measures may include but are not limited to structural projects, plans, studies, outreach and training.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☒ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA with DLNR support
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	Existing state budget

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	
Status/Component	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	2		
Will the action have a positive impact on the natural <u>Environment</u>?	4		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		HI-EMA State Hazard Mitigation Officer
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	56		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-008

Mitigation Action Title: Long Term Plan for GIS Staff, Training, and Technology – Implementation of GIS Assessment

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	GIS, as a system of components that play a vital role to facilitate the coordination, collection, and dissemination of geographic information. A GIS system is comprised of 5 key components – hardware, software, data, people, and methods. Together GIS can help decision makers: MITIGATE - identify and prioritize threat levels to develop plans for evacuations and containment, PREPARE – inventory and assess assets and capabilities, training and exercises, inform the public, RESPOND - visualize and share real-time situations, dispatch first responders, direct limited resources, and RECOVER – via mapping damaged infrastructure, affected populations, and resources to more efficiently coordinate recovery efforts. HI-EMA should implement the recommendations of the GIS Assessment to facilitate communication and shared situational awareness between State and County EOCs.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Proceed - GIS/IT trained staff can facilitate communication and situational awareness between State and County EOCs 2. Do nothing - no GIS support in EOC or IT support untrained in GIS, lack of readily available situational awareness between State and Counties 3. Partial implementation - GIS staff, no training, no shared situational awareness OR GIS trained IT staff with minimal time devoted to GIS
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1) Hire GIS staff 2) Acquire GIS resources (hardware, software, people, data, and methods) to fit State EOC needs and scale up as situation and County acceptance proceeds 3) Assess GIS system during exercise and adjust as resources and situation dictates
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☒Other Describe: GIS implementation to provide situational awareness between State and County EOCs.
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount:
Plan for Implementation	
Responsible Department/Organization	HI-EMA should lead this action and conduct outreach, training and establish methods to Counties to facilitate communication and situational awareness between EOCs.
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Grants, cost reduction through State/ESRI (ArcGIS developer) Enterprise Licensing Agreement for software license and instructor-led training, County matching funds

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Implementation of the recommendation of the GIS Assessment is a long term (2-4 years) plan designed to guide scale the statewide GIS for EOCs as needed based upon the hazard or situation.
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	3 x 2 =	GIS can be used to aid decision makers in preventing loss of life
Will the action result in Property Protection?	3	GIS can aid decision makers in protecting property
Will the action be Cost-Effective? (future benefits exceed cost)	4	GIS can aid decision makers in making cost effective decisions
Is the action Technically feasible	4	Yes
Is the action Politically acceptable?	4	GIS can provide analysis to support policy
Does the jurisdiction have the Legal authority to implement?	3	Will need MOU between State and County to facilitate data sharing
Is Funding available for the action?	3	FEMA grants, FEMA Corps, cost reduction through ESRI (ArcGIS developer) Enterprise Licensing Agreement for software licensing, and cost reduction and cost sharing of training with Counties is possible.
Will the action have a positive impact on the natural Environment?	3	GIS analysis can provide decision makers with information to have a positive impact on the natural environment.
Is the action Socially acceptable?	4	Yes
Does the jurisdiction have the Administrative capability to execute the action?	4	MOU between State & County agencies necessary to ensure data sharing to execute action.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	3	GIS can aid in risk reduction for multiple hazards.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	Yes
Is there an Agency/Department Local Champion for the action?	4	HI-EMA, with assistance from County EOCs
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Yes, implementation of GIS should support policies, plans and programs.
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-009

Mitigation Action Title: Short Term Plan for GIS Staff, Training, and Technology – GIS Needs Assessment

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	GIS, as a system of components that play a vital role to facilitate the coordination, collection, and dissemination of geographic information. A GIS system is comprised of 5 key components – hardware, software, data, people, and methods. Together GIS can help decision makers: MITIGATE - identify and prioritize threat levels to develop plans for evacuations and containment, PREPARE – inventory and assess assets and capabilities, training and exercises, inform the public, RESPOND - visualize and share real-time situations, dispatch first responders, direct limited resources, and RECOVER – via mapping damaged infrastructure, affected populations, and resources to more efficiently coordinate recovery efforts. HI-EMA should conduct a GIS needs assessment to inventory available resources and assess how to best leverage existing resources with technology to facilitate situational awareness between State and County EOCs..
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Proceed - GIS/IT trained staff can facilitate communication and situational awareness between State and County EOCs 2. Do nothing - no GIS support in EOC or IT support untrained in GIS, lack of readily available situational awareness between State and Counties 3. Partial implementation - GIS staff, no training, no shared situational awareness OR GIS trained IT staff with minimal time devoted to GIS, minimal shared situational awareness
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1) Contract GIS consultant to conduct GIS needs analysis; 2) Inventory and assess existing State and County EOC hardware, software, people, data, and methods for use in GIS 3) Analyze results and provide recommendations for implementing statewide GIS for EOCs that leverage existing resources, are cost effective, and technologically feasible.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☒Loss of Function ☒Other Describe: GIS needs assessment will inventory and assess available resources, identify gaps in data and resources, and provide recommendations, justification, and identify possible funding sources on how to implement a GIS to provide situational awareness between State and County EOCs.
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount:
Plan for Implementation	
Responsible Department/Organization	HI-EMA should lead this action and conduct outreach to Counties to identify available hardware, software, people, and data resources.
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Grants, cost reduction through State/ESRI (ArcGIS developer) Enterprise Licensing Agreement for software license and instructor-led training

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	This GIS Needs Assessment is a short term, <1 year, plan designed to guide implementation of a long term plan to implement a statewide GIS for EOCs.
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	3 x 2 =	Assessment will provide guidance for the implementation of GIS which can be used to aid decision makers in preventing loss of life
Will the action result in Property Protection?	3	Assessment will provide guidance for the implementation of GIS to aid decision makers in protecting property
Will the action be Cost-Effective? (future benefits exceed cost)	4	Assessment will provide guidance for the implementation of GIS can aid decision makers in making cost effective decisions
Is the action Technically feasible	4	Technology is currently available to make situational awareness implementation feasible
Is the action Politically acceptable?	4	Assessment will provide guidance for the implementation of GIS which can provide analysis to support policy
Does the jurisdiction have the Legal authority to implement?	4	Yes
Is Funding available for the action?	3	FEMA grants, cost reduction through ESRI (ArcGIS developer) Enterprise Licensing Agreement for software licensing, and cost reduction and cost sharing of training with Counties is possible.
Will the action have a positive impact on the natural Environment?	2	Assessment does not have direct impact
Is the action Socially acceptable?	4	GIS solutions, analysis, and models are socially acceptable.
Does the jurisdiction have the Administrative capability to execute the action?	4	MOU between State & County agencies necessary to ensure data sharing to execute action.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	3	Assessment will provide guidance for the implementation of GIS applicable statewide and could aid in risk reduction for multiple hazards.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	Yes
Is there an Agency/Department Local Champion for the action?	4	HI-EMA, with assistance from County EOCs
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Yes, implementation of GIS staff and training should support policies, plans and programs.
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-10

Mitigation Action Title: Water Bags for Distribution

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	After a disaster, water can be in short supply. Many folks are unprepared to store water. HI-EMA recommends at least one gallon per person per day for at least 14 days. This program would partner with the Boards of Water Supply and Non-Governmental Organizations purchase and distribute 1-gallon water containers to remind folks to store water and to provide (limited) emergency storage capacity, especially to those with special needs.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Provide larger, bulkier water storage containers 3. Provide 1-gallon storage containers as a reminder and as emergency capacity
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	HI-EMA will coordinate with the Honolulu Board of Water Supply (BWS) to purchase collapsible, 1-gallon water bags with an imprinted reminder to store 1-gallon of water per person per day for at least 14 days in preparation for an impending event. HI-EMA and BWS will coordinate with various partners to distribute the water bags at various events prior to the next hurricane season.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, Honolulu Board of Water Supply
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: State HMP and Emergency Operations Plan
Potential Funding Sources	FEMA Mitigation Grants, Tsunami Mitigation Program, Honolulu Board of Water Supply, Donations

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1 – 5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	3	x 2 = 6	
Will the action result in <u>Property Protection</u>?	1		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	4		
Will the action have a positive impact on the natural <u>Environment</u>?	2		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		Honolulu BWS
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	52		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-011

Mitigation Action Title: Housing Vulnerability Assessment

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Hawaii has a shortage of shelter spaces for the immediate pre (for hazards with some lead time) and post event needs. The gap can be addressed with a combination of strengthening the existing housing stock through retrofits and building code upgrades and strengthening public buildings to serve as evacuation shelters.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Implement stronger building codes on all new residences and public buildings 3. Assess and prioritize public buildings for retrofits.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Engage FEMA in an Inter-Agency Agreement (IAA) with the EPA Smart Growth program to conduct a housing stock and social vulnerability assessment for possible seismic, high wind and flooding vulnerabilities. The study would prioritize the retrofit actions, including incentives for homeowners to strengthen their residences, and to develop guidance for shelter retrofit guidance consistent with FEMA's Pre-Disaster Mitigation grant program guidance.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, HETAC
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Mitigation Grants, NEHRP,

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1 – 5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	3		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		HETAC
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	56		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-012

Mitigation Action Title: Retrofit of the Kauai War Memorial Convention Hall (KWMCH)-Emergency Shelter

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Mass care, specifically tropical cyclone evacuation shelters, is a top priority of the County of Kauai. A USACE study estimates that 27% of the population will seek shelter. Presently, there is a significant shortage of shelter spaces in the county (exact numbers being determined by on-going surveys).
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Upgrade to the highest level (too costly) 3. Build a shelter (too costly)
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Structural Analysis to determine suitability of KWMCH to serve as an emergency shelter and to determine scope of work. The retrofit will include hardening of the doors (33) and windows (40) which will serve as a minimum Type B Shelter (category 1 hurricane). This project will add about 1,668 shelter spaces for the County and the heavily populated area of Lihue. This increases by 44% the amount of residents/visitors seeking shelters during hurricanes in the central portion of the Island.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, County of Kauai Department Parks and Recreation
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	State CIP funds

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1-5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	3		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		County of Kauai Department of Parks & Recreation
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	58		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-013

Mitigation Action Title: Retrofit of Molokai High School Gym-Emergency Shelter

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☒Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The island of Molokai in the County of Maui presently has no suitable hurricane shelters. This is a life-saving issue that must be addressed immediately.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do Nothing 2. Complete Retrofit of Gym (Too Costly) 3. Build Shelters (Too Costly)
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	This facility involves extensive retrofit of the doors and windows as well as some structural measures. An engineering analysis has been completed which certified that the building is suitable to be designated as an emergency shelter. This will create 1,500 shelter spaces to an island which has none at this time. When completed this facility will be a Type B Shelter-category 1 hurricane.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, State Department of Education, State Department of Accounting and General Services
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	State CIP Funds, HMGP

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1-5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	3		
Will the action have a positive impact on the natural <u>Environment</u>?	3		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		HI-EMA
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	57		
Priority: **Low** = <35 **Medium** = 35-49 **High** = >50	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-014

Mitigation Action Title: Retrofit of Molokai High School Locker Room and Cafeteria-Emergency Shelter

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☒Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	This project will provide safe haven for the residents of Molokai when a hurricane strikes the island. Presently, there are no suitable emergency shelters on this island.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do Nothing 2. Completely Retrofit the Facilities (Too Costly) 3. Build a Shelter (Too Costly)
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	This project will involve the hardening of doors and windows to create Type B shelters which will withstand hurricane force winds up to category 1. A total of 600 emergency shelter spaces will be created on an island which has none at this time. An engineering evaluation of the buildings has been accomplished which certified that the buildings are sound to serve as emergency shelters.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, State Department of Education, State Department of Accounting and General Services
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	State CIP Funds

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1-5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	3		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		HI-EMA
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	58		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-015

Mitigation Action Title: Retrofit of Kapaa Middle School-Emergency Shelter

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Emergency Sheltering is needed for the well-being for our residents during tropical cyclone events which threatens the State annually. There is a significant shortfall of emergency shelter spaces in the county.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Completely Retrofit the School (Too Costly) 3. Build a Shelter (Too Costly)
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	An engineering analysis has been conducted to insure that the school buildings are structural sound to serve as shelters. Four quads (classrooms) will have the doors and windows hardened to become Type B Shelters (category 1 hurricane). This increase emergency shelter spaces by 600 in a county where there is a serious shortfall.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA, State Department of Education, State Department of Accounting and General Services
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	State CIP Funds

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	1-5 years
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	4		
Will the action have a positive impact on the natural <u>Environment</u>?	3		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		HI-EMA
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	58		
Priority: Low = <35 Medium = 35-49 High = >50	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-016

Mitigation Action Title: Development of Standard Operating Procedures for State Technical Assistance Program for County Local Hazard Mitigation Plans and Mitigation Activities

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	During the period of performance of the 2013 HMP, limited resources were available to provide a linkage between the local plans and the HMP. This made it challenging to roll-up the local plans into the 2018 HMP Update that is required by FEMA. It is the current SHMO's vision to get all four counties on the same local HMP update cycle. The HI-EMA envisions that this will allow for wise use of resources and better coordination of risk assessment and mitigation strategies among the counties and with the State. In addition, it is the intention of the HI-EMA to develop a standard operating procedure for state technical assistance program for local county hazard mitigation plans and mitigation activities, implement an annual review coordinated with and through the annual mitigation program consultation with FEMA Region IX.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing – this will not provide greater assistance to the counties to have plans that contain information for the local roll-up required by FEMA for the next State HMP update 2. Provide training to counties describing framework for local HMPs – this does not provide the counties a reference to refer to but does provide HI-EMA the opportunity to provide assistance 3. Development of Standard Operating Procedures for State Technical Assistance Program for County Local Hazard Mitigation Plans and Mitigation Activities – best alternative to provide the greatest benefit to the State and Counties
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	The HI-EMA will develop a standard operating procedure for providing counties technical assistance in updating their local hazard mitigation plans and implementing hazard mitigation actions to reduce future losses in the State.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☐Goal #1 ☐Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☒ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA Mitigation Section
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hazard Mitigation Plan
Potential Funding Sources	FEMA HMGP

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	Hazard mitigation plans provide the action plan to implement projects that result in life safety
Will the action result in Property Protection?	4		Hazard mitigation plans provide the action plan to implement projects that result in property protection
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	2		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		HI-EMA may request contractor assistance to develop but can manage the project
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		HI-EMA State Hazard Mitigation Officer
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	56		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM) **Mitigation Action #:** 2018-017

Mitigation Action Title: Monitor water resources and conduct drought forecasts and impact assessments.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	**Drought is a slow-onset natural hazard. Monitoring and forecasting drought is important for managing this hazard through early mitigation and preparedness actions as well as response actions.**
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No action – not chosen since it does not offer a solution to the problem. 2. Use private weather company – not feasible due to cost 3. Utilize CWRM staff to conduct drought forecasts – not trained for this specialized skill
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Continue to and expand monitoring of hydrologic elements (rainfall, stream flow, reservoir water levels, ground water levels). 2. Improve drought forecasting 3. Increase drought research 4. Collaborate with the National Integrated Drought Information System See Hawaii Drought Plan 2017 Update for more details
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☐ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Land and Natural Resources, Commission on Water Resource Management
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hawaii Drought Plan
Potential Funding Sources	Federal (NOAA), State (CWRM, University of Hawaii), County (water departments)

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	Ongoing and Long Term
Reporting on Progress	
Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Some actions are ongoing and some are not started.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	2x 2 = 4	
Will the action result in <u>Property Protection</u>?	3	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3	.
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	2	
Will the action have a positive impact on the natural <u>Environment</u>?	2	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	Will also reduce risk to wildland fire hazard
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department <u>Local Champion</u> for the action?	4	
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3	
Total	48	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM) **Mitigation Action #:** 2018-018

Mitigation Action Title: Increase water conservation, reuse, and recharge.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	**The archipelago state of Hawaii is surrounded by the Pacific Ocean and relies 100% on rainfall for its fresh water supplies. Reduced rainfall due to drought affects Hawaii's fresh water supply. To increase drought resilience, the state must make the most efficient use of available rainfall through water conservation, reuse of storm water and recycled waste water, and increasing groundwater recharge.**
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No action – not chosen since it does not offer a solution to the problem. 2. Issue mandatory water restrictions – not chosen since it is not a mitigation action 3. Require mandatory wastewater reuse for all new developments – this would require multiple ordinance and rule modifications and would likely be opposed by developers
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Implement the Hawaii Water Conservation Plan 2. Incentivize and promote reuse (e.g., grants, rebates, policies, etc.) 3. Protect and restore watersheds important to water supply (e.g., fencing, invasive species removal, replanting, etc.) See Hawaii Drought Plan 2017 Update for more details
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Loss of Function ☒Other Describe: Provide fresh water security for the state of Hawaii by maintaining/increasing water supply
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR – CWRM, DLNR – DOFAW, County water and wastewater departments, County planning departments
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☒Ordinance ☒Other: Hawaii Water Conservation Plan; Hawaii Drought Plan
Potential Funding Sources	Federal (Bureau of Reclamation Title XVI program), State (CWRM, DOFAW Watershed Grant), County (water departments, watershed funding), Private grant funding

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	Projects would range from ongoing to short and long term.
Reporting on Progress	
Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Some projects in-progress while some not started

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	2x 2=4	
Will the action result in <u>Property Protection</u>?	2	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	2	
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	3	
Is <u>Funding</u> available for the action?	2	
Will the action have a positive impact on the natural <u>Environment</u>?	4	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	Will also reduce risk to wildland fire hazard
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	3	
Is there an Agency/Department <u>Local Champion</u> for the action?	4	
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Supports the Hawaii Water Conservation Plan and the Freshwater Initiative/Water Security programs
Total	47	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM) **Mitigation Action #:** 2018-019

Mitigation Action Title: Support the Hawaii Association of Watershed Partnerships

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Healthy watersheds are key to a resilient and robust water supply. The Hawaii Association of Watershed Partnerships protects and restores watersheds to ensure that water is captured efficiently to replenish and maintain our water supplies, which are especially important during drought periods.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No action – not chosen since it does not offer a solution to the problem 2. Institute a watershed tax/fee – not chosen since it would be difficult to establish equitable rates, is unpopular, and would be very difficult to manage administratively statewide 3. Establish and support an alternative watershed association – not feasible and would be opposed by current watershed partnerships
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Seek dedicated, long term funding for watershed protection, restoration, and maintenance 2. Support forest stewardship programs See Hawaii Drought Plan 2017 Update for more details
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☐ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Loss of Function ☒Other Describe: Increases the protection of Hawaii's watersheds
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR - DOFAW
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Respective watershed partnership action/protection plans; Hawaii Drought Plan
Potential Funding Sources	Federal (USDA Forest Service), State (DOFAW Watershed Grant, general funds), County (water departments), private (Firewise Grant), Private funding

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	Projects would range from ongoing to short and long term.
Reporting on Progress	
Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Some projects in-progress while some not started

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	2x 2=4	
Will the action result in Property Protection?	2	
Will the action be Cost-Effective? (future benefits exceed cost)	3	
Is the action Technically feasible	4	
Is the action Politically acceptable?	4	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	3	
Will the action have a positive impact on the natural Environment?	4	
Is the action Socially acceptable?	4	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	Will also reduce risk to wildland fire hazard
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	3	
Is there an Agency/Department Local Champion for the action?	4	
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Supports Hawaii Association of Watershed Partnerships
Total	51	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM) **Mitigation Action #:** 2018-020

Mitigation Action Title: Develop water sources.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	**During drought, it is important to have multiple/backup water sources to ensure uninterrupted water supply to end users or customers. Developing backup water sources in strategic locations would improve a water supply's resilience during drought.**
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Construct water transmission pipelines between islands – too expensive and would face numerous environmental challenges 2. Establish desalination plants – not feasible due to high electricity prices 3. Ship water between islands – too expensive and would require several transportation segments
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Encourage counties to develop emergency or backup water supplies 2. Encourage county water departments to develop their own drought/water shortage plans 3. Encourage counties to explore the use of alternative sources of water for non-potable uses (e.g., recycled wastewater, storm water) See Hawaii Drought Plan 2017 Update for more details
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☐ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☒Loss of Function ☐Other Describe: Community preparedness
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	County water departments, public and private water purveyors, irrigation system owner/operators
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hawaii Drought Plan
Potential Funding Sources	Federal (EPA Drinking Water State Revolving Funds), State (DLNR – Engineering Division CIP), County (water department CIP), Private funding (water system owners/operators)

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	Projects would range from ongoing to short and long term.
Reporting on Progress	
Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Some projects in-progress while some not started

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	2x 2 = 4	
Will the action result in Property Protection?	2	
Will the action be Cost-Effective? (future benefits exceed cost)	3	.
Is the action Technically feasible	4	
Is the action Politically acceptable?	4	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	3	
Will the action have a positive impact on the natural Environment?	2	
Is the action Socially acceptable?	3	
Does the jurisdiction have the Administrative capability to execute the action?	3	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	2	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	2	
Is there an Agency/Department Local Champion for the action?	3	
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3	May align with County water departments' capital improvement plans
Total	42	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Commission on Water Resource Management (CWRM) **Mitigation Action #:** 2018-021

Mitigation Action Title: Provide drought public education awareness and outreach.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	**Communities, sectors and stakeholders impacted by drought may not have the capacity to prepare for and respond to drought. Drought outreach and awareness will help to improve overall preparedness for drought.**
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No action – not chosen since it does not offer a solution to the problem 2. Ask stakeholders to conduct own outreach/education – many impacted stakeholders (e.g., agricultural producers) do not have time or resources to do this 3. Request federal government to establish a dedicated drought outreach office in Hawaii – not feasible and many federal agencies already partner to create drought awareness
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Continue to promote drought awareness campaigns and public outreach events (e.g., Wildfire & Drought LOOK OUT!; Halawa Xeriscape Garden Open House and Unthirsty Plant Sale, etc.) 2. Seek cooperative outreach & education opportunities with agricultural agencies and organizations to promote drought awareness and conservation actions 3. Encourage water purveyors, businesses, and agricultural producers to develop individual drought plans See Hawaii Drought Plan 2017 Update for more details
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☐ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Loss of Function ☒Other Describe: Community preparedness
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR – CWRM; county water departments; Soil & Water Conservation Districts
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hawaii Drought Plan

State of Hawaiʻi
Mitigation Action Worksheet

Potential Funding Sources	Federal (USDA, NOAA), State (CWRM; DOFAW; University of Nebraska – NDMC), County (water departments), Private funding
Timeline for Completion: **Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)**	Projects would range from ongoing to short and long term
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: This is an ongoing, programmatic action

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	2x 2 = 4	
Will the action result in <u>Property Protection</u>?	3	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	2	.
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	3	
Will the action have a positive impact on the natural <u>Environment</u>?	3	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	3	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	Drought education and awareness is an ongoing program in many agencies
Is there an Agency/Department <u>Local Champion</u> for the action?	4	.
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Supports policies and plans of CWRM, DOFAW, county water departments
Total	49	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA/DLNR **Mitigation Action #:** 2018-022

Mitigation Action Title: Statewide Public Information Campaign to Increase Citizen Resilience to Flooding

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Property owners with a Federally-backed mortgage that have structure(s) located inside a Special Flood Hazard Area on FEMA FIRMs are required to have flood insurance, However, many property owners who have paid off their mortgage or are outside these zones are also at risk to flooding but likely have not maintained or have optionally purchased flood insurance. Public awareness and understanding of what insurance policies cover would encourage citizen resilience to flooding. This campaign would explain the three types of insurance homeowners should have: basic for property/fire, hurricane, and flood. For example, hurricane insurance doesn't cover flooding unless flooding occurs from a wind-driven rain. This public information campaign should be conducted annually well before hurricane season starts because there is a standard 30-day waiting period for new applications and for endorsements to increase coverage, with some exceptions. It's important to note that in 2017, the National Flood Insurance Program (NFIP) committed to a multi-year effort to close the insurance gap across the nation called Moonshots. Through public outreach campaigns to increase the flood insurance policy base in both new and renewal policies, the NFIP is reaching for the moon by declaring to double the number of structures insured against flood risks by 2023. David Maurstad (FEMA) said, "we know insured survivors recover faster and more fully from a flood than uninsured survivors. We are driven to build a culture of preparedness, be ready for catastrophic disasters and reduce complexity for our policyholders and stakeholder partners." Therefore, this mitigation action would compliment FEMA's moonshot initiative. The effectiveness of such a campaign can be measured as % increase in the number of flood insurance policies compared to baseline.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action: citizens without flood insurance will continue to risk insurmountable financial loss during flood events. 2. Give presentations to neighborhood boards: expensive and inadequate reach 3. Work with insurance carriers to advertise the need for flood insurance: cost for insurance carriers but they may interested in pursuing after the information campaign
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Work with federal agencies with a role in insurance and State insurance regulator (DCCA) to develop campaign strategy and key messages. 2. Develop a public information campaign including public service announcements, fact sheets, and other forms of communication on the types of insurance and the need to purchase flood insurance. 3. Measure change in the number of active flood insurance policies compared to baseline levels. As of February 2018, there are 60,423 active flood insurance policies statewide.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	

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Mitigation Action Worksheet

Responsible Department/Organization	HI-EMA and DLNR
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Education and outreach
Potential Funding Sources	FEMA
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	2 x 2 = 4	
Will the action result in Property Protection?	4	
Will the action be Cost-Effective? (future benefits exceed cost)	4	
Is the action Technically feasible	4	
Is the action Politically acceptable?	3	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	4	
Will the action have a positive impact on the natural Environment?	2	
Is the action Socially acceptable?	3	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department Local Champion for the action?	3	
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	51	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	DLNR and DOT	**Mitigation Action #:**	2018-023

Mitigation Action Title: Integrated Hazard Mitigation of State Coastal Highways and Beaches from Chronic Coastal Flooding

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Segments of State coastal highways are eroding due to annual high waves and coastal erosion exacerbated by sea level rise. The State is constantly engaged in repairing these segments to protect human safety and transportation. For many communities, coastal highways are the only way into or out of an area. Similarly, 75% of Hawaii's beaches are eroding due to a similar combination of hazards. The landward migration of beaches with sea level rise will be impeded by coastal highways and other structures resulting in the permanent loss of beaches for shoreline protection, recreational and cultural purposes and critical habitat for the Hawaiian monk seal. Some segments of coastal highways cross geological features such as sand deposits and dunes. In these areas, the redesign of coastal highways to enable landward beach migration would provide an opportunity to support multiple hazard mitigation objectives to protect human safety, reduce structure loss, and protect beaches that serve as natural buffer to waves and habitat to wildlife and reef ecosystems.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No action. Loss of coastal highways are already occurring statewide and permanent loss of beaches 2. Transportation mitigation only. Potential for unintended consequences of permanent loss of dunes and beaches that can serve as natural buffer. 3. Beach conservation only. Cannot be addressed without consideration of coastal highways and other structures.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Identify coastal highway segments across the state based on vulnerability to coastal hazards exacerbated by sea level rise and geological and physical viability for landward beach migration. 2. Select top five state coastal highway segments, in consultation with county and community stakeholders, to develop coastal highway mitigation alternatives and evaluate feasibility of each alternative. 3. Develop design specifications and implementation plan for the preferred alternative for each coastal highway segment 4. Implement coastal highway-beach mitigation
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☒Other Describe: Ecosystem Services, Habitat for Endangered Monk Seal
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Hawaiʻi Department of Land and Natural Resources, Office of Conservation and Coastal Lands Hawaiʻi Department of Transportation, Highways Division
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hawaiʻi Sea Level Rise Vulnerability and Adaptation Report; Hawaiʻi Ocean Resources Management Plan

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Potential Funding Sources	FEMA, Federal DOT, State DLNR and DOT
Timeline for Completion: **Short (1-5 years), Long Term (5 years or greater), OG (On-going program)**	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4 x 2 = 8	
Will the action result in Property Protection?	4	
Will the action be Cost-Effective? (future benefits exceed cost)	4	
Is the action Technically feasible	3	
Is the action Politically acceptable?	2	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	2	
Will the action have a positive impact on the natural Environment?	4	
Is the action Socially acceptable?	3	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department Local Champion for the action?	3	
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-024

Mitigation Action Title: Reduce and/or convert hazardous fuels on fallow agricultural lands.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	With the passing of the plantation era in both sugar and pineapple production, including the closure of the State's last sugar plantation in 2016, abandoned agricultural land is susceptible to invasive, fire prone grasses and shrubs, thereby increasing fire risk to nearby communities and conservation land.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Prescribed Fire: Prescribed fire is used by a few agencies in specific areas to reduce hazardous fuel. However, prescribed fire smoke can have significant public health and safety impacts. Also, invasive, fire prone grasses grow back quickly after being burned.
	2. Pave, gravel, or plow under all agricultural land to remove invasive, fire prone grasses and shrubs. Although this would reduce fire risk, loss of land for farming and reforestation would occur and large tracts of land with exposed soil would be susceptible to erosion.
	3. No Action. Over 25% of the State is covered by invasive, fire prone grasses and shrubs. Abandoned agricultural land is susceptible to invasive, fire prone grasses and shrubs, thereby increasing fire risk to nearby communities and conservation land
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Implement fuel management through alternative land uses, such as reforestation and active agriculture. Also create and maintain fuel and fire breaks.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW and DOA
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans; Private Landowner Assistance Program Management Plans
Potential Funding Sources	USFS Grant (Federal Funds); Private Landowner Assistance Programs (State and Federal Funds); Private Sector Funds
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	OG
Reporting on Progress	

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Mitigation Action Worksheet

Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Routine maintenance as well as reforestation and farming done on an ongoing basis. However, additional land is in need of implementing fuel management.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	3	x 2 = 6	
Will the action result in <u>Property Protection</u>?	3		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		Native ecosystems in Hawaii evolved with little or no fire. Wildfire is a threat to native forests, including watersheds (the Governor's Hawaii Sustainable Initiative aims to protect 30% of priority watersheds by 2030) and threatened and endangered species (Hawaii has the highest number of species listed as threatened and endangered in the U.S.). Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	4		
Will the action have a positive impact on the natural <u>Environment</u>?	4		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	0		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		Rainfall and mild temperatures that occur throughout the year contribute to a year-round growing season, thus requiring continual maintenance. Over 25% of the State is covered by invasive, fire prone grasses and shrubs, which grow back quickly after being cleared
Is there an Agency/Department <u>Local Champion</u> for the action?	3		Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state jurisdictions.
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	52		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-025

Mitigation Action Title: Reduce and/or convert hazardous fuels in the Wildland Urban Interface (WUI) to reduce the threat of wildfires to communities and conservation land near them.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Reducing and/or converting hazardous fuels in the WUI slow the spread of fire and stop the grass fire cycle through fuel breaks, including greenbreaks or vegetated fuel breaks; managed grazing; and as necessary, prescribed burns. Over 25% of the state is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Wildfires in the WUI have been carried rapidly by invasive grasses into forested watersheds, which recharge water supplies, control erosion and run off, and supply culturally important plants.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Instead of encouraging voluntary mitigation actions, force regulations upon land owners which may not be socially or politically acceptable.
	2. Deforest, pave, gravel, or plow nearby conservations areas abutting developed areas to remove fuel. Although this would reduce fire risk, it would be in conflict with DOFAW's mission which is to responsibly manage and protect watersheds, native ecosystems, and cultural resources and provide outdoor recreation and sustainable forest products opportunities, while facilitating partnerships, community involvement and education.
	3. No action. Wildfires will continue to threaten communities and conservation land nearby. Wildfires cause losses, which often exceed the cost of mitigation.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Implement fuel breaks, including greenbreaks or vegetated fuel breaks; managed grazing; and as necessary, prescribed burns. Increase plant propagation for outplantings in the greenbreaks.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR, DHHL, DOA, County Fire Departments, HWMO
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; State Fire Code: Chapter 17 WUI; Hawaii Forest Action Plan; Community Wildfire Protection Plans; DOFAW Management Plans; Watershed Management Plans; Private Landowner Assistance Program Management Plans
Potential Funding Sources	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grants (Federal Funds); Private Landowner Assistance Programs (State and Federal Funds); Private Sector Funds
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Routine maintenance and restoration done on an ongoing basis. However, additional land is in need of restoration, which would stop the grass fire cycle by converting invasive dominated grassland to native forest.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	3	x 2 = 6	
Will the action result in Property Protection?	3		
Will the action be Cost-Effective? (future benefits exceed cost)	4		Native ecosystems in Hawaii evolved with little or no fire. Wildfire is a threat to native forests, including watersheds (the Governor's Hawaii Sustainable Initiative aims to protect 30% of priority watersheds by 2030) and threatened and endangered species (Hawaii has the highest number of species listed as threatened and endangered in the U.S.). Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	0		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Rainfall and mild temperatures that occur throughout the year contribute to a year-round growing season, thus requiring continual maintenance. Over 25% of the State is covered by invasive, fire prone grasses and shrubs, which grow back quickly after being cleared.
Is there an Agency/Department Local Champion for the action?	2		Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state and county jurisdictions, including the WUI.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	51		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-026

Mitigation Action Title: Assess, identify, and implement state nursery improvements needed to provide native plants for green breaks.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Green breaks help shade out grass to break the grass fire cycle, by replacing non-native, invasive grasses and shrubs with mostly native plants and trees.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Purchase plants from contractors. Plant propagation through state facilities allows for setting pest control standards and ensuring those standards are met. 2. Prescribed fire instead of plant propagation for green breaks. Since native ecosystems in Hawaii evolved with little or no fire, it is not appropriate to conduct prescribed burns in native forests. Over 25% of the State is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Prescribed fire is used by a few agencies in specific areas to reduce hazardous fuel. However invasive, fire prone grasses grow back quickly after being burned. 3. No Action. Nurseries will continue to deteriorate resulting in fewer native plants for green breaks.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Nursery improvements are needed in order to increase plant propagation for outplantings in the greenbreaks.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans; DOFAW Management Plans
Potential Funding Sources	CIP (State General Obligation Bond Funds); Operating Funds (State Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	OG
Reporting on Progress	
Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Some planning and nursery improvements have been implemented, while additional needs exist.

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	3 x 2 = 6	
Will the action result in Property Protection?	3	
Will the action be Cost-Effective? (future benefits exceed cost)	4	Native ecosystems in Hawaii evolved with little or no fire. Wildfire is a threat to native forests, including watersheds (the Governor's Hawaii Sustainable Initiative aims to protect 30% of priority watersheds by 2030) and threatened and endangered species (Hawaii has the highest number of species listed as threatened and endangered in the U.S.). Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4	
Is the action Politically acceptable?	4	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	3	
Will the action have a positive impact on the natural Environment?	4	
Is the action Socially acceptable?	4	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	0	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	3	
Is there an Agency/Department Local Champion for the action?	4	Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state and county jurisdictions.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	51	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization: State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-027

Mitigation Action Title: Develop water sources, including installation of water storage structures.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Limited water sources in remote areas.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Transport water to remote, steep terrain through miles of hoses which would be logistically challenging. 2. Pave a system of roads to transport water through remote, steep terrain which would pave over sensitive, conservation land and not be cost effective. 3. Prescribed Fire. Since native ecosystems in Hawaii evolved with little or no fire, it is not appropriate to conduct prescribed burns in native forests. Over 25% of the State is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Prescribed fire is used by a few agencies in specific areas to reduce hazardous fuel. However invasive, fire prone grasses grow back quickly after being burned.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Install water storage structures, such as portable catchment tanks, reservoirs, and dip tanks.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☒Other Describe: Community preparedness
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW, DLNR-CWRM, DOA, DHHL, County Water Supply Agencies
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans; DOFAW Management Plans, Hawaii Drought Plan
Potential Funding Sources	CIP (State General Obligation Bond Funds); Operating Funds (State Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	OG
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☒Completed ☐No Longer Required Comment: Water storage structures have been installed, but additional needs exist.

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4, Maybe Yes = 3, Unknown/Neutral = 2, Probably No = 1, Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	3 x 2 = 6	
Will the action result in Property Protection?	3	
Will the action be Cost-Effective? (future benefits exceed cost)	4	Native ecosystems in Hawaii evolved with little or no fire. Wildfire is a threat to native forests, including watersheds (the Governor's Hawaii Sustainable Initiative aims to protect 30% of priority watersheds by 2030) and threatened and endangered species (Hawaii has the highest number of species listed as threatened and endangered in the U.S.). Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4	
Is the action Politically acceptable?	4	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	3	
Will the action have a positive impact on the natural Environment?	4	
Is the action Socially acceptable?	4	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	3	
Is there an Agency/Department Local Champion for the action?	4	Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state and county jurisdictions.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	55	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-028

Mitigation Action Title: Provide wildfire awareness, preparedness, and prevention education involving all sectors.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Pursuant to Chapter 185, HRS, DLNR is mandated to take measures for prevention of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance of prevention of wildland fires on land not managed by DLNR-DOFAW. Over 98% of wildfires in Hawaii are human caused, which means many are preventable. Preventable wildfires cause losses which exceed the cost of prevention education. While under-publicized, the percentage of land area burned per year in Hawaii exceeds the national average, and some years surpasses the western states. Each fire agency and other entities present wildfire prevention materials differently and with varying frequency. A coordinated public awareness campaign allows for consistent messaging.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Instead of encouraging voluntary action through educating the public about awareness, preparedness, and prevention, force regulations upon residents which may not be socially or politically acceptable. 2. Allow each fire agency and other entities to present prevention materials differently and with varying frequency resulting in inconsistent messaging and resources not being leveraged. 3. No Action. Over 98% of wildfires in Hawaii are human caused, which means many are preventable. By not encouraging prevention, wildfires will continue to threaten communities and native forests, including watersheds and threatened and endangered species. Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Create a statewide, inter-agency wildfire prevention plan. Continue all-agency, unified wildfire and drought awareness campaign annually. Hold National Wildfire Community Preparedness Day events in each county annually. Establish Outreach and Education Specialists at each DLNR-DOFAW District Office. Reach a wider audience by participating in inter-agency wildfire outreach and education efforts at community emergency preparedness fairs.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☒Other Describe: Community preparedness
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW, DLNR-CWRM, HWMO, PFX, County Fire Departments
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans, Hawaii Drought Plan
Potential Funding Sources	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grants (Federal Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (Ongoing program)	OG
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: This is an ongoing, programmatic action

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	3	x 2 = 6	
Will the action result in Property Protection?	3		
Will the action be Cost-Effective? (future benefits exceed cost)	4		Native ecosystems in Hawaii evolved with little or no fire. Wildfire is a threat to native forests, including watersheds (the Governor's Hawaii Sustainable Initiative aims to protect 30% of priority watersheds by 2030) and threatened and endangered species (Hawaii has the highest number of species listed as threatened and endangered in the U.S.). Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across governmental jurisdictions.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	57		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-029

Mitigation Action Title: Maintain and improve fire and fuel breaks/access roads on state land.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Fire and fuel breaks/access roads stop advancing fire and provide access to firefighters to reduce the impacts of wildfires to native ecosystems and watersheds. Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1.Prescribed Fire. Since native ecosystems in Hawaii evolved with little or no fire, it is not appropriate to conduct prescribed burns in native forests. Over 25% of the State is covered by invasive, fire prone grasses and shrubs. Each time fire burns into native forest, this percentage increases. Prescribed fire is used by a few agencies in specific areas to reduce hazardous fuel. However invasive, fire prone grasses grow back quickly after being burned 2. Deforest conservation areas to remove fuel. Although this would reduce fire risk, it would be in conflict with DOFAW's mission which is to responsibly manage and protect watersheds, native ecosystems, and cultural resources and provide outdoor recreation and sustainable forest products opportunities, while facilitating partnerships, community involvement and education. 3. No action. Wildfires will continue to threaten native forests, including watersheds and threatened and endangered species. Wildfires cause losses, some irreplaceable, which often exceed the cost of mitigation.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Clear, reduce, and convert hazardous fuel in fire and fuel breaks and on both sides of access roads. Monitor vegetative regrowth due to year-round growing season and invasive, fire-prone grasses that grow back quickly. Improve access roads, including paving, repaving, or grading.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans; DOFAW Management Plans; Watershed Management Plans
Potential Funding Sources	Operating Funds (State Funds); CIP (State General Obligation Bond Funds); USFS and USFWS Grants (Federal Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Routine maintenance done on an ongoing basis.

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	**Numeric Rank:** Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	3 x 2 =6	
Will the action result in <u>Property Protection</u>?	3	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	Native ecosystems in Hawaii evolved with little or no fire. Wildfire is a threat to native forests, including watersheds (the Governor's Hawaii Sustainable Initiative aims to protect 30% of priority watersheds by 2030) and threatened and endangered species (Hawaii has the highest number of species listed as threatened and endangered in the U.S.). Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	4	
Will the action have a positive impact on the natural <u>Environment</u>?	4	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	0	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	Rainfall and mild temperatures that occur throughout the year contribute to a year-round growing season, thus requiring continual maintenance. Over 25% of the State is covered by invasive, fire prone grasses and shrubs, which grow back quickly after being cleared
Is there an Agency/Department <u>Local Champion</u> for the action?	4	Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state jurisdictions.
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-030

Mitigation Action Title: Establish additional Community Wildfire Protection Plans (CWPP).

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☒Lānaʻi ☐Molokaʻi ☒Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	CWPPs help communities address wildfire response, hazard mitigation, and community preparedness. Newly established CWPPs will make additional lands eligible for funds available through the WUI Grant Program, which funds mitigation actions. CWPPs are also an interagency planning tool.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Instead of encouraging voluntary action through a planning tool, such as CWPPs, force regulations upon residents which may not be socially or politically acceptable. 2. Allow each fire agency and other entities to establish their own plans resulting in fragmented efforts and resources not being leveraged. 3. No Action. By not establishing CWPPs, including identifying mitigation actions and projects with input from communities and government agencies, wildfires will continue to threaten communities and conservation land nearby. Wildfires cause losses, some irreplaceable, which often exceed the cost of planning.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	There are 13 CWPPs established throughout Hawaii, which cover over half of the State. Each county has at least one CWPP. Areas not covered by a CWPP will need to be prioritized. Once funding is secured, the entity writing the CWPP will hold community and agency meetings, process data, and write plan.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☒Other Describe: Community Preparedness
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HWMO, DLNR-DOFAW, County Fire Departments, County Emergency Management Agencies
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan
Potential Funding Sources	Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grant (Federal Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: An update to the Kahikinui (Maui) CWPP is in-progress, while additional CWPPs are needed to ensure statewide coverage.

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	3	x 2 =6	
Will the action result in Property Protection?	3		
Will the action be Cost-Effective? (future benefits exceed cost)	4		Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	0		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state and county jurisdictions.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	53		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW)	**Mitigation Action #:**	2018-031

Mitigation Action Title: Prevent structure ignition from wildfires in the home ignition zone through home hardening.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Fire science research indicates that embers and low intensity surface fires are the primary ways that most homes ignite in wildfires. Home hardening with ignition resistant building materials and landscaping that supports vegetation removal and replacement with fire resistant plants can reduce home ignition potential and increase home survivability.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Instead of encouraging voluntary mitigation action through Firewise USA, force regulations upon residents which may not be socially or politically acceptable. 2. Deforest, pave, gravel, or plow nearby conservations areas abutting developed areas to remove fuel. Although this would reduce fire risk, it would be in conflict with DOFAW's mission which is to responsibly manage and protect watersheds, native ecosystems, and cultural resources and provide outdoor recreation and sustainable forest products opportunities, while facilitating partnerships, community involvement and education. 3. No action. Wildfires will continue to threaten communities and conservation land nearby. Wildfires cause losses, which often exceed the cost of mitigation.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Educate residents and assist them with home hardening through voluntary mitigation programs for existing communities, such as Firewise USA. Increase the number of recognized Firewise USA sites throughout the State as well as establish recognized Firewise USA sites in all counties. Increase the amount of risk reduction investment by each recognized Firewise USA site. Ensure that new development is following the State Fire Code's Chapter 17 WUI.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW, DHHL, County Fire Departments, HWMO
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans; State Fire Code: Chapter 17 WUI
Potential Funding Sources	Operating Funds (State Funds); Operating GIA pursuant to Chapter 42F, HRS (State General Funds); USFS Grant (Federal Funds); Private Sector Funds
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☒Completed ☐No Longer Required Comment: Some communities are already recognized Firewise USA sites, while others are in the process of gaining recognition.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	3	x 2 = 6	
Will the action result in Property Protection?	3		
Will the action be Cost-Effective? (future benefits exceed cost)	4		Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	0		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	3		Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state and county jurisdictions, including the WUI.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	50		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW)	**Mitigation Action #:**	2018-032
Mitigation Action Title:	Install and maintain remoted automated weather stations (RAWS).		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Remote automated weather stations ensure that microclimate data is captured to help rate fire danger and monitor fuels.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Send several staff to remote areas on a daily basis to collect and record weather data. DOFAW does not have staff capacity to do this and it would not be cost effective. 2. Rely on RAWS located on nearby federal lands resulting in inaccurate info for state lands. State operated RAWS ensures that microclimate data is captured for DOFAW managed lands. 3. Rely on other weather services, such as the National Weather Service, which may not accurately capture microclimate data to help rate fire danger and monitor fuels.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Purchase and install additional RAWS. Maintain RAWS to ensure that all stations within Hawaii's network are operational.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☒Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DLNR-DOFAW for state operated RAWS. There are 66 RAWS statewide maintained by federal and state agencies, including 21 operated by DLNR-DOFAW.
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Chapter 185, HRS; Hawaii Forest Action Plan; Community Wildfire Protection Plans
Potential Funding Sources	Operating Funds (State Funds); USFS Grant (Federal Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	
Status/Comment	☒Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Additional RAWS are needed and current stations are maintained on an ongoing basis.

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	3	x 2 =6	
Will the action result in Property Protection?	3		
Will the action be Cost-Effective? (future benefits exceed cost)	4		Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Additional RAWS can be installed in less 5 years, however stations are maintained on an ongoing basis.
Is there an Agency/Department Local Champion for the action?	4		Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across governmental jurisdictions.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	57		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii Department of Health **Mitigation Action #:** 2018-033

Mitigation Action Title: Cesspool Abatement Program

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based Flooding ☒Hazardous Materials ☒Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The State of Hawaii has identified 14 priority areas of the state where cesspool upgrades are critically needed to protect public health and the environment. There are approximately 88.000 cesspools within the state – 43,000 of which are in the identified priority areas. Cesspools provide no treatment of wastewater and inject an estimated 53 million gallons of raw sewage into the State's groundwater every day, potentially spreading disease and harming the quality of the state's only available drinking water supplies and recreational waters. The cost of upgrading all the state's roughly 88,000 cesspools is estimated at $1.75 billion. State law currently requires the elimination of cesspools in Hawaiʻi by 2050.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action – State requires removal of cesspools by 2050 2. High Priority Area Cesspool Abatement Program 3. Income Tax Credit for Voluntary Upgrades
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	High Priority Area Cesspool Abatement Program – Implement a public-private cost share program between the State, counties, and the private landowners to incentivize upgrades of qualified cesspools to a septic tank or aerobic treatment system, prioritizing identified high priority areas and cesspools posing the greatest risk to ground water contamination and/or surface water impairment as a result of system overflow during heavy rainfall events.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Loss of Function ☒Other Describe: Pollution prevention & protection of drinking water quality
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Health; Department of Business, Economic Development; & Tourism – Office of Planning; City & County Planning Departments
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: public-private cost sharing program
Potential Funding Sources	State & County - Capital Improvement Plan budgeting; Public-private partnership
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term and/or on-going due to the volume of cesspools within the state that require system upgrades. Project would likely be completed in a phased approach based upon risk prioritization of identified cesspools.
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: A current program exists in the State under Act 120 in which a taxpayer may apply for a tax credit of up to $10,000 for cesspools upgraded to a sewer or septic system. The program has been limited to a total of $5 million – roughly 500 cesspool upgrades per-year. To date only about 50 taxpayers have utilized the program. A new strategy is therefore required to increase cesspool abatement participation.

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	2 x 2 = 4	Unknown, project implementation will result in increased water quality and reduce potential of detrimental health impacts
Will the action result in Property Protection?	2	Neutral, project will indirectly result in greater conservation of environmental quality and maintenance of long term availability of viable groundwater drinking water resources
Will the action be Cost-Effective? (future benefits exceed cost)	4	Yes, the cost of prolonging cesspool abatement will increase overtime as the migration of pollutants from untreated wastewater continue to percolate down towards the aquifer, compromising groundwater quality and consequently incurring greater costs as a result of water treatment facilities required to filter pollutants prior to distribution for drinking water should groundwater impairment occur that exceeds safe drinking water quality standards.
Is the action Technically feasible	4	Yes, the technology exists to update cesspools to wastewater systems that are able to provide better treatment prior to discharge to ground and or surface waters
Is the action Politically acceptable?	2	Unknown, the legislature passed Act 120 in 2016 that bans all new cesspools state wide and requires their removal by 2050. However, legislation that has been proposed that requires updating systems upon the point of sale have stalled in the past. Project approval likely to depend upon overall costs and who remains liable for the cost of system upgrades. Socio-economic factors of financial impacts upon communities must also be taken into consideration.
Does the jurisdiction have the Legal authority to implement?	2	DOH remains the responsible jurisdiction having authority over water quality and wastewater discharge into the environment. However, private property land-use decisions remain under the responsible jurisdiction of the counties, therefore a joint effort would likely be required between the State, Counties, and private land owners
Is Funding available for the action?	2	Unknown, the issue of cesspools has been identified as a legislative priority and a tax credit program has been instituted in the past. However, with a program cap of only $5 million per year and further limited public participation in the program, the existing funding commitments remain insufficient to cover the scope of the issue.
Will the action have a positive impact on the natural Environment?	4	Definitely yes, currently cesspools within the state discharge approximately 53 million gallons of raw sewage into the State's groundwater on a daily basis. Abatement of cesspools would substantially reduce the volume of pollutants entering into and contaminating the state's groundwater, surface waters, and coastal areas.
Is the action Socially acceptable?	3	Maybe yes, there is common consensus that pollutants entering into the state's water resources is causing detrimental impacts to water quality and impacting the state's environmental resources. Challenges however exist with regards to the mechanisms for removal of the cesspools and the potential financial impacts that could be borne upon communities already struggling as a result of socio-economic disparity. Social acceptability is therefore likely to be correlated with abatement costs for system upgrades.
Does the jurisdiction have the Administrative capability to execute the action?	2	Unknown, this project would require significant coordination across state and county partners with private landowners. Additional staff resources may be required for the successful planning, public education, and implementation in order for such a project to be successful.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	Definitely yes, this project will reduce the risk of cesspools to vulnerabilities as a result of chronic coastal flooding, event based flooding, hurricane, and public health impacts
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	0	Definitely no, there are a total of 88,000 cesspools within the state that are require system upgrades. Only 43,000 of which have been evaluated. While success may be achieved for upgrading systems within priority areas that pose the greatest risk, it is still likely that implementation of such an undertaking would exceed 5 years.
Is there an Agency/Department Local Champion for the action?	4	Definitely yes, the Hawaii Department of Health however, challenges arise as a result of the number of overlapping entities having jurisdiction at State and County levels.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	This action meets general objectives identified in several state and county plans pertaining to the preservation and long-term sustainability of the state's environmental resources and coastal waters.
Total	41	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii Department of Health **Mitigation Action #:** 2018-034

Mitigation Action Title: Hardening State Laboratory Facility

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☒Hazardous Materials ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The State Laboratories Division (SLD) plays an essential role in public health and safety. Data provided by the SLD include those related to detecting infectious outbreaks, identifying hazardous chemicals, responding to emergencies, identifying environmental contaminants, and monitoring significant public health trends. It is imperative that the SLD is able to continue its core population-based activities when events occur that disrupt its normal operation. Originally constructed over 20 years ago, the State Laboratory has several critical vulnerabilities that pose a threat to the facilities continued operations during disaster. As there is only one State Laboratory facility within the State, hardening of the State Laboratory facility is necessary in order to ensure continuity of operations during all hazards.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action – Continue routine facility maintenance for the remaining duration of building lifespan 2. Harden state laboratory facility to increase all-hazards resilience 3. Build redundant laboratory capacity through development of alternate facility
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Harden state laboratory facility to increase all-hazards resilience: • Add protective closure for cooling tower (est. $116,000) • Add shatter proof window films (est. $197,000) • Provide second transformer and double ended switchgear (est. $1,251,000) • Provide separate feeders to mechanical equipment (est. $878,000) • Provide redundant emergency generator (est. $3,758,000) • Provide additional fuel tank for 7-day supply of emergency generator fuel (5 additional days from current capacity) (est. $428,000)
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☐Goal #1 ☒Goal #2 ☐Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Hawaii State Department of Health
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Pre-Disaster Mitigation Grant; State appropriation of funding through CIP budget
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short term and/or long term depending upon funding availability
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: An initial assessment of the facility was conducted in 2013 which identified the recommended hardening actions and provided an initial cost estimate. An additional analysis would likely be required to assess if the initial quotes provided (reflected in the project description) are still accurate and/or if additional hardening actions may be required.

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	Definitely yes, the state lab provides analytical laboratory testing and services for the identification of communicable diseases, hazardous materials, bio-chemical agents, and environmental contaminates that can pose an immediate threat to life safety if left undetected as a result of lab inoperability.
Will the action result in <u>Property Protection</u>?	4		Definitely yes, hardening of the state lab would increase the resilience of the state lab facility and further result in the protection of state property and assets that are housed within the state lab.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		Definitely yes, if there is a loss of operability of the state lab, samples will have to be shipped to CONUS for analytical testing resulting in significant delays of sample testing and incurred costs for expedited shipping of samples. Additionally, if the state lab facility is compromised, it would place millions of dollars of lab equipment at a significant vulnerability to loss.
Is the action <u>Technically</u> feasible	4		Definitely yes, based upon the analysis of the state lab from 2013, all identified tasks required for hardening are technically feasible
Is the action <u>Politically</u> acceptable?	3		Maybe yes, although there is some uncertainty with the potential for turnover in state governance, there is a significant likelihood for general political support for this project depending upon funding availability.
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		Definitely yes, the State Lab is a State owned facility that is under the jurisdictional authority of DOH, some coordination maybe required with DAGS
Is <u>Funding</u> available for the action?	2		Unknown, hardening actions have been identified and were proposed in a measure during the 2018 Legislative Session, the standing of measure is however currently unknown regarding if funds will be appropriated. The likelihood for funding receipt will be increased if state funds can be leveraged via a competitive grant award.
Will the action have a positive impact on the natural <u>Environment</u>?	3		Maybe yes, hardening of the state lab will increase the resilience of the state lab's operability during a disaster and provide for the continued ability to maintain analytical testing capabilities of environmental samples for potential pollutants and/or contaminants following a disaster. Thereby expediting the response capability for effective containment and remediation of contaminants of concern within the natural environment.
Is the action <u>Socially</u> acceptable?	4		Definitely yes, as the state lab is an existing facility, there is likely to be no or limited opposition to a project intending to harden the state lab in order to maintain laboratory analytical testing capability within the state in order to protect public health and the environmental quality.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		Definitely yes, the State Lab is a facility under the jurisdiction of DOH
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		Definitely yes, the action will reduce the risk of culminating/cascading impacts resulting from the occurrence of a single disaster (i.e. HazMat release following a flood event; or, early identification of an infectious disease outbreak following hurricane impact)
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	3		Maybe yes, depending upon availability of funding for project implementation
Is there an Agency/Department <u>Local Champion</u> for the action?	4		Definitely yes, Hawaii Department of Health
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		Definitely yes, the action would contribute to meeting objectives within the SHMP and the Hawaii State Emergency Operations Plan by increasing the resilience and continuity of operations of the state laboratory. Additionally, hardening the state lab would support county health and safety objectives since the state lab conducts the testing for DHO who partner with the counties.
Total	55		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii State Climate Office **Mitigation Action #:** 2018-035

Mitigation Action Title: Enhance Hawaii Rain Gauge Network

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☐Drought ☐Earthquake ☒ Event-based Flooding ☐Hazardous Materials ☒Health Risks ☐High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The existing rain gauge network in Hawaii is sporadic and does not capture rainstorms distributions well because of the micro climate nature.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	To install more rain gauges and monitor and collect the data on a timely basis, maintain a website for this.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☐Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe: To know better rainstorm distributions and damage
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $150,000
Plan for Implementation	
Responsible Department/Organization	Hawaii State Climate Office, UH
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other: Retrofit related to building code
Potential Funding Sources	
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	3 - yr
Reporting on Progress	

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Mitigation Action Worksheet

Status/Comment	☐Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	3		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	3		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		
Total	57		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization UH/Hawaii State Climate Office **Mitigation Action #:** 2018-036

Mitigation Action Title: High-resolution Numerical Simulation of the April 2018 Kauai Flooding Events

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☒Drought ☐Earthquake ☒ Event-based flooding ☒Health Risks ☐High Wind Storms ☐Hurricane ☒Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Kauai was recently devastated by heavy downpours and extensive flooding. It is necessary to understand the cause of this flooding event and simulates the probability of this event for future hazard mitigation plans.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Use a high-resolution numerical weather model and the large scale meteorological conditions to simulate the flooding event. Will use a dynamical downscaling approach and ensemble forecasting techniques to assess the probability of flooding.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☒ Existing Development ☒Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < \$10,000; ☐\$10,000 to \$100,000; ☒>\$100,000 Other Amount: \$300,000 for a 2-yr project
Plan for Implementation	
Responsible Department/Organization	Hawaii State Climate Office
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	State and Federal

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short (2-years)
Reporting on Progress	
Status/Comment	☐Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	3		
Does the jurisdiction have the Administrative capability to execute the action?	3		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	58		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization UH/Hawaii State Climate Office **Mitigation Action #:** 2018-037

Mitigation Action Title: Estimating return periods of Extreme Rainfall Events for Kauai, Hawaii

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☐Hurricane ☒Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Recent torrential rainfall events (April 13-15, 2018) caused extensive flooding with many homes severely damaged in northern and southern parts of Kauai. Torrential downpours with thunders and lightning also triggered landslides along Kuhio Highway that cut off the communities on the north shore of Kauai for many days. The NWS said a rain gauge in Hanalei recorded 49.69 inches of rain in a 24-hr period. If certified, this would be a new U.S. record. Given the huge damage and the potential U.S. rainfall record, it is important to carry out the return period analysis of extreme rainfall events for Kauai. This information will be useful in hazard mitigation plans and flood policy making..
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Collect and process high-frequency (hourly if available) rainfall data; quality control of raw rainfall data; use the extreme-value distribution to compute extreme rainfall corresponding to different return-periods (e.g., 20-yr, 50-yr); spatial analysis of extreme rainfall events defined by return values Reference: Chu, P.-S., coauthors, 2009: Extreme rainfall events in the Hawaiian Islands. Journal of Applied Meteorology and Climatology, 48, 502-516.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $200,000 for a two-yr project
Plan for Implementation	
Responsible Department/Organization	University of Hawaii/Hawaii State Climate Office
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:

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Mitigation Action Worksheet

Potential Funding Sources	State and Federal Funding
Timeline for Completion: **Short (1-5 years), Long Term (5 years or greater), OG (On-going program)**	Short
Reporting on Progress	
Status/Comment	☐Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	3		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	59		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii Sea Grant **Mitigation Action #:** 2018-038

Mitigation Action Title: Model Resources for Streamlined and Resilient Disaster Reconstruction in Hawaiʻi

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The severity of impacts from both chronic and event-based coastal hazards will increase with sea level rise and other impacts of climate change. The SLR Report is focused primarily on addressing vulnerabilities to chronic coastal flooding due to rising seas. This project addresses episodic disasters with a specific focus on reconstruction following disasters with significant coastal impacts. The goal of this project is to increase the capacity of coastal communities in Hawaiʻi to “bounce forward” and build back safer, stronger, smarter, and faster after a l disaster through recovery preparedness activities that improve resilience to future hazards and conserve natural resources.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Continue to do recovery planning post-disaster. – The rebuilding process will not be as efficient or able to address future hazard mitigation and natural resource conservation. 2. Only consider chronic flooding from sea level rise. – Climate change and sea level rise will also cause increasing frequency and severity of impacts from less frequent events like storms, extreme high waves, and tsunami. 3. Plan to build back the same way as before. – Resilience to future disasters will not be improved.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	This Guidance is intended to help state and county agencies, communities, and other stakeholders: • Expand and support the institution of reconstruction guidelines and policies that will balance regulatory control and recovery speed, protect sensitive environmental and cultural resources, and incorporate mitigation and adaptation strategies throughout the process to increase resilience for future hazards; • Support Hawaiʻi Sea Grant in conducting reconstruction and resilience workshops to inform development of guidelines, ordinances and policies; • Bring planners and emergency managers to a common understanding how their fields interact after a disaster; and • Inform the Climate Commission of guidelines and model resources for improving resilience to coastal flooding-related disaster events, building on the recommendations of the State SLR Report. Model resources developed through the project will include recovery preparedness plan outline, state-level emergency proclamation including considerations of resilient recover, model reconstruction ordinance, and model communication between agencies and community. The project is building on previous work by Maui County and Hawaii Sea Grant.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Increase resilience to future coastal hazards through the disaster rebuilding process.
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA. Project is part of larger Hawaii Sea Grant –led program “Building Resilience to Coastal Hazards and Sea Level Rise in Hawaii” (see funding NOAA funding info, below). Tetra Tech, Inc. is the lead consultant.
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☒Ordinance ☐Other:

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Potential Funding Sources	Funding from the NOAA FY16 Regional Coastal Resilience Grants Program with 50% cost-match from State of Hawaii DLNR through Hawaii Climate Adaptation Initiative (State Act 83, 2014)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short (1-5 years); through April, 2019
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	3	x 2 =	Improve resilience to future disasters through the rebuilding and recovery process.
Will the action result in <u>Property Protection</u>?	4		Improve resilience to future disasters through the rebuilding and recovery process.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3		Benefit-cost of SLR adaptation strategies is a key next step for many sectors. But FEMA estimates of 6:1 benefit to cost would likely apply.
Is the action <u>Technically</u> feasible	4		Project concept was proven by Maui County and Hawaii Sea Grant through an earlier project that we are building on.
Is the action <u>Politically</u> acceptable?	4		Addresses recommendation(s) related to disaster recovery planning in the State SLR Report
Does the jurisdiction have the <u>Legal</u> authority to implement?	3		Working with DLNR, OP, state and County EMAs and planning departments and through State Climate Commission.
Is <u>Funding</u> available for the action?	4		Funded by NOAA and State of Hawaii
Will the action have a positive impact on the natural <u>Environment</u>?	4		One overall goal of program is to maintain quality of coastal environments during disaster recovery
Is the action <u>Socially</u> acceptable?	4		Maui county project was well accepted
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		Yes, through the Hawaii Interagency Climate Commission and DLNR, OP, and county planning departments
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		Yes, improve resilience to severe coastal flooding, high wave, erosion, storm, hurricane, and tsunami events through the rebuilding process
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		Yes. Project completion by April 2019
Is there an Agency/Department <u>Local Champion</u> for the action?	4		Yes, DLNR-OCCL and OP. Working with HIEMA and local EMAs.
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		Inform planning of CIP, community development, and environmental quality (e.g., beach and wetland conservation)
Total			
Priority: Low = <35 Medium = 35-49 High = >50	☐Low ☐Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii Sea Grant **Mitigation Action #:** 2018-039

Mitigation Action Title: Guidance for Addressing Sea Level Rise in Community Planning

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Chronic coastal flooding with climate change and sea level rise. Providing guidance and supporting the community comprehensive planning process through integrating coastal hazards and sea level rise data and recommendations.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Provide guidance on integrating SLR in the State Plan. – Would not support community, ground-level planning for SLR resilience and adaptation 2. Rely just on the Climate Adaptation Priority Guidelines in the State Planning Act to guide climate adaptation. – Guidelines are not specific-enough for moving toward on the ground adaptation planning. 3. Focus solely on implementing coastal hazards and SLR planning in policy and regulation. – This approach was not successful in a previous in a previous project by State OP-CZM.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	This Guidance is intended to help state and county agencies, communities, and other stakeholders: • Use the best available science and tools in community planning for sea level rise • Apply the State's climate adaptation priority guidelines to enhance coastal resilience through planning • Integrate policies, strategies, and actions in community-level plans to address existing and future chronic coastal flooding with sea level rise • Identify ways to promote horizontal and vertical policy consistency • Define a process for monitoring, evaluation, and learning to support adaptive management needed with evolving climate science and under changing conditions.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Reduce hazard risks and improve resilience to chronic coastal flooding and erosion with sea level rise through comprehensive
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA. Project is part of larger Hawaii Sea Grant –led program "Building Resilience to Coastal Hazards and Sea Level Rise in Hawaii" (see funding NOAA funding info, below). Tetra Tech is the lead consultant.
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☒Ordinance ☐Other:

State of Hawaiʻi
Mitigation Action Worksheet

Potential Funding Sources	Funding from the NOAA FY16 Regional Coastal Resilience Grants Program with 50% cost-match from State of Hawaii DLNR through Hawaii Climate Adaptation Initiative (State Act 83, 2014)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short (1-5 years); through April, 2019
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	2	x 2 =	Long-term chronic flooding and erosion hazards with SLR
Will the action result in <u>Property Protection</u>?	4		Addressing SLR hazards to property through community planning
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3		Benefit-cost of SLR adaptation strategies is a key next step for many sectors.
Is the action <u>Technically</u> feasible	4		Presently have support and working directly with all 4 county planning departments
Is the action <u>Politically</u> acceptable?	4		Grant proposal and award was supported by Governor
Does the jurisdiction have the <u>Legal</u> authority to implement?	3		TBD how SLR in community planning will translate to on-the-ground implementation
Is <u>Funding</u> available for the action?	4		Funded by NOAA and State of Hawaii
Will the action have a positive impact on the natural <u>Environment</u>?	4		One overall goal of program is to maintain quality of coastal environments while improving resilience
Is the action <u>Socially</u> acceptable?	4		Support from communities through outreach activities has been good overall.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		Yes, through the Hawaii Interagency Climate Commission and DLNR, OP, and county planning departments
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		Yes, to chronic tidal flooding, wave overwash, and coastal erosion with SLR
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		Yes. Project completion by April 2019
Is there an Agency/Department <u>Local Champion</u> for the action?	4		Yes, DLNR-OCCL and OP
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		Inform planning of CIP, community development, and environmental quality (e.g., beach and wetland conservation)
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii Sea Grant **Mitigation Action #:** 2018-040

Mitigation Action Title: Hawaii Sea Level Rise Viewer

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Sea level rise. Serves as an online atlas and mapping tool for the Hawaii Sea Level Rise Vulnerability and Adaptation Report
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Providing hard copy of maps exclusively with the State Sea Level Rise Report (no online tool). - Too many maps to publish. 2. Continuing to use just existing SLR mapping tools (e.g., NOAA SLR Viewer). – Other tools do not consider coastal erosion and wave runup. 3. Release State Sea Level Rise Report hazard and vulnerability GIS layers without a viewer. – SLR Viewer provides an easy user interface and education, explanation, interpretation of the data and supports planning.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Viewer has been built and released. Developed and hosted by PacIOOS. hawaiisealevelriseviewer.org Ongoing actions include trainings and demonstrations of utility of viewer, utilizing viewer in community planning. Project is part of larger Hawaii Sea Grant –led program “Building Resilience to Coastal Hazards and Sea Level Rise in Hawaii” (see funding NOAA funding info, below). Viewer was accepted along with State SLR Report by State Interagency Climate Change Mitigation and Adaptation Commission.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Improve resilience to chronic coastal flooding with sea level rise
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	UH Sea Grant in partnership with State DLNR and OP through grant and cooperative agreement with NOAA. Viewer was developed by PacIOOS at UH.
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☒Ordinance ☐Other:
Potential Funding Sources	Funding from the NOAA FY16 Regional Coastal Resilience Grants Program with 50% cost-match from State of Hawaii DLNR through Hawaii Climate Adaptation Initiative (State Act 83, 2014)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short (1-5 years); through April, 2019
Reporting on Progress	

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Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	2 x 2 =	Long-term chronic flooding and erosion hazards with SLR
Will the action result in <u>Property Protection</u>?	4	Identifies properties in future chronic flooding hazard areas with SLR.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3	Benefit-cost of SLR adaptation strategies is a key next steps for many sectors.
Is the action <u>Technically</u> feasible	4	Viewer has been completed
Is the action <u>Politically</u> acceptable?	4	Viewer accepted by State Interagency Climate Commission
Does the jurisdiction have the <u>Legal</u> authority to implement?	2	Next steps needed by State Legislature to require SLR adaptation implementation.
Is <u>Funding</u> available for the action?	4	Funded by NOAA and State of Hawaii
Will the action have a positive impact on the natural <u>Environment</u>?	4	Includes layers identifying beach environments and backshore sand deposits where beaches may migrate with SLR.
Is the action <u>Socially</u> acceptable?	4	Viewer well-accepted through government and community outreach so far.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	Yes, through the Hawaii Interagency Climate Commission and members
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	Yes, to chronic tidal flooding, wave overwash, and coastal erosion with SLR
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	Viewer is completed. Outreach and planning integration work ongoing.
Is there an Agency/Department <u>Local Champion</u> for the action?	4	Yes, DLNR-OCCL and OP
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Inform planning of CIP, community development, and environmental quality (e.g., beach and wetland conservation)
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Dennis Hwang: UH Sea Grant **Mitigation Action #:** 2018-041

Mitigation Action Title: Comprehensive Education/Outreach Plan for State

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☒High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	People do not know where to go for hurricane vs., tsunami, or get evacuation steps confused. People-flooded properties- no insurance
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No knowledge of risk 2. Small % of public attend 3. Emergency fairs and workshops
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	2017 HB-571 – Require Comprehensive Education and Outreach Plan – Team with US Sea Grant to implement strategies to reach all individuals and all organizations
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable Retrofits make home more resilient
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	University of Hawaii, Sea Grant
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: But related to building codes because retrofits tied to building code, at the time of building
Potential Funding Sources	Some limited State Funding under HB571 FEMA

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short, + Long Term Some on going as part of the plan See homeowners handbook to prepare for Natural Hazards (3rd Edition) and later 4th
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 =	Evacuation planning for all members of community
Will the action result in Property Protection?	4		Inform of home strengthening
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		Ongoing related to HB-5711 2017
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?	4		Yes – it's an education/outreach plan
Is Funding available for the action?	Partly	3	HB-571
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		Only a plan
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	55		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization University of Hawaii/Sea Grant- NOAA **Mitigation Action #:** 2018-042

Mitigation Action Title: Homeowners Handbook to Prepare for Natural Hazards

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☒Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	1) If Hurricane Iniki hit Oahu – 50,000 houses damaged or destroyed Handbook shows how – homeowners can – reduce damage – retrofit windows, load path
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. All helps homeowners 2. Create evacuation plans 3. For tsunami and hurricane
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Update homeowners handbook for hazard event – triggering funding - -incorporate lessons learned
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable Includes Retrofits of existing houses – measures for new
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Evacuation planning
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	UH Sea Grant
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☐Ordinance ☐Other: Retrofit related to building code
Potential Funding Sources	State – 20 partners (companies, flood insurance program, CZM) and FEMA

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short, + Long Term Continuous updates
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 =	Evacuation planning in detail
Will the action result in Property Protection?	4		Retrofits reduce damage
Will the action be Cost-Effective? (future benefits exceed cost)	4		Education and outreach FEMA 4/1 or 6/1
Is the action Technically feasible	4		Book in 10 states and country
Is the action Politically acceptable?			No policy – all guidance
Does the jurisdiction have the Legal authority to implement?	4		Yes – see above
Is Funding available for the action?	3		Sometimes – book in effect 1- years some years none some enough
Will the action have a positive impact on the natural Environment?	4		Resilience sustainable adaptive all cove - ca
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		Multi – Hazard – major emphasis hurricane plan for worse hope for best
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Short + longterm Books and videos
Is there an Agency/Department Local Champion for the action?	4		UH Sea Grant
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		HI EMA Red Cross – shelter in place it can
Total	55		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Daniele Spirandelli DURP + UH Sea Grant **Mitigation Action #:** 2018-043

Mitigation Action Title: Comprehensive Wastewater Management Program

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based Flooding ☐Hazardous Materials ☒Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Department of Health has identified priority areas for cesspool upgrades and conversions across the state. The state also needs a comprehensive inventory of all onsite systems and outreach program with mandatory inspections, moving forward. Only upgrading does not address future vulnerabilities and risk of onsite system.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action – state requires removal of cesspools by 2050 2. Comprehensive onsite wastewater management program 3. Basic education and outreach on maintenance of systems
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Implement statewide wastewater management program with funding to inventory and maintain database of onsite systems. Implement statewide code that requires maintenance contracts. Develop robust education and outreach program.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☒Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe: Evacuation planning
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	DOH, County Planning Dept., Office of Planning, UH Sea Grant
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☒Ordinance ☐Other: Retrofit related to building code
Potential Funding Sources	State and County – Capital improvement plan budgeting, public-private partnerships, Philanthropic Foundations (NOAA)

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long-term and or on going due to both cesspools and other. ONTS (Present and future) in many different communities.
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4	x 2 =	Failing OWTS is a health hazard
Will the action result in <u>Property Protection</u>?	4		Failing OWTS impacts properties
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	3		
Is the action <u>Politically</u> acceptable?	1		
Does the jurisdiction have the <u>Legal</u> authority to implement?	1		
Is <u>Funding</u> available for the action?	1		
Will the action have a positive impact on the natural <u>Environment</u>?	4		
Is the action <u>Socially</u> acceptable?	3		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	0		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	3		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	1		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		UH Sea Grant
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	41		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii DBEDT OP CZMP **Mitigation Action #:** 2018-044

Mitigation Action Title: Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the City & County of Honolulu, Hawaii

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Building code amendments to reduce existing and future building stock vulnerability to coastal hazards and climate impacts in the City and County of Honolulu, Hawaii
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the County of Maui, Hawaii and not selected due to more population located in the City & County of Honolulu, Hawaii 2. Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the County of Kauai, Hawaii and not selected due to more population located in the City & County of Honolulu, Hawaii 3. Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the County of Hawaii, Hawaii and not selected due to more population located in the City & County of Honolulu, Hawaii
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Report was produced for the City and County of Honolulu to implement as useful
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < \$10,000; ☐\$10,000 to \$100,000; ☒>\$100,000 Other Amount: \$
Plan for Implementation	
Responsible Department/Organization	Hawaii DBEDT OP CZMP
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	National Oceanic and Atmospheric Administration Coastal Resilience Networks Grant Program

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short term
Reporting on Progress	
Status/Comment	☐Not Started ☐In-progress ☐Delayed ☒Completed ☐No Longer Required Comment: Undergoing final editorial revisions.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	Report prepared for the City and County of Honolulu and is dependent upon it to adopt.
Will the action result in <u>Property Protection</u>?	4		Same as above
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3		Same as above
Is the action <u>Technically</u> feasible	2		Same as above
Is the action <u>Politically</u> acceptable?	2		Same as above
Does the jurisdiction have the <u>Legal</u> authority to implement?	2		Same as above
Is <u>Funding</u> available for the action?	2		Same as above
Will the action have a positive impact on the natural <u>Environment</u>?	2		Same as above
Is the action <u>Socially</u> acceptable?	2		Same as above
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	2		Same as above
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		Same as above
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	2		Same as above
Is there an Agency/Department <u>Local Champion</u> for the action?	2		Same as above
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	2		Same as above
Total	35 / 39		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii DBEDT OP CZMP **Mitigation Action #:** 2018-045

Mitigation Action Title: Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts for the Counties of Hawaii, Maui and Kauai, State of Hawaii

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☐Tsunami ☒ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☒Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☒Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Building code amendments to reduce existing and future building stock vulnerability to coastal hazards and climate impacts for the Counties of Hawaii, Maui and Kauai, Hawaii
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. State Building Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts and not selected due counties control building permitting 2. Zoning Code Amendments to Reduce Existing and Future Stock Vulnerability to Coastal Hazards & Climate Impacts in the City and County of Honolulu, Hawaii and not selected because building codes may have broader impacts 3. No Action
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Report to be produced for the counties to implement as useful
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $ TBD
Plan for Implementation	
Responsible Department/Organization	Hawaii DBEDT OP CZMP
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	National Oceanic and Atmospheric Administration and TBD

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short term
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: No funding received for the project

Criteria	Numeric Rank: Definitely Yes = 4, Maybe Yes = 3, Unknown/Neutral = 2, Probably No = 1, Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4	x 2 = 8	Report prepared for the City and County of Honolulu and is dependent upon it to adopt.
Will the action result in Property Protection?	4		Same as above
Will the action be Cost-Effective? (future benefits exceed cost)	4		Same as above
Is the action Technically feasible	4		Same as above
Is the action Politically acceptable?	2		Same as above
Does the jurisdiction have the Legal authority to implement?	4		Same as above
Is Funding available for the action?	2		Same as above
Will the action have a positive impact on the natural Environment?	4		Same as above
Is the action Socially acceptable?	2		Same as above
Does the jurisdiction have the Administrative capability to execute the action?	2		Same as above
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		Same as above
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Same as above
Is there an Agency/Department Local Champion for the action?	2		Same as above
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		Same as above
Total	44 / 48		
Priority: **Low** = <35 **Medium** = 35-49 **High** = >50	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii-Office of Planning Special Plans Branch-Sustainability Program **Mitigation Action #:** 2018-046

Mitigation Action Title: Green Infrastructure Study and Plan

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☒ Event-based flooding ☒Health Risks ☐High Wind Storms ☐Hurricane ☒Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	A green infrastructure approach to stormwater management and flood risk reduction seeks to capture rainwater as close to where it falls as possible and let that water soak back into the ground. It integrates multiple smaller practices throughout the watershed, encourages the preservation of existing free space, increases tree canopy cover, works to restore degraded natural areas, and adds green space where possible. All of this is done with consideration of traditional piped stormwater systems, so that the green infrastructure elements reduce the volume of runoff that streams and piped systems need to carry.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. H.B. 2545 (2018) Legislation to authorize the development of a Green Infrastructure Plan, legislation died. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Identify green infrastructure opportunities in the State, including any related costs and savings. 2. Identify green infrastructure planning and development best practices in the State for potential application, including financing and community engagement practices. 3. Complete a plan that details how the State can move forward to cost effectively take advantage of identifies opportunities, including and related costs and savings. 4. Identify any legal or regulatory changes that will be needed to execute the completed plan.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $750,000
Plan for Implementation	
Responsible Department/Organization	DBEDT/Office of Planning
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	N/A
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short (1-2 years)

State of Hawaiʻi
Mitigation Action Worksheet

Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	3	3x 2 = 6	The plan will designate potential green infrastructure sites, which will assist in the future designation & use of green infrastructure to capture and recharge runoff and flooding waters.
Will the action result in Property Protection?	4		The plan will designate potential green infrastructure sites, which will assist in the future designation & use of green infrastructure to capture and recharge runoff and flooding waters.
Will the action be Cost-Effective? (future benefits exceed cost)	4		Yes, a green infrastructure plan can identify many benefits, including improved water quality, reduced flooding, infrastructure cost savings, and healthier communities
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		The original legislation passed unanimously out of the State's House of Representatives and the Senate's subject matter committees.
Does the jurisdiction have the Legal authority to implement?	4		Yes the Office of Planning Special Plans Branch has the legal authority to create a Green Infrastructure Plan through its Sustainability program.
Is Funding available for the action?	2		Funding is reliant on this proposal
Will the action have a positive impact on the natural Environment?	4		Yes, the EPA recently published a report in March 2018 recommending the integrating Green Infrastructure into local Hazard Mitigation Plans.
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		Yes, the Sustainability program is under development and is interested in producing such a plan.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		Yes, the plan can lead to the development of green infrastructure projects which provide: flood reduction, water quality improvement, public safety, and property loss prevention.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Yes the development of the State's Green Infrastructure Plan can take 1-2 years.
Is there an Agency/Department Local Champion for the action?	4		The State's Office of Planning's Sustainability program.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		This plan will support the State's Hazard Mitigation Plan as well as county hazard mitigation planning. It will encourage open space preservation and the improvement of environmental and water quality. The plan can identify future green infrastructure capital improvement projects.
Total	55		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii DBEDT OP CZMP **Mitigation Action #:** 2018-047

Mitigation Action Title: Report Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawaii

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	As part of efforts to address Management Priorities 1 and 2 of Appropriate Coastal Development and Management of Coastal Hazards of the Ocean Resources Management Plan (ORMP), Hawaii DBEDT OP CZMP is assessing the feasibility and implications of implementing managed retreat strategies (e.g., shoreline armoring restrictions, rebuilding restrictions, structure removal requirements, acquisition and buy-out programs, conservation easements, rolling easements, etc.) to gradually shift threatened development inland and away from vulnerable coastal areas. These preliminary discussions will result in a report.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Managed Retreat Pilot Infrastructure Project on the North Shore, City and County of Honolulu, Hawaii and not selected due to need to first determine if managed retreat is feasible 2. Managed Retreat Pilot Utility Project in the County of Maui, Hawaii and not selected due to need to first determine if managed retreat is feasible 3. Managed Retreat Pilot Single-Family Home Private Property in the County of Hawaii, Hawaii and not selected due to need to first determine if managed retreat is feasible
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Information gathered will feed into a report covering the potential for and feasibility of a managed retreat framework in the state. This report will summarize the complex systems affected by potential managed retreat, and provide a solid basis to inform future legislation for the State, under which funding and requirements for a managed retreat framework would occur.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $ 125,000.
Plan for Implementation	
Responsible Department/Organization	Hawaii DBEDT OP CZMP
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	National Oceanic and Atmospheric Administration
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short term

State of Hawaiʻi
Mitigation Action Worksheet

Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	3	x 2 = 6	Managed Retreat is fraught with legal, social and political implications. Some property may be saved at great collective cost needing immense political will and social sacrifice.
Will the action result in Property Protection?	3		Same as above
Will the action be Cost-Effective? (future benefits exceed cost)	1		Same as above
Is the action Technically feasible	2		Same as above
Is the action Politically acceptable?	2		Same as above
Does the jurisdiction have the Legal authority to implement?	2		Same as above
Is Funding available for the action?	2		Same as above
Will the action have a positive impact on the natural Environment?	2		Same as above
Is the action Socially acceptable?	2		Same as above
Does the jurisdiction have the Administrative capability to execute the action?	2		Same as above
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		Same as above
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	1		Same as above
Is there an Agency/Department Local Champion for the action?	1		Same as above
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		Same as above
Total	31 / 34		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☒Low ☐Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	Hawaii DBEDT OP CZMP	**Mitigation Action #:**	2018-048
Mitigation Action Title:	Infrastructure Managed Retreat and/or Nature Based Solutions Engineering Pilot Project to Protect Threatened Hawaii Infrastructure		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	A pilot project to examine methods to protect infrastructure, such as a roadway or a sewage treatment plant or a power generation facility, threatened by chronic coastal flooding, climate change and sea level rise by shifting it way from vulnerable coastal areas through retreat and/or a nature based engineering solution to harden, if retreat is not possible.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. A pilot project to examine methods to protect a single family private home threatened by chronic coastal flooding, climate change and sea level rise by shifting it way from vulnerable coastal areas through managed retreat and not selected due to lack of nexus between using public funds to pay for private homes. 2. A pilot project to examine methods to protect a condominium complex threatened by chronic coastal flooding, climate change and sea level rise by shifting it way from vulnerable coastal areas through managed retreat and not selected due to lack of nexus between using public funds to pay for private property. 3. No Action
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Develop criteria to rank, infrastructure most threatened by chronic coastal flooding, climate change and sea level rise, develop mitigation strategy to either retreat threatened infrastructure or Nature Based engineering solution to harden, if retreat is not possible, and retreat or harden infrastructure
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $ TBD
Plan for Implementation	
Responsible Department/Organization	Hawaii DBEDT OP CZMP
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☒Ordinance ☐Other:
Potential Funding Sources	National Oceanic and Atmospheric Administration and TBD
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term

State of Hawaiʻi
Mitigation Action Worksheet

Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: No funding received for the project

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4 x 2 = 4	Managed Retreat is fraught with legal, social and political implications. Some property may be saved at great collective cost needing immense political will and social sacrifice.
Will the action result in <u>Property Protection</u>?	4	Same as above
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	2	Same as above
Is the action <u>Technically</u> feasible	2	Same as above
Is the action <u>Politically</u> acceptable?	2	Same as above
Does the jurisdiction have the <u>Legal</u> authority to implement?	3	Same as above
Is <u>Funding</u> available for the action?	2	Same as above
Will the action have a positive impact on the natural <u>Environment</u>?	3	Same as above
Is the action <u>Socially</u> acceptable?	2	Same as above
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3	Same as above
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	Same as above
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	2	Same as above
Is there an Agency/Department <u>Local Champion</u> for the action?	2	Same as above
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Same as above
Total	39 / 43	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii DBEDT OP CZMP **Mitigation Action #:** 2018-049

Mitigation Action Title: Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Oahu, State of Hawaii

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The State of Hawaii Department of Business, Economic Development & Tourism (DBEDT), Office of Planning (OP) Coastal Zone Management Program's (HCZMP's) federally approved Section 309 Assessment and Strategy for FY2016-2020 identifies key problems and opportunities to improve HCZMP's ability to prevent or significantly reduce coastal hazard's risk in high-hazard areas and to manage the effects of potential sea level rise. To implement Section 309 Assessment and Strategy, OP seeks implement this strategy to develop comprehensive high resolution probabilistic Tsunami Design Zone maps for the Island of Oʻahu, State of Hawaiʻi for upcoming use with the International Building Code (IBC) 2018 / American Society of Civil Engineers (ASCE) 7-2016, Chapter 6, Tsunami Loads and Effects standards.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Maui, State of Hawaii and not selected due to more population located in the City & County of Honolulu, Hawaii 2. Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Kauai, State of Hawaii and not selected due to more population located in the City & County of Honolulu, Hawaii 3. Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of Hawaii, State of Hawaii and not selected due to more population located in the City & County of Honolulu, Hawaii
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	This project is Phase I / Years 1 and 2 of a multi-phase and -year endeavor described as follows: (see table below)

Timeframe	Description of Activities
Phase I / Year 1	• Develop Phase I project work plan • Conduct modeling / mapping of the City & County of Honolulu (Urban core south coast and Haleʻiwa)
Phase I / Year 2	• Complete modeling / mapping for entire City & County of Honolulu Island of Oʻahu • Conduct independent technical review to ensure compliance with the ASCE 7-16 Chapter 6 Probabilistic Tsunami Hazard Analysis mapping criteria • Draft proposed language for the Honolulu City Council to consider amending the City & County of Honolulu Building Code to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate for use in the City & County of Honolulu Building Code and the ASCE Tsunami Design Geodatabase

Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $ 430,000.
Plan for Implementation	

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Responsible Department/Organization	Hawaii DBEDT OP CZMP
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☒Ordinance ☐Other:
Potential Funding Sources	National Oceanic and Atmospheric Administration
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short term
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: In procurement

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Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	Project has two components – technical mapping and code adoption. Technical mapping is doable but code adoption is a political change.
Will the action result in Property Protection?	4		Same as above
Will the action be Cost-Effective? (future benefits exceed cost)	2		Same as above
Is the action Technically feasible	4		Same as above
Is the action Politically acceptable?	2		Same as above
Does the jurisdiction have the Legal authority to implement?	2		Same as above
Is Funding available for the action?	3		Same as above
Will the action have a positive impact on the natural Environment?	3		Same as above
Is the action Socially acceptable?	2		Same as above
Does the jurisdiction have the Administrative capability to execute the action?	3		Same as above
Will the action reduce risk to more than one hazard (Multi-Hazard)?	1		Same as above
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	3		Same as above
Is there an Agency/Department Local Champion for the action?	4		Same as above
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		Same as above
Total	41 / 45		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

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Mitigation Action Worksheet

Name of Agency/Organization Hawaii DBEDT OP CZMP **Mitigation Action #:** 2018-050

Mitigation Action Title: Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Counties of Hawaii, Maui and Kauai, State of Hawaii

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☒Molokaʻi ☒Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The State of Hawaii Department of Business, Economic Development & Tourism (DBEDT), Office of Planning (OP) Coastal Zone Management Program's (HCZMP's) federally approved Section 309 Assessment and Strategy for FY2016-2020 identifies key problems and opportunities to improve HCZMP's ability to prevent or significantly reduce coastal hazard's risk in high-hazard areas and to manage the effects of potential sea level rise. To implement Section 309 Assessment and Strategy, OP seeks implement this strategy to develop comprehensive high resolution probabilistic Tsunami Design Zone maps for the Counties of Hawaii, Maui and Kauai, State of Hawaiʻi for upcoming use with the International Building Code (IBC) 2018 / American Society of Civil Engineers (ASCE) 7-2016, Chapter 6, Tsunami Loads and Effects standards.

Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Development of Comprehensive High Resolution Hurricane Probabilistic Design Zone Maps for the Island of Oahu, State of Hawaii and not selected due to the desire to implement the newly adopted ASCE 7-16 Chapter 6 – Tsunami Loads and Effects. 2. Development of Comprehensive High Resolution Hurricane Probabilistic Design Zone Maps for the County of Maui, State of Hawaii and not selected due to desire to implement newly adopted ASCE 7-16 Chapter 6 – Tsunami Loads and Effects. 3. Development of Comprehensive High Resolution Hurricane Probabilistic Design Zone Maps for the County of Kauai, State of Hawaii and not selected due to desire to implement the newly adopted ASCE 7-16 Chapter 6 – Tsunami Loads and Effects.

Action/Project Intended for Implementation

Describe how action will be implemented (main steps involved)

This project will be Phase II of a multi-phase and multi-year project.

Timeframe	Description of Activities
Phase I / Year 1	• Develop Phase I project work plan • Conduct modeling / mapping of City & County of Honolulu (Urban core south coast and Haleʻiwa) • Conduct independent technical review to ensure compliance with ASCE 7 criteria
Phase I / Year 2	• Complete modeling / mapping for entire City & County of Honolulu Island of Oʻahu • Conduct independent technical review to ensure compliance with ASCE 7 criteria • Draft proposed language for the Honolulu City Council to consider amending the City & County of Honolulu Building Code to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate for use in the City & County of Honolulu Building Code and the ASCE Tsunami Design Geodatabase
Phase I / Year 3	• Initiate modeling / mapping for Hawaiʻi, Maui, and Kauaʻi counties
Phase(s) I & II/ Year 4	• Complete modeling / mapping for Hawaiʻi, Maui, and Kauaʻi counties • Conduct independent technical review to ensure compliance with ASCE 7 criteria • Draft proposed language for county councils of Hawaiʻi, Maui, and Kauaʻi to consider amending their building codes to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate for use in their respective county building codes and the ASCE Tsunami Design Geodatabase
Phase II/ Year 5	• Complete drafting proposed language for county councils of Hawaiʻi, Maui, and Kauaʻi to consider amending their building codes to adopt the

	probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with styles of maps appropriate for use in their respective county building codes and the ASCE Tsunami Design Geodatabase • Draft proposed language to adopt the probabilistic Tsunami Design Zone maps / model data developed pursuant to this project along with style of maps appropriate for use in State of Hawaiʻi Building Code • Present building code amendments for SBCC review and approval • Conduct rulemaking in accordance with HRS Chapter 91
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $ TBD
Plan for Implementation	
Responsible Department/Organization	Hawaii DBEDT OP CZMP
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☒Ordinance ☐Other:
Potential Funding Sources	National Oceanic and Atmospheric Administration and TBD
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term and OG
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Probabilistic Tsunami Design Zone Mapping of Hawaii, Maui and Kauai Counties (Phase II) will occur after Probabilistic Tsunami Design Zone Mapping of Oahu (Phase I) is completed. Phase I is in progress.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	Project has two components – technical mapping and code adoption. Technical mapping is doable but code adoption is a political change.
Will the action result in Property Protection?	4		Same as above
Will the action be Cost-Effective? (future benefits exceed cost)	2		Same as above
Is the action Technically feasible	4		Same as above
Is the action Politically acceptable?	2		Same as above
Does the jurisdiction have the Legal authority to implement?	2		Same as above
Is Funding available for the action?	3		Same as above

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Will the action have a positive impact on the natural <u>Environment</u>?	3	Same as above
Is the action <u>Socially</u> acceptable?	2	Same as above
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3	Same as above
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	1	Same as above
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	3	Same as above
Is there an Agency/Department <u>Local Champion</u> for the action?	4	Same as above
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Same as above
Total	41 / 45	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

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Mitigation Action Worksheet

Name of Agency/Organization: HI-EMA **Mitigation Action #:** 2018-051

Mitigation Action Title: Flood Engineering Analysis of Waimanalo Watershed

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Waimanalo like many watersheds in Hawaii is subject to flooding. Erosion and development have exacerbated the flooding risk and existing infrastructure may no longer be adequate to contain the risk, leading to damage to farms, residences and businesses.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action: chronic flooding will continue. 2. Replace specific culverts without studying area 3. Study full watershed to develop holistic approach to addressing flood risk in Waimanalo watershed
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Form workgroup of affected state and county agencies, affected land owners and th. 2. Develop a public information campaign including public service announcements, fact sheets, and other forms of communication on the types of insurance and the need to purchase flood insurance. 3. Measure change in the number of active flood insurance policies compared to baseline levels. As of February 2018, there are 60,423 active flood insurance policies statewide.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA in cooperation with DLNR
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Education and outreach
Potential Funding Sources	FEMA, State funding, US Geological Survey, US Department of Agriculture, Natural Resources Conservation Service

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Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	2	x 2 = 4	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3		
Is the action <u>Technically</u> feasible	3		
Is the action <u>Politically</u> acceptable?	3		
Does the jurisdiction have the <u>Legal</u> authority to implement?	3		
Is <u>Funding</u> available for the action?	3		
Will the action have a positive impact on the natural <u>Environment</u>?	2		
Is the action <u>Socially</u> acceptable?	3		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	3		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	42		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

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Mitigation Action Worksheet

Name of Agency/Organization: HI-EMA **Mitigation Action #:** 2018-052

Mitigation Action Title: Include Climate Change in North Shore Coastal Flooding Restudy

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The analysis underlying the flood maps for the Northshore of Oahu is dated and should be redone using modern methods and current data reflecting the changes to the built environment. This will produce a better representation of the coastal flooding risk. It also provides an opportunity to include the effect of rising sea level on passive flooding and on event based flooding.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. No Action: existing FIRMs will remain. 2. Conduct the restudy without explicit inclusion of Climate Change analysis 3. Conduct the restudy including Climate Change analysis
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Coordinate with FEMA Region IX Risk Map staff to develop scope of work for north shore restudy including climate change analysis. 2.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA in coordination with DLNR
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Education and outreach
Potential Funding Sources	FEMA Risk Map

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Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	2	x 2 = 4	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	3		
Is the action Technically feasible	3		
Is the action Politically acceptable?	3		
Does the jurisdiction have the Legal authority to implement?	3		
Is Funding available for the action?	3		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	3		
Does the jurisdiction have the Administrative capability to execute the action?	3		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	3		
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	42		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

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Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-053

Mitigation Action Title: Coordinate the compilation of projected development to assist with future local and State HMPs

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Development continues to occur in the State. To avoid future losses, it is best to assess if projected new development may be impacted by hazards by conducting a spatial analysis. A statewide spatial layer of projected development (eg, buildings, infrastructure) is not available. To conduct this exercise for the 2018 HMP Update, the following data was used: 1) Hawaiʻi Community Development Authority's Community Development Districts; 2) Enterprise Zones and 3) Maui Development Projects; refer to Section 3 (State Profile). It is recognized that these datasets do not represent all projected development in the State and a centralized location for this spatial data is needed to ensure a complete analysis is conducted.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. HI-EMA compile the data without consultation and coordination with other state and local resources 3. The HI-EMA will work with other departments at the state and local levels, to coordinate the compilation of projected development to avoid development in hazard areas, and include with the update of future local and state hazard mitigation plans. - Preferred and selected action.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	The HI-EMA will work with other departments at the state and local levels, to coordinate the compilation of projected development in a spatial format to enable a more comprehensive analysis to identify problems and exposure prior to construction. This information will be included in the future update of local and state hazard mitigation plans; and be available to all entities for planning use.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☒Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☒ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA Mitigation Section, in coordination with planning departments at the state and local levels
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hazard Mitigation Plan
Potential Funding Sources	FEMA HMGP; State budget
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short

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Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	2	x 2 = 4	Action centered on development which will in turn protect life by avoiding future development in high risk areas
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	2		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	2		HI-EMA may need GIS resources to assist
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		HI-EMA State Hazard Mitigation Officer
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

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Mitigation Action Worksheet

Name of Agency/Organization State of Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) **Mitigation Action #:** 2018-055

Mitigation Action Title: Reduce and/or convert hazardous fuels along roadsides.

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The State Wildfire Ignitions Mapping Project showed that the majority of ignitions occur along roads. Reducing and/or converting hazardous fuels along roadsides help prevent wildfires and stop or slow the spread of wildfires to communities and native ecosystems and watersheds.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Pave or cement areas within 10 feet on each side of highways and private streets. This is not cost effective and will encourage water run-off, including stormwater and pollution, into streams and oceans. 2. Build cement walls to act as a hardened barrier between roads and abutting vegetation. This is not cost effective, is aesthetically unpleasing, and may not be social acceptable. 3. No Action. The majority of ignitions occur along roads. Wildfires will continue to threaten communities and conservation land. Wildfires cause losses, which often exceed the cost of mitigation.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Per the State Fire Code, Chapter 17 WUI, 17.3.5.3 Roadways, areas within 10 ft on each side of portions of highways and private streets shall be cleared of combustible vegetation and other combustible growth. Certain ground covers shall be permitted to be exempt provided that they do not form a means of readily transmitting fire. Keep invasive, fire prone grasses and shrubs short. Monitor vegetative regrowth due to year-round growing season and invasive, fire-prone grasses that grow back quickly.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	State and County Departments of Transportation
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: State Fire Code: Chapter 17 WUI; Chapter 19-127.1, Hawaii Administrative Rules; Chapter 185, HRS; Community Wildfire Protection Plans
Potential Funding Sources	Operating Funds (State Funds)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Routine maintenance done on an ongoing basis.

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	3 x 2 = 6	
Will the action result in Property Protection?	3	
Will the action be Cost-Effective? (future benefits exceed cost)	4	Wildfires cause losses, some irreplaceable, which often exceed the cost of prevention and mitigation.
Is the action Technically feasible	4	
Is the action Politically acceptable?	4	
Does the jurisdiction have the Legal authority to implement?	4	
Is Funding available for the action?	4	
Will the action have a positive impact on the natural Environment?	4	
Is the action Socially acceptable?	4	
Does the jurisdiction have the Administrative capability to execute the action?	4	
Will the action reduce risk to more than one hazard (Multi-Hazard)?	0	
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	Rainfall and mild temperatures that occur throughout the year contribute to a year-round growing season, thus requiring continual maintenance. Over 25% of the State is covered by invasive, fire prone grasses and shrubs, which grow back quickly after being cleared.
Is there an Agency/Department Local Champion for the action?	4	Pursuant to Chapter 185, Hawaii Revised Statutes (HRS), DLNR is mandated to take measures for prevention, control, and extinguishment of wildland fires on DLNR-DOFAW managed lands, and is required to cooperate with established fire control agencies of the counties and federal governments in developing plans and programs and mutual aid agreements for assistance on land not managed by DLNR-DOFAW. However, there is no permanent Mitigation Specialist dedicated solely to wildfire risk reduction at the state level to coordinate multi-sector mitigation actions across state and county jurisdictions.
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-056

Mitigation Action Title: Annually evaluate progress on linking the 2018 HMP Update and local HMPs as part of the Mitigation Program Consultation

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	In the process of updating the earlier versions of the HMP, it became apparent that mitigation processes, although well-intentioned, have been interrupted; including during the performance period of the 2013 State HMP. The State HMP needs to remain a living document in order to reduce future losses to the State. To do so, an annual evaluation on progress by meeting with the Forum, updates to the plan, supported by the local HMP roll-up and annual consultation with FEMA needs to take place. The HI-EMA is committed to this annual evaluation and update.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing – No progress will be made on maintaining the plan
	2. Only participate in the annual consultation but no formal update to the 2018 HMP Update
	3. Continuously monitor, evaluate and update the 2018 HMP Update while consistently meeting with FEMA Region IX for the annual consultation
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	At a minimum of one Forum meeting per year, the SHMO will lead the HMP update discussion to evaluate the content of the State HMP. The framework and questions are outlined in Section 7 (Plan Maintenance). At the conclusion of these Forum meetings, the HI-EMA will capture the changes and progress discussed, and combine into an annual review report. The annual review report will be structured to align with the main sections of the 2018 HMP Update and be included in an appendix to the plan for record. This will facilitate the incorporation of changes and progress made in the 2023 HMP Update. The SHMO will continue to host the current version of the 2018 HMP Update on the HI-EMA website and ensure the annual review reports are included in an appendix to the State HMP and uploaded to the website for transparency and to keep stakeholders and the public up to date. The SHMO will meet annually with FEMA Region IX for the annual consultation process to ensure continual progress is made and feedback is obtained.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Loss of Function ☒Other Describe: Enhanced State HMP, implementation of actions, demonstration of mitigation success
Estimated Cost	☒ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA Mitigation Section, State Hazard Mitigation Officer
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hazard Mitigation Plan
Potential Funding Sources	State funding: HI-EMA

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4 x 2 = 8	
Will the action result in <u>Property Protection</u>?	4	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	4	
Will the action have a positive impact on the natural <u>Environment</u>?	2	
Is the action <u>Socially</u> acceptable?	4	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department <u>Local Champion</u> for the action?	4	HI-EMA State Hazard Mitigation Officer
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	58	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization HI-EMA **Mitigation Action #:** 2018-057

Mitigation Action Title: Coordinate access to Hawai`i State Historic Preservation Division maintained cultural resource information

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Cultural asset information in the State of Hawaiʻi is managed by the Hawai`i State Historic Preservation Division in the Department of Land and Natural Resources. This information is not available for public review and use at this time and as such, could not be included in the analysis in the 2018 HMP Update. It is a goal of the HI-EMA to work with the Department in the future in order to access this information for inclusion in future state hazard mitigation plan updates.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing – maintain the same analysis in the 2018 HMP Update using only Hawaiian Home Lands 2. Coordinate with Hawai`i State Historic Preservation Division in the Department of Land and Natural Resources to obtain the dataset to enhance the 2023 HMP Update – best alternative 3. HI-EMA to develop their own cultural sites data set – duplication of efforts and not preferred
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	HI-EMA to work with the Department in the future in order to access to cultural resource information for inclusion in future state hazard mitigation plan updates.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☒Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe: Enhanced analysis for the State Hazard Mitigation Plan to assess potential future losses to cultural assets and develop mitigation strategies
Estimated Cost	☒ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	HI-EMA as the lead, in coordination with the Hawai`i State Historic Preservation Division in the Department of Land and Natural Resources
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Hazard Mitigation Plan
Potential Funding Sources	HI-EMA internal funding
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Initial outreach was started while the 2018 HMP Update was in progress

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	2	x 2 =	
Will the action result in Property Protection?	4		More detailed all-hazard analysis will identify vulnerable cultural sites to then, as a next step, identify mitigation actions to reduce future losses
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	2		
Is Funding available for the action?	4		
Will the action have a positive impact on the natural Environment?	4		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department Local Champion for the action?	4		HI EMA – State Hazard Mitigation Officer
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	52		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawaii State Department of Transportation **Mitigation Action #:** 2018-058

Mitigation Action Title: Implement recommendations of the Statewide Highway Shoreline Protection Study

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based Flooding ☐Hazardous Materials ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☒Kauaʻi ☐Lānaʻi ☒Molokaʻi ☒Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Several roadways in the State flood from chronic coastal flooding as well as storm events; and flooding may be exacerbated by projected sea level rise and changes in future conditions identified in this plan. These roads have been identified and catalogued in a recent study (State Highway Shoreline Protection Study: Final Report of Preliminary Field Investigation, Rankings and Recommendations; January 2018). The next step is the implementation of mitigation measures recommended in the study in order to avoid road failure affected by shoreline activity, reduce possible road closures during the next storm and hurricane and maintain the existing State infrastructure.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing – roads continue to deteriorate from flooding, leading to road closures and loss of function 2. Implement mitigation measures identified in the study 3. Close the existing roads that have been identified as vulnerable and build new roads outside the hazard area – may not be cost-effective
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Implement the mitigation measures as outlined in State Highway Shoreline Protection Study: Final Report of Preliminary Field Investigation, Rankings and Recommendations; January 2018. The study has recommendations for next steps and has prioritized the roadways that require attention.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Hawaii State Department of Transportation – Highway Division
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA HMA (PDM, FMA, HMGP); State funding

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4	x 2 = 8	
Will the action result in Property Protection?	4		
Will the action be Cost-Effective? (future benefits exceed cost)	4		
Is the action Technically feasible	4		
Is the action Politically acceptable?	4		
Does the jurisdiction have the Legal authority to implement?	4		
Is Funding available for the action?	2		
Will the action have a positive impact on the natural Environment?	2		
Is the action Socially acceptable?	4		
Does the jurisdiction have the Administrative capability to execute the action?	4		
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	2		Some progress may be made in the next 5 years; work will need to continue long-term
Is there an Agency/Department Local Champion for the action?	4		State DOT
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	54		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-001

Mitigation Action Title: Long-term Recovery and Adaptation Plan

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The City and County of Honolulu faces numerous long-term hazards, exacerbated by the impacts from climate change. A long-term Recovery and Adaptation Plan would frame the hazards and vulnerabilities and would develop a strategy for addressing the long-term risks. Potential projects could include Kamehameha Highway realignment and drainage improvements; Waianae Coast Drainage Master Plan, Alternate Emergency Route, and Land Purchases; Stream Debris Prevention and Adjacent Land Purchases; Koolauloa Coastal Land Purchases; and Coastal Setback Regs
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	- Hire a Planner to develop the Long-term Recovery & Adaption Plan - Work with C & County + State Stakeholders to develop the plan, including development of specific recovery and adaptation projects to address the long-term impacts of climate change.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	City and County DEM, Of
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short term
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	x 2 =	
Will the action result in <u>Property Protection</u>?		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)		
Is the action <u>Technically</u> feasible		
Is the action <u>Politically</u> acceptable?		
Does the jurisdiction have the <u>Legal</u> authority to implement?		
Is <u>Funding</u> available for the action?		
Will the action have a positive impact on the natural <u>Environment</u>?		
Is the action <u>Socially</u> acceptable?		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?		
Is there an Agency/Department <u>Local Champion</u> for the action?		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?		
Total		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-002

Mitigation Action Title: Lualualei Navy Lands Drainage Improvements

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Maʻiliʻili Watershed Management Plan 4.2.4 Series of small detention ponds/check dams on Navy lands - $ 1 million per pond (5 acre feet), $22,000 per check dam (25 ft x 10 ft x 18 ft).
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	The Navy should coordinate with DOH and the watershed coordinator to identify depressions or relatively flat areas along stream channels to construct small detention ponds and/or check dams to reduce peak flood flows. These are easier to construct than a full sediment basin and will help reduce some of the sediment load and peak flows, potentially reducing flooding downstream
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	US Navy, Honolulu Department of Design and Construction (DCC), State Department of Land and Natural Resources (DLNR)
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	US Navy, County, State, USGS, NRCS, FEMA
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?		x 2 =	
Will the action result in Property Protection?			
Will the action be Cost-Effective? (future benefits exceed cost)			
Is the action Technically feasible			
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?			
Is Funding available for the action?			
Will the action have a positive impact on the natural Environment?			
Is the action Socially acceptable?			
Does the jurisdiction have the Administrative capability to execute the action?			
Will the action reduce risk to more than one hazard (Multi-Hazard)?			
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department Local Champion for the action?			
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-003

Mitigation Action Title: Makiki and Kanaha Stream Flood Mitigation Project

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	2003 Ala Wai Watershed Analysis (available here), Project No. 14, pp.58-59 Potential flood damage in Makiki Valley from Wilder Avenue to Ala Wai Canal
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	- Develop design specifics for flooding problem that are compatible with developed, urban areas along Makiki and Kanaha streams - Channel improvements from Ala Wai Canal to King Street to handle a design flow of 5,600 cfs - Channel improvements for Kanaha Stream makai of Roosevelt High School - Accommodate multiple purposes in flood control features, including ecosystem improvements, recreational activities & maintenance activities
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Honolulu Department of Design and Construction (DCC), State Department of Land & Natural Resources (DLNR)
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State & Federal (FEMA, USGS, USACE, NRCS, NOAA, Sea Grant)

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?		x 2 =	
Will the action result in Property Protection?			
Will the action be Cost-Effective? (future benefits exceed cost)			
Is the action Technically feasible			
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?			
Is Funding available for the action?			
Will the action have a positive impact on the natural Environment?			
Is the action Socially acceptable?			
Does the jurisdiction have the Administrative capability to execute the action?			
Will the action reduce risk to more than one hazard (Multi-Hazard)?			
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department Local Champion for the action?			
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-004

Mitigation Action Title: Hardening of Critical Facilities, Utilities, and Port Facilities

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☐Health Risks ☒High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Widespread vulnerability of Oʻahu's critical facilities, including ports, utilities, facilities, critical roadways and bridges in the event of hazards.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Prioritize facilities for hardening 2. Seek funding for drawing up hardening plans 3. Draw up plans for hardening 4. Seek funding for hardening retrofits
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Ongoing
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☒Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?		x 2 =	
Will the action result in <u>Property Protection</u>?			
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)			
Is the action <u>Technically</u> feasible			
Is the action <u>Politically</u> acceptable?			
Does the jurisdiction have the <u>Legal</u> authority to implement?			
Is <u>Funding</u> available for the action?			
Will the action have a positive impact on the natural <u>Environment</u>?			
Is the action <u>Socially</u> acceptable?			
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?			
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?			
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department <u>Local Champion</u> for the action?			
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-005

Mitigation Action Title: Long Term Congregate Care Shelters

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	At present, Oʻahu has precious few facilities that can be utilized for public shelters when disaster strikes. At present the City and County recommends “shelter in place” and has also designated many schools as short-term backup shelters. But we need to create long term congregate care shelters in public parks and recreation centers and gymnasiums so that schools can return to teaching as soon as possible.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Create long term congregate care shelters at public parks and recreation centers and gymnasiums. This will require hardening and retrofitting these facilities.
Action/Project Type	☒State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☐Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Ongoing
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?		x 2 =	
Will the action result in Property Protection?			
Will the action be Cost-Effective? (future benefits exceed cost)			
Is the action Technically feasible			
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?			
Is Funding available for the action?			
Will the action have a positive impact on the natural Environment?			
Is the action Socially acceptable?			
Does the jurisdiction have the Administrative capability to execute the action?			
Will the action reduce risk to more than one hazard (Multi-Hazard)?			
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department Local Champion for the action?			
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	City & County of Honolulu	**Mitigation Action #:**	Honolulu-006
Mitigation Action Title:	Post-Disaster Staging Areas		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Oʻahu currently lacks protected staging areas for post-disaster response, so that teams can quickly and effectively clear critical roadways and bridges and provide access to airports and harbors.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	The City and County of Honolulu would like to build new staging facilities as opportunities allow, and to harden existing staging facilities to create between 5 and 8 (optimal) disaster response staging areas.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	x 2 =	
Will the action result in <u>Property Protection</u>?		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)		
Is the action <u>Technically</u> feasible		
Is the action <u>Politically</u> acceptable?		
Does the jurisdiction have the <u>Legal</u> authority to implement?		
Is <u>Funding</u> available for the action?		
Will the action have a positive impact on the natural <u>Environment</u>?		
Is the action <u>Socially</u> acceptable?		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?		
Is there an Agency/Department <u>Local Champion</u> for the action?		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?		
Total		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-007

Mitigation Action Title: Temporary Electrical Charging Stations for Oʻahu Post Disaster

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	In event that power grid goes down, Oʻahu will need to provide temporary electrical charging stations for public to charge medical equipment, refrigeration systems for medications, cell phones and other critical devices. These could be solar powered with battery storage, which would help reduce fuel demand and need for fuel storage, both of which are of concern for HIEMA
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Outfit staging areas and congregate care shelters with solar powered, battery operated charging systems.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Tern
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	x 2 =	
Will the action result in <u>Property Protection</u>?		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)		
Is the action <u>Technically</u> feasible		
Is the action <u>Politically</u> acceptable?		
Does the jurisdiction have the <u>Legal</u> authority to implement?		
Is <u>Funding</u> available for the action?		
Will the action have a positive impact on the natural <u>Environment</u>?		
Is the action <u>Socially</u> acceptable?		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?		
Is there an Agency/Department <u>Local Champion</u> for the action?		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?		
Total		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-008

Mitigation Action Title: Tsunami Evacuation Signage

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Lack of installed signage demarcating Tsunami Evacuation routes on the island of Oʻahu.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	The City & County of Honolulu has purchased signs to demarcate Tsunami Evacuation Routes, but does not currently have the funding to install them. Project requests funds for installing the signs, and also using templates to indicate evacuation lines and routes on the streets/ sidewalks under our jurisdiction.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal (FEMA, NOAA, Tsunami Hazard Mitigation Program)
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	

State of Hawaiʻi
Mitigation Action Worksheet

Status/Comment	☐Not Started ☐In-progress ☒Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?		x 2 =	
Will the action result in Property Protection?			
Will the action be Cost-Effective? (future benefits exceed cost)			
Is the action Technically feasible			
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?			
Is Funding available for the action?			
Will the action have a positive impact on the natural Environment?			
Is the action Socially acceptable?			
Does the jurisdiction have the Administrative capability to execute the action?			
Will the action reduce risk to more than one hazard (Multi-Hazard)?			
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department Local Champion for the action?			
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-009

Mitigation Action Title: Micro Grids for Critical Health Infrastructure Support

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	If Oʻahu's electrical grid goes down, critical health facilities will lose both power and water (the island's water system depends on electricity for pumping). A pressing example is that kidney dialysis centers. If more than 3 days pass with no power and water, kidney dialysis machinery will have to be shipped to the Mainland to be sanitized, and the sizeable community of Oʻahu citizens requiring dialysis will have to be sent to the mainland for care.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Install micro grids to support medical facilities such as hospitals and dialysis centers in the event that the island's primary power grid goes down.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☒Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term

State of Hawaiʻi
Mitigation Action Worksheet

Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	x 2 =	
Will the action result in <u>Property Protection</u>?		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)		
Is the action <u>Technically</u> feasible		
Is the action <u>Politically</u> acceptable?		
Does the jurisdiction have the <u>Legal</u> authority to implement?		
Is <u>Funding</u> available for the action?		
Will the action have a positive impact on the natural <u>Environment</u>?		
Is the action <u>Socially</u> acceptable?		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?		
Is there an Agency/Department <u>Local Champion</u> for the action?		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?		
Total		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-010

Mitigation Action Title: Structural Retrofitting of Existing Buildings and Construction of Safe Rooms

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Oʻahu currently lacks facilities that provide safe rooms for Emergency Response Workers to shelter in place. Having safe rooms situated at various city facilities will both protect and enable these workers to rapidly activate the City's response and recovery—for example, if they shelter in place, they can begin clearing debris from critical roads and bridges immediately after storm or event.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Working with DDC engineers, the City would harden windows, doors and roofs of identified facilities and/or install an interior safe room within or adjacent to the identified facilities. The goal is to create 15 such facilities that are retrofitted or constructed with a safe room.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☒Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Emergency Management
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State and Federal

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: **Short (1-5 years), Long Term (5 years or greater), OG (On-going program)**	Long Term
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

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Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?		x 2 =	
Will the action result in Property Protection?			
Will the action be Cost-Effective? (future benefits exceed cost)			
Is the action Technically feasible			
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?			
Is Funding available for the action?			
Will the action have a positive impact on the natural Environment?			
Is the action Socially acceptable?			
Does the jurisdiction have the Administrative capability to execute the action?			
Will the action reduce risk to more than one hazard (Multi-Hazard)?			
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department Local Champion for the action?			
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization City & County of Honolulu **Mitigation Action #:** Honolulu-011

Mitigation Action Title: Lualualei Drainage Improvements

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☒ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Maʻiliʻili Watershed Management Plan 4.2.5 Replacement of Aging/Undersized Culverts and Bridges in Ma'ili'ili Residential Areas.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. 2. 3.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	As outlined in the Lualualei Flood Study, there are multiple culverts in residential areas in need of repair or replacement. The Army Corps of Engineers should coordinate with the City & County of Honolulu to implement the upgrades identified in the flood study (2). $740,000 estimated in Lualualei Flood Study for all necessary replacements
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☒Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	US Navy, City & County of Honolulu, Department of Land & Natural Resources.
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	County, State & Federal (US Navy, USACE, USGS, NRCS, FEMA Sea Grant)

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long term
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?		x 2 =	
Will the action result in Property Protection?			
Will the action be Cost-Effective? (future benefits exceed cost)			
Is the action Technically feasible			
Is the action Politically acceptable?			
Does the jurisdiction have the Legal authority to implement?			
Is Funding available for the action?			
Will the action have a positive impact on the natural Environment?			
Is the action Socially acceptable?			
Does the jurisdiction have the Administrative capability to execute the action?			
Will the action reduce risk to more than one hazard (Multi-Hazard)?			
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?			
Is there an Agency/Department Local Champion for the action?			
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?			
Total			
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	Maui Emergency Management Agency	**Mitigation Action #:**	Maui-001
Mitigation Action Title:	Dam Inundation – Public Awareness Campaign		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☒Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Residents impacted by potential dam failure may be unaware of their risks, the implications of the hazard and what to do.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Ensure the dam will not fail 3. Relocate businesses and residents within the dam inundation areas
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Develop a public outreach awareness campaign targeting residents located within a dam inundation area. Include information about what to do in an emergency, community questions and answers and where to receive information.
Action/Project Type	☐State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☒Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☐Goal #2 ☐Goal #3 ☐Goal#4 ☒Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	State of Hawaii Department of Land and Natural Resources, Hawaii Emergency Management Agency, county emergency management agencies
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: Local Hazard Mitigation Plan
Potential Funding Sources	PDM
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short

State of Hawaiʻi
Mitigation Action Worksheet

Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	3		
Will the action have a positive impact on the natural <u>Environment</u>?	2		
Is the action <u>Socially</u> acceptable?	4		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	57		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Maui Emergency Management Agency **Mitigation Action #:** Maui-002

Mitigation Action Title: Emergency Barge and Ferry Service

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☒Lānaʻi ☒Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Develop an MOU to formalize emergency barge and ferry service to reach isolated communities within Maui County. Action needed due to community isolation and limited resources on island.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Just in time contracting – not effective during disaster 3. Emergency Barge and Ferry Service
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Make contact with each barge/ferry company and work toward formalizing agreements for prioritized shipments.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☐Goal #1 ☐Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☒ < $10,000; ☐$10,000 to $100,000; ☐>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Transportation, HI-EMA, County of Maui
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☒Other: MOU
Potential Funding Sources	Staff time

State of Hawaiʻi
Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Short
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4 x 2 =	
Will the action result in <u>Property Protection</u>?	2	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	3	
Is the action <u>Technically</u> feasible	3	
Is the action <u>Politically</u> acceptable?	3	
Does the jurisdiction have the <u>Legal</u> authority to implement?	3	
Is <u>Funding</u> available for the action?	4	
Will the action have a positive impact on the natural <u>Environment</u>?	2	
Is the action <u>Socially</u> acceptable?	3	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	
Is there an Agency/Department <u>Local Champion</u> for the action?	3	
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	2	
Total	48	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☒Medium ☐High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Maui Emergency Management Agency **Mitigation Action #:** Maui-003

Mitigation Action Title: Realign Honoapiilani Highway

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☒Chronic Coastal Flooding ☒Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☒ Event-based flooding ☐Health Risks ☐High Wind Storms ☒ Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☒Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Honoapiilani Highway is the only safe transportation route from Central Maui to West Maui. The current location of the highway is subject is significant erosion. The State of Hawaii Department of Transportation has made costly repairs but remains threatened. If the highway is impacted by wave inundation, residents and visitors will not have access to medical care and essential transportation routes. Resources into west Maui will be significantly restricted.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Continue costly repairs 3. Construct an elevated road
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Realign Honoapiilani Highway outside of coastal hazard area – Initiate a planning process with HDOT; Document planning process steps and timeline; Develop environmental documents showing alternative alignments; Acquire/purchase any additional land needed for realignment; Implement construction for realignment.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	State of Hawaii Department of Transportation and County of Maui Planning Department
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA HMGP, PDM and FMA, CDBG; Hawaii DOT; Staff Time; Federal Highway Fund
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Portion of the highway has been realigned

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	
Will the action result in <u>Property Protection</u>?	4		
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		
Is the action <u>Technically</u> feasible	4		
Is the action <u>Politically</u> acceptable?	4		
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		
Is <u>Funding</u> available for the action?	2		
Will the action have a positive impact on the natural <u>Environment</u>?	4		
Is the action <u>Socially</u> acceptable?	3		
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3		
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	1		
Is there an Agency/Department <u>Local Champion</u> for the action?	4		
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		
Total	53		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Maui Emergency Management Agency **Mitigation Action #:** Maui-004

Mitigation Action Title: Retrofit Shelter Facilities

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☒Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☒All Islands ☐Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☒Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Very limited shelter facilities in Hawaii are able to withstand Category 3 hurricane force winds. Due to the geographic isolation of the islands there is no safe public sheltering option.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Do nothing 2. Build alternate facilities for sheltering 3. Evacuate the state for hurricanes
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Harden emergency shelters throughout the planning area to ensure that they are able to withstand Category 3 hurricane force wind speeds.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	State Department of Education and county Parks and Recreation
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA HMGP and PDM, CDBG, Hawaii EMA, DLNR
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Long Term
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Portion of the highway has been realigned

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	4 x 2 = 8	
Will the action result in <u>Property Protection</u>?	4	
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	
Is the action <u>Technically</u> feasible	4	
Is the action <u>Politically</u> acceptable?	4	
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	
Is <u>Funding</u> available for the action?	2	
Will the action have a positive impact on the natural <u>Environment</u>?	4	
Is the action <u>Socially</u> acceptable?	3	
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	3	
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	1	
Is there an Agency/Department <u>Local</u> Champion for the action?	4	
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	
Total	53	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawai'i County Civil Defense Agency **Mitigation Action #:** Hawaiʻi-001

Mitigation Action Title: Damage Assessment Software Licenses & Field Data Collection Equipment

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Collection of Damage Assessment Field Data is to be reported to FEMA within 24-hours of incident. ESRI ArcGIS Collector Application is compatible and interfaces well with the County's Real Property data system. Application is easily loaded onto multiple device platforms; however, it requires ArcGIS Online Named Used Level 2 Term licenses. With over 100 communities/subdivisions, 11 Climate Zones, and virtually ever natural hazard, procurement of 100 each ArcGIS Online Named User Level 2 Term licenses and 20 iPad devices will assure the County of Hawaii accurately and effectively performs its Damage Assessment responsibility.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Manual Forms- not real-time; double entry, delayed reporting and service. 2. Custom Software- tried this previously; not easily updated to improve performance. 3. Damage Assessment Software Licenses & Field Data Collection Equipment
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Purchase licenses and tablets 2. Install application software on tablets 3. Test software in the field 4. Conduct training 5. Be Mission-ready for Recovery Phase damage assessment operations
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☐Goal #1 ☐Goal #2 ☐Goal #3 ☒Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☐Life Safety ☐Damage Reduction ☐Loss of Function ☒Other Describe: Reduction in administrative costs in response and recovery actions
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $60,000
Plan for Implementation	
Responsible Department/Organization	Hawai'i County Civil Defense Agency, County of Hawai'i
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☐Comprehensive Plan ☒Building Code ☐Ordinance ☐Other:
Potential Funding Sources	Hazard Mitigation Grant, County Operational Budget
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	OG
Reporting on Progress	
Status/Comment	☐Not Started ☒In-progress ☐Delayed ☐Completed ☐No Longer Required Comment: Researched alternatives and demo of ArcGIS Collector program.

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0	Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	3 x 2 = 6	Yes. Prompt and accurate Damage Assessments allow responders to more effectively utilize on-island limited resources in Life Safety and Protection of Property Operations.
Will the action result in <u>Property Protection</u>?	4	Yes. Remediation needs a baseline and funding source. This application provides field data support for better formulation of strategies and wise use of limited funding.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	Yes. This product provides high accuracy, quick field data collection, and automatic populating of database and reports resulting in faster recovery, reduction of trauma to survivors, and effective use of resources and limited funding.
Is the action <u>Technically</u> feasible	4	Yes. Application technology allows collection data even without telecommunications connection. Application is operator-friendly. Application automatically uploads captured data.
Is the action <u>Politically</u> acceptable?	4	Yes. A speedy recovery is everyone's responsibility.
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	Yes. Hawaii Revised Statues HRS-127a and FEMA Damage Assessment Requirements clearly define the County's responsibility in Damage Assessment Operations.
Is <u>Funding</u> available for the action?	4	Funding alternatives being examined. Hurricane Season is less than 1 month away. Timing is sensitive.
Will the action have a positive impact on the natural <u>Environment</u>?	4	Yes. An accurate Damage Assessment Operation reduces environmental impact and limits activity to affected areas.
Is the action <u>Socially</u> acceptable?	4	Yes. Accurate first-time, single-entry collection of personal data reduces public intolerance.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	Yes. County has certified ArcGIS technicians to install and train personnel. The County's Civil Defense Agency is required by law and by the Office of the Mayor to administer Damage Assessment Operations for the County.
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	Yes. The County of Hawaii experiences the most kinds of natural hazards than any of the 3,143 counties in the USA.
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	Yes. Procurement, installation, training, and mission-readiness will be completed within 6 months.
Is there an Agency/Department <u>Local Champion</u> for the action?	4	Yes. Office of the Mayor, Hawaii County Civil Defense Agency, Real Property, and Office of Housing & Community Development.
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Yes. Application Program can be used to track lava eruption flows and displaced populations, map locations of Alert Sirens, FEMA Caches, Evacuation Shelters/Center, Law Enforcement, homeless point-in-time surveys, and more.
Total	55	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Department of Water Supply, County of Hawaii **Mitigation Action #:** Hawaiʻi-002

Mitigation Action Title: Waimea Operations Facility Emergency Power System Hardening

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☐ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Project will mitigate the delay in the Department of Water Supply's (DWS) ability to respond and perform repairs to well sources and water transmission/distribution system in the aftermath of a natural disaster. The installation of an emergency back-up generator set at the Kona baseyard will help DWS to timely coordinate, respond and support repair efforts to ensure continuity of water service and to protect the health and welfare of the public.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Seek alternative funding for the emergency power system project. However, available funding opportunities are limited. 2. Postpone the emergency power system project until internal funding allocated. However, time is of essence and funds are limited. It would take minimum 5 years to budget and approve the project. 3. No action. However, this would increase the time it would take to coordinate and respond to disaster emergencies, which may put increase risk to the health and welfare of the public.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Gain proper approval for project and funding; execute agreements, as required. 2. Execute professional services contract and obtain materials required for construction permit and solicitation. 3. Solicit bids and award construction contract. 4. Order materials, complete construction, and close out construction and professional services contracts. 5. Close out with HIEMA and FEMA, as required.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Hazard Mitigation Grant Program (HMGP) funds DWS Capital Improvement Plan

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Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Year 1 – Design complete Year 2 – Construction started and completed Year 3 – Close out project
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4 x 2 = 8	The project will ensure timely response to water emergencies. Clean drinking water is essential for survival. Clean water is also required for medical and fire protection needs.
Will the action result in <u>Property Protection</u>?	4	The project will ensure timely response to water emergencies. Water feeds many fire sprinkler and hydrants designed to protect property.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4	The project will ensure timely response to water emergencies. Water service provides fire protection.
Is the action <u>Technically</u> feasible	4	Yes, using ready available technology.
Is the action <u>Politically</u> acceptable?	4	No foreseeable negative political implications.
Does the jurisdiction have the <u>Legal</u> authority to implement?	4	The project will affect only DWS owned structures and equipment.
Is <u>Funding</u> available for the action?	3	Partial funding may be available.
Will the action have a positive impact on the natural <u>Environment</u>?	2	There will be minimal impact on the natural environment.
Is the action <u>Socially</u> acceptable?	4	No foreseeable negative social impact. The project will allow DWS to better serve the public.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4	DWS has the appropriate staff to implement the project.
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4	The project would mitigate risks due to flood, high winds, hurricanes, earthquakes, lightning storms, and tsunamis.
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4	Construction should be completed in 3 years.
Is there an Agency/Department <u>Local Champion</u> for the action?	4	Department of Water Supply, County of Hawaii
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	The project will provide capital improvement, and economic development (in the form of local construction jobs). The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	57	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

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Mitigation Action Worksheet

Name of Agency/Organization Department of Water Supply, County of Hawaii **Mitigation Action #:** Hawaiʻi-003

Mitigation Action Title: Hilo Operations Facility Hardening and Improvements

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Project will mitigate the delay in the Department's ability to respond and perform repairs to well sources and water transmission/distribution system in the aftermath of a natural disaster. Work will safeguard resources and personnel to ensure the Department's ability to coordinate, respond and support repair efforts to ensure continuity of service. The Hilo operations facility serves as the primary base yard and supports the other three district base yards across the island.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Seek alternative funding for the hardening project. However, available funding opportunities are limited. 2. Postpone the hardening project until internal CIP funding allocated. However, time is of essence and internal funds are limited. It would take minimum 5 years to budget and approve the project. 3. No action. However, this would increase the time it would take to coordinate and respond to disaster emergencies, which will increase risk to the health and welfare of the public.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Gain proper approval for project and funding; execute agreements, as required. Phase 1 • Execute professional services contract and obtain materials required for construction permit and solicitation. Phase 2 • Solicit bids and award construction contract. • Order materials, complete construction, and close out construction and professional services contracts. Close out with HIEMA and FEMA, as required.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Hazard Mitigation Grant Program (HMGP) funds; FEMA Pre-Disaster Mitigation Program (PDM) funds; DWS Capital Improvement Plan
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Phase 1: Year 1 – Design complete Phase 2: Year 3 – Construction complete; Year 4 – Close out project
Reporting on Progress	

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Mitigation Action Worksheet

Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4	x 2 = 8	Primary function of the structure hardening project is to protect the life of personnel and materials required to maintain/restore potable water service during and after an emergency.
Will the action result in Property Protection?	4		The hardening project will directly result in the protection of DWS property.
Will the action be Cost-Effective? (future benefits exceed cost)	4		The hardening project will reduce the use of local public funds to do repairs.
Is the action Technically feasible	4		Yes, materials are readily available to harden structures. Project will include typical hardening design.
Is the action Politically acceptable?	4		No foreseeable negative political implications.
Does the jurisdiction have the Legal authority to implement?	4		The project will affect only DWS owned structures.
Is Funding available for the action?	3		Partial funding may be available.
Will the action have a positive impact on the natural Environment?	3		The structure hardening project may improve the building envelop and may require lighting and air conditioning improvements; reducing the building energy use and lessening its carbon footprint.
Is the action Socially acceptable?	4		No foreseeable negative social impact. The project will allow DWS to better serve the public.
Does the jurisdiction have the Administrative capability to execute the action?	4		DWS has the appropriate staff to implement the project.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		The project would mitigate hazards such as flood, high winds, hurricanes, earthquakes, and lightning storms.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Construction should be completed in 4 years.
Is there an Agency/Department Local Champion for the action?	4		Department of Water Supply, County of Hawaii
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		The project will provide capital improvement and economic development (in the form of local construction jobs). The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	58		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	Department of Water Supply, County of Hawaii	**Mitigation Action #:**	Hawaiʻi-004
Mitigation Action Title:	Kona Operations Facility Emergency Power System Hardening		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☒ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Project will mitigate the delay in the Department of Water Supply's (DWS) ability to respond and perform repairs to well sources and water transmission/distribution system in the aftermath of a natural disaster. The installation of an emergency back-up generator set at the Kona baseyard will help DWS to timely coordinate, respond and support repair efforts to ensure continuity of water service and to protect the health and welfare of the public.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Seek alternative funding for the emergency power system project. However, available funding opportunities are limited. 2. Postpone the emergency power system project until internal funding allocated. However, time is of essence and funds are limited. It would take minimum 5 years to budget and approve the project. 3. No action. However, this would increase the time it would take to coordinate and respond to disaster emergencies, which may increase risk to the health and welfare of the public.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Gain proper approval for project and funding; execute agreements, as required. 2. Execute professional services contract and obtain materials required for construction permit and solicitation. 3. Solicit bids and award construction contract. 4. Order materials, complete construction, and close out construction and professional services contracts. 5. Close out with HIEMA and FEMA, as required.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Hazard Mitigation Grant Program (HMGP) DWS Capital Improvement Plan

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Year 1 – Design complete Year 2 – Construction started and completed Year 3 – Close out project
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4, Maybe Yes = 3, Unknown/Neutral = 2, Probably No = 1, Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4	x 2 = 8	The project will ensure timely response to water emergencies. Clean drinking water is essential for survival. Clean water is also required for medical and fire protection needs.
Will the action result in Property Protection?	4		The project will ensure timely response to water emergencies. Water feeds many fire sprinkler and hydrants designed to protect property.
Will the action be Cost-Effective? (future benefits exceed cost)	4		The project will ensure timely response to water emergencies. Providing water for fire protection will save in potential property damage.
Is the action Technically feasible	4		Yes, using ready available technology.
Is the action Politically acceptable?	4		No foreseeable negative political implications.
Does the jurisdiction have the Legal authority to implement?	4		The project will affect only DWS owned structures and equipment.
Is Funding available for the action?	3		Partial funding may be available.
Will the action have a positive impact on the natural Environment?	2		There will be minimal impact on the natural environment.
Is the action Socially acceptable?	4		No foreseeable negative social impact. The project will allow DWS to better serve the public.
Does the jurisdiction have the Administrative capability to execute the action?	4		DWS has the appropriate staff to implement the project.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		The project would mitigate risks due to flood, high winds, hurricanes, earthquakes, lightning storms, and tsunamis.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Construction should be completed in 3 years.
Is there an Agency/Department Local Champion for the action?	4		Department of Water Supply, County of Hawaii
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		The project will provide capital improvement, and economic development (in the form of local construction jobs). The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	57		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization	Department of Water Supply, County of Hawaii	**Mitigation Action #:**	Hawaiʻi-005
Mitigation Action Title:	Kona Operations Facility Hardening and Improvements		

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Project will mitigate the delay in the Department's ability to respond and perform repairs to well sources and water transmission/distribution system in the aftermath of a natural disaster. Work will safeguard resources and personnel to ensure the Department's ability to coordinate, respond and support repair efforts to ensure continuity of service.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Seek alternative funding for the hardening project. However, available funding opportunities are limited. 2. Postpone the hardening project until internal CIP funding allocated. However, time is of essence and internal funds are limited. It would take minimum 5 years to budget and approve the project. 3. No action. However, this would increase the time it would take to coordinate and respond to disaster emergencies, which will increase risk to the health and welfare of the public.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Gain proper approval for project and funding; execute agreements, as required. <u>Phase 1</u> • Execute professional services contract and obtain materials required for construction permit and solicitation. <u>Phase 2</u> • Solicit bids and award construction contract. • Order materials, complete construction, and close out construction and professional services contracts. Close out with HIEMA and FEMA, as required.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Hazard Mitigation Grant Program (HMGP) funds FEMA Pre-Disaster Mitigation Program (PDM) funds DWS Capital Improvement Plan

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Mitigation Action Worksheet

Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	<u>Phase 1:</u> Year 1 – Design complete <u>Phase 2:</u> Year 3 – Construction complete Year 4 – Close out project
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**		**Provide brief rationale for numeric rank when appropriate**
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	Primary function of the structure hardening project is to protect the life of personnel and materials required to maintain/restore potable water service during and after an emergency.
Will the action result in <u>Property Protection</u>?	4		The hardening project will directly result in the protection of DWS property.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		The hardening project will reduce the use of local public funds to do repairs.
Is the action <u>Technically</u> feasible	4		Yes, materials are readily available to harden structures. Project will include typical hardening design.
Is the action <u>Politically</u> acceptable?	4		No foreseeable negative political implications.
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		The project will affect only DWS owned structures.
Is <u>Funding</u> available for the action?	3		Partial funding may be available.
Will the action have a positive impact on the natural <u>Environment</u>?	3		The structure hardening project may improve the building envelop and may require lighting and air conditioning improvements; reducing the building energy use and lessening its carbon footprint.
Is the action <u>Socially</u> acceptable?	4		No foreseeable negative social impact. The project will allow DWS to better serve the public.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		DWS has the appropriate staff to implement the project.
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		The project would mitigate hazards such as flood, high winds, hurricanes, earthquakes, and lightning storms.
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		Construction should be completed in 4 years.
Is there an Agency/Department <u>Local Champion</u> for the action?	4		Department of Water Supply, County of Hawaii
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4		The project will provide capital improvement and economic development (in the form of local construction jobs). The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	58		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Hawai'i County Civil Defense Agency **Mitigation Action #:** Hawaiʻi-006

Mitigation Action Title: Community-Based 2-wat Radio Communications Repeater Equipment

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☒All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☐Earthquake ☐ Event-based flooding ☐Health Risks ☐High Wind Storms ☐Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	To better meet FEMA's guideline of building "Community Resiliency" through a "Whole Community" approach, and based on prior communications challenges between resulting from a local earthquake that disrupted radio station broadcasts and a hurricane that cutoff communities for days, the County of Hawaii has prioritized the development of 2-Way emergency communications with communities throughout the county. Working with the FEMA CERT Program the County has over 160 amateur radio licensed operators. This Mitigation Action will establish 12 radio repeaters throughout the county with 8 high school and 4 community locations.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Private equipment Use – Commandeer private existing repeater equipment. Not socially acceptable. 2. CB (Citizen Band) Equipment – Not robust, FCC enforcement less severe, equipment quality poor. 3. Community-Based 2-wat Radio Communications Repeater Equipment
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Purchase repeater equipment 2. Train local licensed amateur radio licensed operators in handling emergency traffic of Emergency Alert Messaging (EAM), Situational Reporting (SitRep), Requests for Assistance (RFA), and Requests for Information (RFI). 3. Program repeater equipment 4. Register repeater equipment with FCC and Frequency Controller. 5. Install repeater equipment 6. Implement new capability and be Mission-Ready to standup Emergency Communications Operations
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☐Goal #1 ☒Goal #2 ☐Goal #3 ☐Goal#4 ☐Goal #5 ☐Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☐Damage Reduction ☐Loss of Function ☐Other Describe: Enhance communication in the field with remote communities
Estimated Cost	☐ < $10,000; ☒$10,000 to $100,000; ☐>$100,000 Other Amount: $70,000
Plan for Implementation	
Responsible Department/Organization	Hawaii County Civil Defense Agency
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	Hazard Mitigation Funding, County CIP
Timeline for Completion: Short (1-5 years), Long (5 years or greater), OG (On-going program)	Short – 1 year
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

State of Hawaiʻi
Mitigation Action Worksheet

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in <u>Life Safety</u>?	4	x 2 = 8	Yes. Facilitate professional responders communication with remote communities.
Will the action result in <u>Property Protection</u>?	4		Yes. Civil Defense able to mobilize appropriate resources, mitigate damage, impact, and loss of life from flooding rain, damaging surf, wildfire, landslides, and high winds; based on communications between County and communities.
Will the action be <u>Cost-Effective</u>? (future benefits exceed cost)	4		Yes. Repeaters enhance communication capability, builds Common Operating Picture, and allows for prompt and effective response.
Is the action <u>Technically</u> feasible	4		Yes. Other areas of the USA have very successful local government – community 2-way communications program. Knowing the challenges the local terrain and limited transportation corridors place on response, repeater-based emergency communication technology is a viable asset in mitigating communication needs.
Is the action <u>Politically</u> acceptable?	4		Yes. County Council (lawmakers) have and continue to expressed support in bettering communications with their constituents to work together to mitigate risks.
Does the jurisdiction have the <u>Legal</u> authority to implement?	4		Yes. Hawaii Revised Statues HRS-127a and FEMA Response Framework and "Whole Community" initiatives target local government working closely with communities to work together to mitigate risk.
Is <u>Funding</u> available for the action?	2		Funding alternatives being examined.
Will the action have a positive impact on the natural <u>Environment</u>?	3		Yes. The community and Civil Defense having the ability to provide timely communication reduces risk, addresses issues, and leads to Resilient Communities.
Is the action <u>Socially</u> acceptable?	4		Yes. Hawaii County has the highest per capita ratio of licensed amateur radio operators in the State of Hawaii.
Does the jurisdiction have the <u>Administrative</u> capability to execute the action?	4		Yes. Administrative capability already in place to administer this communication system. One Civil Defense staff is a County's Communications Coordinator, and two Civil Defense staff are licensed amateur radio operators, of which one is a former president of a local amateur radio club.
Will the action reduce risk to more than one hazard (<u>Multi-Hazard</u>)?	4		Yes. The County of Hawaii experiences the most kinds of natural hazards than any of the 3,143, counties in the USA.
<u>Timeline</u> - Can the action be completed in less than 5 years (within our planning horizon)?	4		Yes. Procurement and Installation will be completed in 1 year. Training has already been initiated and will be on-going. Mission-Readiness will be completed within 1 year.
Is there an Agency/Department <u>Local</u> <u>Champion</u> for the action?	4		Yes. A position was created within Civil Defense to manage the County's Communication Systems. Two Civil Defense staff are licensed operators. Civil Defense has more than 160 CERT volunteers FCC licensed to operate radios.
Will the action meet <u>Other Local</u> Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		Yes. These repeaters can be used to provide redundant Auxiliary Communications Capability for County emergency responders should Public Safety Communication System become compromised, disrupted, or fail.
Total	54		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Department of Water Supply, County of Hawaii **Mitigation Action #:** Hawaiʻi-007

Mitigation Action Title: Hardening of the Parker No. 2, Waiaha and Keonepoko Nui Water Well

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☒Tsunami ☒ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	If there is a wide spread and prolonged power outage, and if power is not restored or no backup power source is connected, most of the population in that area would be without potable water and fire hydrant / fire sprinkler water in approximately eight (8) hours (depending on the usage). The hardening of the Parker No. 2, Waiaha and Keonepoko Nui potable water producing facilities through the purchase and installation of transfer switches and supporting infrastructure will allow the County of Hawaii, Department of Water Supply (DWS) to better protect the health and welfare of the public. DWS will be able to quickly and safely switch the power supply, via the transfer switches, from the electric utility (Hawaii Electric Light Company (HELCO)) to the on-site standby generators, reducing the potable water facility's downtime by about 7 hours.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Install transfer switches to connect DWS generators to critical potable water producing facilities. 2. Postpone installation of transfer switches until DWS can allocate funding for this project. Include in 20-year CIP. 3. No action.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Gain project funding approval and execute agreements, as required. 2. Execute professional services contract and obtain materials required for construction permit. 3. Generate bid documents, solicit bids, and award contract. 4. Order materials, complete construction, and close out contract. 5. Close out with HIEMA and FEMA, as required.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☐Goal #5 ☒Goal #6
Applies to existing or future development	☒ Existing Development ☐Future Development ☐ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	- FEMA Hazard Mitigation Grant Program - DWS 20-year CIP
Timeline for Completion:	Short Term: 3 Years

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Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	Numeric Rank: Definitely Yes = 4 Maybe Yes = 3 Unknown/Neutral = 2 Probably No = 1 Definitely No = 0		Provide brief rationale for numeric rank when appropriate
Will the action result in Life Safety?	4	x 2 = 8	Clean drinking water is essential for survival. Clean water is also required for medical and fire protection needs.
Will the action result in Property Protection?	4		Water feeds many fire sprinkler and hydrants designed to protect property.
Will the action be Cost-Effective? (future benefits exceed cost)	4		Providing 7 hours of additional fire protection could save millions in potential property damage.
Is the action Technically feasible	4		Electrical plans are already complete, but they were not routed through for construction permit. DWS has staff engineers capable of the project management.
Is the action Politically acceptable?	4		The project does not have any political implications.
Does the jurisdiction have the Legal authority to implement?	4		The project would be within DWS's property lines and would affect only DWS owned equipment.
Is Funding available for the action?	2		The project has not been budgeted for under the DWS's 5-year CIP or 20-year CIP.
Will the action have a positive impact on the natural Environment?	2		There will be little to no impact on the natural environment.
Is the action Socially acceptable?	4		The project consists of typical electrical work; work that is common to most construction projects, private and public.
Does the jurisdiction have the Administrative capability to execute the action?	4		The Energy Management Analyst would oversee the project management.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4		Prolonged power outages can occur due to flood, high winds, hurricanes, earthquakes, lightning storms, tsunamis, lava flows, etc.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4		Construction contract should take about 3 years to complete.
Is there an Agency/Department Local Champion for the action?	4		Department of Water Supply, County of Hawaii
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	3		Many hazards can be mitigated by the availability of safe drinking water. The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	55		
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High		

State of Hawaiʻi
Mitigation Action Worksheet

Name of Agency/Organization Department of Water Supply, County of Hawaii **Mitigation Action #:** Hawaiʻi-008

Mitigation Action Title: Furnishing two (2) Water Hauling Tankers to Harden the Potable Water System

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☒Climate Change ☒Dam Failure ☒Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☒Landslide/Rockfall ☒Tsunami ☒ Volcanic (Lava Flow & VOG) ☒Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	The above identified natural disasters have the potential to disrupt potable water service. Water hauling tankers would help prevent complete water service disruption and help the Department of Water Supply (DWS) to better protect the health and welfare of the public.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Furnish one (1) water hauling tanker. However, two tankers would ideal protect the both sides of the island. 2. Procure commercial water hauling service. However, commercial water hauling service is expensive and subject to availability. 3. No action. However, this would increase risk the health and welfare of the public.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	1. Gain proper approval for project and funding; execute agreements, as required. 2. Generate bid documents, solicit bids, and award contract. 3. Receive tankers and close out project. 4. Close out with HIEMA and FEMA, as required.
Action/Project Type	☒State & Local Plans and Regulations ☐Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☐ Both Existing and Future Development ☒Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☐Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☐Capital Improvement Plan ☒Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Hazard Mitigation Grant Program (HMGP) DWS Operations Budget
Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Year 1 – Procurement contract awarded and executed Year 2 – Tankers received and close out project

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Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4 x 2 = 8	Clean drinking water is essential for survival. Clean water is also required for medical and fire protection needs.
Will the action result in Property Protection?	4	Hauled water will feed many fire sprinkler and hydrants designed to protect property.
Will the action be Cost-Effective? (future benefits exceed cost)	4	Providing water for fire protection could save in potential property damage. DWS will save money on commercial water hauling services.
Is the action Technically feasible	4	DWS has CDL certified drivers on staff.
Is the action Politically acceptable?	4	No foreseeable negative political implications.
Does the jurisdiction have the Legal authority to implement?	4	Yes, the tankers will be owned by DWS.
Is Funding available for the action?	3	The tanker procurement has not been budgeted for under the DWS Operations budget. Partial funding available.
Will the action have a positive impact on the natural Environment?	2	There will be minimal impact on the natural environment.
Is the action Socially acceptable?	4	No foreseeable negative social impact. The procurement will allow DWS to better serve the public.
Does the jurisdiction have the Administrative capability to execute the action?	4	DWS has the appropriate staff to procure the tankers.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	The tankers would mitigate risks due to droughts, floods, high winds, hurricanes, earthquakes, lightning storms, and tsunamis.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	The procurement should be complete in 2 years.
Is there an Agency/Department Local Champion for the action?	4	Department of Water Supply, County of Hawaii
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	Many hazards and risks can be mitigated by the availability of safe drinking water. The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	57	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	

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Mitigation Action Worksheet

Name of Agency/Organization Department of Water Supply, County of Hawaii **Mitigation Action #:** Hawaiʻi-009

Mitigation Action Title: Waimea Operations Facility Hardening and Improvements

Assessing the Risk	
Hazard(s) addressed: (check all that apply)	☐All Hazards ☐Chronic Coastal Flooding ☐Climate Change ☐Dam Failure ☐Drought ☒Earthquake ☒ Event-based flooding ☒Health Risks ☒High Wind Storms ☒Hurricane ☐Landslide/Rockfall ☐Tsunami ☐ Volcanic (Lava Flow & VOG) ☐Wildfire
Location (Islands Impacted)	☐All Islands ☒Hawaiʻi ☐Kauaʻi ☐Lānaʻi ☐Molokaʻi ☐Maui ☐ Oʻahu
Specific problem being Mitigated (describe why action is needed)	Project will mitigate the delay in the Department's ability to respond and perform repairs to well sources and water transmission/distribution system in the aftermath of a natural disaster. Work will safeguard resources and personnel to ensure the Department's ability to coordinate, respond and support repair efforts to ensure continuity of service.
Evaluation of Potential Alternatives	
Alternatives Considered (name of project and reason for not selecting)	1. Seek alternative funding for the hardening project. However, available funding opportunities are limited. 2. Postpone the hardening project until internal CIP funding allocated. However, time is of essence and internal funds are limited. It would take minimum 5 years to budget and approve the project. 3. No action. However, this would increase the time it would take to coordinate and respond to disaster emergencies, which will increase risk to the health and welfare of the public.
Action/Project Intended for Implementation	
Describe how action will be implemented (main steps involved)	Gain proper approval for project and funding; execute agreements, as required. Phase 1 • Execute professional services contract and obtain materials required for construction permit and solicitation. Phase 2 • Solicit bids and award construction contract. • Order materials, complete construction, and close out construction and professional services contracts. Close out with HIEMA and FEMA, as required.
Action/Project Type	☐State & Local Plans and Regulations ☒Structure and Infrastructure Project ☐Natural Systems Protection ☐Education and Awareness Programs
Applicable Goals (refer to list of goals)	☒Goal #1 ☒Goal #2 ☒Goal #3 ☐Goal#4 ☒Goal #5 ☒Goal #6
Applies to existing or future development	☐ Existing Development ☐Future Development ☒ Both Existing and Future Development ☐Not Applicable
Describe benefits (losses avoided)	☒Life Safety ☒Damage Reduction ☒Loss of Function ☐Other Describe:
Estimated Cost	☐ < $10,000; ☐$10,000 to $100,000; ☒>$100,000 Other Amount: $
Plan for Implementation	
Responsible Department/Organization	Department of Water Supply, County of Hawaii
Local Planning Mechanism (check all that apply)	☒Capital Improvement Plan ☐Comprehensive Plan ☐Building Code ☐Ordinance ☐Other:
Potential Funding Sources	FEMA Hazard Mitigation Grant Program (HMGP) funds FEMA Pre-Disaster Mitigation Program (PDM) funds DWS Capital Improvement Plan

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Timeline for Completion: Short (1-5 years), Long Term (5 years or greater), OG (On-going program)	Phase 1: Year 1 – Design complete Phase 2: Year 3 – Construction complete Year 4 – Close out project
Reporting on Progress	
Status/Comment	☒Not Started ☐In-progress ☐Delayed ☐Completed ☐No Longer Required Comment:

Criteria	**Numeric Rank:** **Definitely Yes = 4** **Maybe Yes = 3** **Unknown/Neutral = 2** **Probably No = 1** **Definitely No = 0**	**Provide brief rationale for numeric rank when appropriate**
Will the action result in Life Safety?	4 x 2 = 8	Primary function of the structure hardening project is to protect the life of personnel and materials required to maintain/restore potable water service during and after an emergency.
Will the action result in Property Protection?	4	The hardening project will directly result in the protection of DWS property.
Will the action be Cost-Effective? (future benefits exceed cost)	4	The hardening project will reduce the use of local public funds to do repairs.
Is the action Technically feasible	4	Yes, materials are readily available to harden structures. Project will include typical hardening design.
Is the action Politically acceptable?	4	No foreseeable negative political implications.
Does the jurisdiction have the Legal authority to implement?	4	The project will affect only DWS owned structures.
Is Funding available for the action?	3	Partial funding may be available.
Will the action have a positive impact on the natural Environment?	3	The structure hardening project may improve the building envelop and may require lighting and air conditioning improvements; reducing the building energy use and lessening its carbon footprint.
Is the action Socially acceptable?	4	No foreseeable negative social impact. The project will allow DWS to better serve the public.
Does the jurisdiction have the Administrative capability to execute the action?	4	DWS has the appropriate staff to implement the project.
Will the action reduce risk to more than one hazard (Multi-Hazard)?	4	The project would mitigate hazards such as flood, high winds, hurricanes, earthquakes, and lightning storms.
Timeline - Can the action be completed in less than 5 years (within our planning horizon)?	4	Construction should be completed in 4 years.
Is there an Agency/Department Local Champion for the action?	4	Department of Water Supply, County of Hawaii
Will the action meet Other Local Objectives (Such as capital improvements, economic development, environmental quality, or open space preservation?) Does it support the policies of other plans and programs?	4	The project will provide capital improvement and economic development (in the form of local construction jobs). The project will support the County of Hawaii's policies and plans to protect the health and welfare of the public.
Total	58	
Priority: **Low = <35** **Medium = 35-49** **High = >50**	☐Low ☐Medium ☒High	