4. RISK ASSESSMENT METHODOLOGY AND TOOLS

4.1 APPROACH

A risk assessment is an evaluation of potential loss of life, personal injury, and economic and property damage that could result from identified hazards. Identifying potential hazards and vulnerable assets allows planning personnel to address and reduce hazard effects and allows emergency management personnel to establish early response priorities. Results of a risk assessment are used in subsequent mitigation planning processes, including determining and prioritizing mitigation actions that reduce each the City's risk from each hazard. Past, present, and future conditions must be evaluated to assess risk most accurately for the City. The process focuses on the following elements:

- **Identify Hazards of Concern**—Use all available information to determine what types of hazards may affect the planning area.
- **Profile Each Hazard**—Understand each hazard in terms of:
    - Extent—Potential severity of each hazard
    - Location—Geographic area most likely to be affected by the hazard
    - Previous occurrences and losses
    - Effects of climate change
    - Probability of future hazard events
- **Assess Risk**—Use all available information to estimate to what extent populations and assets may be adversely affected by a hazard:
    - Determine vulnerability—By overlaying hazard maps with asset inventories, estimate the total number of assets in the planning area likely to undergo a hazard event if it occurs
    - Estimate potential effects—Assess effects of hazard events on people, property, economy, and lands of the planning area, including estimates of the cost of potential damage or cost that can be avoided by mitigation.
    - Evaluate future changes that may affect vulnerability and effects—Analyze how demographic changes, projected development, and climate change effects can alter current vulnerability and potential effects.

The City's risk assessment was updated by use of the following best-available information:

- The 2022 USACE National Structure Inventory (NSI) dataset and 2024 RSMeans cost adjustment values to generate a new building stock inventory
- 2018–2022 American Community Survey 5-year Population Estimates

- Updates and reviews of critical facilities by the City
- Identification of lifelines in the critical facility inventory to align with FEMA's community lifeline definition
- Application of FEMA's Hazus program to estimate potential effects from flood, wind, and seismic hazards
- Best-available hazard data, as described in this section.

4.2 ASSET INVENTORIES

City assets were identified to assess potential vulnerability and effects associated with the hazards of concern. For the LHMP update, the City assessed vulnerability and potential hazard effects for the following types of assets: population, buildings, critical facilities, community lifelines, the environment, historic sites, and new development. Some assets may be more susceptible to effects because of their physical characteristics or socioeconomic uses. Each asset type is described below. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

4.2.1 POPULATION

> The risk assessment included collection and use of an expanded and enhanced asset inventory to estimate hazard vulnerability and effects.

Statistics from the 2018–2022 American Community Survey (ACS) 5-year estimate were used to estimate vulnerability of and potential effects on the City's population. Given that the City's results were aggregated by regional planning areas and the ACS data is aggregated by census tracts, an area analysis was performed to convert the census tract statistics extracted from the ACS data in order to determine the proper estimation of population per regional planning area. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.

FEMA's Hazus program was applied to model estimated potential losses to flood, seismic, and wind hazards, as discussed later in this section. Hazus v6.1 contains 2020 U.S. Census data and was used to estimate sheltering and injuries as part of the hazard analysis.

As discussed in Chapter 3, some populations are at greater risk from hazard events because of decreased resources or physical abilities. This LHMP considers several socially vulnerable population groups:

- Elderly (persons over the age of 65),
- Young (persons under the age of 5),
- Non-English speaking households, those with disabilities, and
- Those living below the poverty level (as defined by the U.S. Census Bureau).

4.2.2 BUILDINGS

A custom general building stock dataset was created for the City. The general building stock was updated citywide with a custom-building inventory by use of the 2022 NSI Database created by USACE. The NSI is a system of databases containing structure inventories of varying quality and spatial coverage. In 2018 and 2019, the NSI team created the data by use of inputs from numerous input data sources. The two main sources of data were CoreLogic parcel files for residential structures and Esri business layer for non-residential structures. Each data file used contains data on the type of existing development at a given location. Used to further define each structure were attributes provided in the associated files such as year built, number of stories, occupancy class, and square footage. The centroid of each building footprint was used to estimate the building location.

Structural and content replacement cost values (RCV) were calculated for each building by use of the available assessor data, the building footprint, and RSMeans 2024 values.

A regional location factor for the City was applied based on the individual building stock's zip code location. The location factor was used to adjust costs based on a specific location. The location factor was multiplied by the base cost for that city/zip code:

Replacement Cost Value Regional Location Factor

968 Honolulu - Residential – 1.15| Non-Residential – 1.22

RCV is the current cost of returning an asset to its pre-damaged condition assuming present-day cost of labor and materials. Total RCV consists of both the structural cost to replace a building and the estimated value of contents of a building. The occupancy classes available in Hazus were condensed into categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

4.2.3 COMMUNITY LIFELINES

As discussed in Chapter 3, community lifelines include critical facilities and essential facilities. Critical facilities are deemed vital to the City's ability to provide essential services while protecting life and property. A critical facility may be a system or an asset, either physical or virtual, the loss of which would have a profound impact across the planning area on security, the economy, public health or safety, the environment, or any combination thereof. Essential facilities are those facilities that are vital to the continued delivery of key government, private sector, and/or non-profit services, or that may significantly affect the City's ability to recover from the disaster.

> A lifeline provides indispensable service that enables continuous operation of critical business and government functions, and is critical to human health and safety, or economic security (FEMA).

A community lifelines inventory, which includes critical facilities, essential facilities, utilities, transportation features, and user-defined facilities, was created by use of data provided by the City for the analyses conducted as part of this risk assessment.

Other essential facility features were sourced from the State of Hawai'i 2017, 2021-24; and the US Energy Atlas 2024. The development involved a review for accuracy, additions, or deletions of new or moved critical assets; identification of backup power for each asset (if known); and whether the critical facility is considered a lifeline in accordance with FEMA's definition (refer to Appendix G, Critical Facilities).

4.2.4 ENVIRONMENT AND LAND USE

Land Use Districts sourced by the Hawai'i Statewide GIS Program and State Land Use Commission (2020) were referenced to assess land use characteristics of the City. This dataset was clipped down to the City boundary, and the land use districts were separated into three land use categories: Urban, Agricultural, and Conservation Districts.

4.2.5 NEW DEVELOPMENT

In addition to assessing vulnerability of the built environment, the City and County of Honolulu provided a file geodatabase containing three categories of new development: potential development within 5 years, buildings still under construction, and tax parcels of buildings with a year built 2020-present. These areas were converted to the centroid point and were analyzed in GIS to determine hazard exposure of these development sites.

Identifying these changes and integrating new development into the risk assessment provides communities with information to consider when developing the mitigation strategy to reduce these vulnerabilities in the future. The new development is listed in Section 3.8.2, and hazard vulnerability analysis results are listed in a table in each annex in Volume II.

4.2.6 IDENTIFIED HISTORIC SITES

As previously stated in Chapter 3, only publicly available and inventoried historic sites were integrated into the LHMP. To aid with identifying historic and cultural resources, the project team collaborated with the Honolulu Department of Planning and Permitting (DPP), which supplied a list of sites on the National and State Registers of Historic Places. For the risk assessment, the City provided a file geodatabase detailing the locations of publicly identified historic sites throughout the island. Structures and buildings were extracted and analyzed using GIS to assess the hazard exposure of these historic sites.

Identifying these and integrating historic sites into the risk assessment provides communities information to consider when developing the mitigation strategy to reduce these vulnerabilities in the future. The historic sites are listed in Table 3-20, and hazard vulnerability analysis results are listed in a table in each hazard profile.

4.3 METHODOLOGY

The City used standardized tools, combined with local, state, and federal data and expertise, to assess potential vulnerability and losses associated with hazards of concern. Three levels of analysis were applied, depending upon data available pertaining to each hazard:

- **Historical Occurrences and Qualitative Analysis**—This analysis includes an examination of historical effects to understand potential effects of future events of similar size. Potential effects and losses are discussed qualitatively by use of best-available data and professional judgment.
- **Vulnerability Analysis**—This analysis involves overlaying available spatial hazard layers, for hazards with defined extents and locations, on asset mapping in GIS to determine which assets are within the area affected by the hazard.
- **Loss Estimation**—The FEMA Hazus modeling software was applied to estimate potential losses from flood, earthquake, and hurricane.

Table 4-1 summarizes the type of analysis conducted by hazard of concern.

Table 4-1. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities	New Development	Historic Sites
Climate Change and Sea Level Rise	V	V	V	V	V
Deliberate Hazards	Q	Q	Q	Q	Q
Drought	V, H	V, H	V, H	V	V
Earthquake	Q	Q	Q	Q	Q
Floods[a]	H	H	H	Q	Q
Hazardous Materials	H	H	H	H	H
Health Risk	V	V	V	V	V
Hurricane	Q	Q	Q	Q	Q
Infrastructure Failure	H	H	H	Q	Q
Invasive Species	Q	Q	Q	Q	Q
Landslides	V	V	V	V	V
Tsunami	V	V	V	V	V
Volcanic Gas	Q	Q	Q	Q	Q
Wildland Fire	Q	Q	Q	Q	Q
Windstorm	Q	Q	Q	Q	Q

Note: V = Vulnerability analysis; H = Hazus analysis; Q = Qualitative analysis

a. Flood Hazus performed by Community Resilience Consulting, LLC (CRC)

4.3.1 HAZUS

Hazus is a GIS-based software tool developed by FEMA that applies engineering and scientific risk calculations developed by hazard and information technology experts to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and furnish a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports evaluation of hazards and assessment of inventory and loss estimates pertaining to these hazards.

Hazus uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems, and utility systems. To generate this information, Hazus uses default data regarding inventory, vulnerability, and hazards; this default data can be supplemented with local data to allow a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic effect), depending on the hazard and available local data. Hazus' open data architecture can be applied to manage community GIS data at a central location. Use of this software also promotes consistency of data output now and in the future, and standardization of data collection and storage. More information on Hazus is available at http://www.fema.gov/hazus.

In general, modeled losses were estimated in the program by use of depth grids for the flood analysis, and probabilistic analyses occurred to develop expected or estimated distribution of losses (mean return period losses) from hurricane wind and seismic hazards. The probabilistic model generates estimated damage and losses for specified return periods (e.g., 100- and 500-year). Table 4-2 lists the possible levels of analysis by use of Hazus software.

Table 4-2. Summary of Hazus Analysis Levels

Level 1	Hazus provides hazard and inventory data with minimal outside data collection or mapping.
Level 2	Analysis involves augmenting the Hazus-provided hazard and inventory data with more recent or detailed data pertaining to the study region, referred to as "local data."
Level 3	Analysis involves adjusting the built-in loss estimation models applied for the hazard loss analyses. This Level typically proceeds in conjunction with use of local data.

4.3.2 HAZARD-SPECIFIC METHODOLOGIES

Climate Change and Sea Level Rise

The City provided Sea Level Rise XA-3.2 data sourced from the University of Hawai'i (School of Ocen and Earth Science and Technology (SOEST) and Coastal Geology Group), the Pacific Islands Ocean Observing System (PacIOOS), and Tetra Tech (2022). To estimate vulnerability to the Sea Level Rise hazard event, the Sea Level Rise boundary was overlaid on the centroids of updated assets (population, building stock, critical facilities, historic sites, and new development). Centroids that intersected the Sea Level Rise boundary were totaled to estimate the building RCV and population vulnerable to the Sea Level Rise hazard.

Deliberate Hazards

All of the City is at risk from effects of deliberate hazards, defined as any form of mass violence or cyber attack. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern.

Drought

All of the City is at risk from effects of drought events. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern. Knowledge of historical drought conditions allowed a time-series analysis of past drought conditions.

Earthquake

A probabilistic assessment for the City and County of Honolulu occurred regarding the 500-year and 2,500-year mean return period events through a Level 2 analysis in Hazus v6.1 to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from historical earthquakes and inferred faults, locations, and magnitudes, and computes by census tract the probable ground shaking levels that may be experienced during a recurrence period.

As noted in the Hazus Earthquake User Manual:

> "Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that uncertainties are inherent in any estimation methodology, even with state-of-the-art techniques. Any region or city studied will have an enormous variety of buildings and facilities of different sizes, shapes, and structural systems that have been constructed over a range of years under diverse seismic design codes. There are a variety of components that contribute to transportation and utility system damage estimations. These components can have differing seismic resistance" (FEMA 2020).

However, Hazus' potential loss estimates are acceptable for the purposes of this LHMP.

Default NEHRP soil data was used in Hazus. Groundwater was set at a depth of 5 feet (default setting). The default assumption is a magnitude 7.0 earthquake for all return periods. Although damage is estimated at the census tract level, results were presented at the regional planning area level. Because multiple Census tracts contain more than one planning area, an area analysis was used to extract the percentage of each tract that falls within individual planning areas. The percentage was multiplied against the results calculated for each tract and summed for each regional planning area.

Damage estimates are calculated for buildings (structural and non-structural) and contents. Structural losses include load-carrying components of the structure. Non-structural losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer, and finishes; ventilation, and air conditioning (HVAC) systems; etc.

Floods

Per the Oʻahu Flood Analysis Report:

> Under a separate project, Tetra Tech performed a FEMA Hazus v.4.2 or later Flood Level 2 Analysis of riverine and coastal flooding to better understand flood risks across the City. Community Resilience Consulting, LLC (CRC), Tetra Tech's subcontractor, conducted a Hazus GIS-based flood risk assessment model incorporating City-provided inventory and hazard, as well as publicly available data. The flood hazard analysis quantified flood exposure to buildings across Oʻahu and estimated economic and social costs of different potential flood event scenarios.

Hazardous Materials

A vulnerability analysis occurred by use of Tier II sites, H-1 (known major transportation route), and areas of concentrated industrial uses data provided by the City to determine the City's risk from the Hazardous Materials Release hazard. To estimate vulnerability to the hazard, 0.5-mile buffers were added to the City's Tier II sites, H-1, and identified areas of concentrated industrial activity and subsequently were overlaid on the centroids of updated assets (population, building stock, critical facilities, historic sites, and new development). Centroids that intersected the buffered hazard areas were totaled to estimate the building RCV and population vulnerable to the Hazardous Materials Release hazard.

Health Risks

All of the City is at risk from effects of health risks. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern. Knowledge of historical occurrences allowed a time-series analysis of past conditions.

Hurricane

SLOSH Categories 1-4 hazard data were sourced from NOAA (2018) for our analysis. To estimate vulnerability to SLOSH Categories 1-4 hazard events, the SLOSH boundaries were overlaid on centroids of updated assets (population, building stock, critical facilities, historic sites, and new development). Centroids that intersected the SLOSH boundaries were totaled to estimate the building RCV and population vulnerable to the Hurricane hazard.

Sea Lake and Overland Surges from Hurricanes (SLOSH) Categories 1-4 hazard data were sourced from NOAA (2018) for our analysis. To estimate vulnerability to SLOSH Categories 1-4 hazard events, the SLOSH boundaries were overlaid on centroids of updated assets (population, building stock, critical facilities, historic sites, and new development). Centroids that intersected the SLOSH boundaries were totaled to estimate the building RCV and population vulnerable to the Tropical Cyclone hazard.

To assess for the combined wind impacts of hurricanes, a Hazus probabilistic analysis occurred to analyze wind hazard losses for the City from 50-,100-, 500-, and 1000-year mean return period events in Hazus v6.1. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of hurricanes observed since 1886 and identifies those with tracks associated with the City. Hazus contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps of the area. Surface roughness and vegetation data support modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the municipal level. Because multiple census tracts contain more than one planning area, a density analysis occurred to extract the percent of building structures that fall within each tract and planning area. The percentage was multiplied by results calculated for each tract, and the resulting products were summed for each regional planning area.

Infrastructure Failure

Dam failure inundation data was sourced from the Pacific Disaster Center and City and County of Honolulu (2024) for our analysis. To estimate vulnerability to the Dam Failure hazard event, the Dam Failure Inundation boundaries were combined into one hazard layer and overlaid on the centroids of updated assets (population, building stock, critical facilities, historic sites, and new development). Centroids that intersected the Dam Failure Inundation boundaries were totaled to estimate the building RCV and population vulnerable to the Dam Failure hazard. In addition, by use of Dam Evacuation Zone data provided by the City and County of Honolulu (2024), the total population was analyzed per evacuation zone, as well as island-wide and within each regional planning area.

The depth grid generated by use of the 100-foot contours obtained through the City and County of Honolulu and subsequent 10-meter digital elevation model was integrated into the Hazus riverine flood model and used to estimate potential losses from the combined dam failure event.

Once updated with the inventories, the Hazus riverine flood model was run to estimate potential losses in the City and County of Honolulu from the combined dam failure event. A user-defined analysis also occurred regarding the building stock. Buildings within the dam failure inundation hazard areas were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. Hazus calculated estimated potential losses of population (default 2020 U.S. Census data across dasymetric blocks), potential damage to the general building stock, and potential damage to critical facility inventories based on the depth grids generated and the default Hazus damage functions in the flood model.

Invasive Species

All of the City is at risk from effects of invasive species. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern. Knowledge of historical conditions allowed a time-series analysis of past conditions.

Landslides

Quantitative data regarding landslides were not available. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern.

Tsunami

The City provided two geospatial datasets for tsunami (2024): evacuation zones (tsunami evacuation, extreme tsunami evacuation, and safe zone) and tsunami inundation hazard areas (standard and extreme) To estimate vulnerability to the tsunami hazard event, the extreme and standard tsunami inundation boundaries were overlaid on updated maps of inventoried assets (population, building stock, critical facilities, historic sites, and new development). Buildings with centroids that intersected the tsunami inundation boundaries were totaled to estimate the building RCV and population vulnerable to the tsunami hazard. The population estimates also were developed for the evacuation zone.

The Hazus coastal flood model was run to estimate potential building losses in the extreme and standard tsunami inundation hazard areas. A depth grid was integrated into the Hazus coastal flood model, based on a 10-meter digital elevation model generated from City-provided 100-foot contours and elevations provided with the standard and extreme tsunami inundation mapping. The latest user-defined building inventory also was imported to Hazus. Based on the new depth grids and the default damage functions in the flood model, Hazus estimated potential population displacements (default 2020 U.S. Census data across dasymetric blocks), potential damage to the general building stock, potential damage to critical facility inventories, and potential flood-generated debris.

Volcanic Gas

Quantitative data regarding volcanic gas were not available. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern.

Wildland Fire

Quantitative data regarding wildland fire was not available. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern.

Windstorm

All of the City is at risk from effects of windstorms. A qualitative analysis occurred to assess the City's vulnerability to this hazard of concern. Knowledge of historical conditions allowed a time-series analysis of past conditions.

4.3.3 RATING PROBABILITY OF OCCURRENCE

Based on records of previous hazard events and consideration of potential future changes that could affect frequency of future events, the risk assessment for each hazard assigns a rating for probability of occurrence of that hazard in the future. These ratings were assigned as indicated in Table 4-3.

Table 4-3. Probability Ratings for Future Hazard Events

Probability of Annual Occurrence	Percent Chance of Annual Occurrence
Unlikely	≤ 10%
Rare	>10% – 25%
Occasional	>25% – 75%
Frequent	>75%

4.4 DATA SOURCE SUMMARY

Table 4-4 summarizes the data sources used for the risk assessment for this plan.

Table 4-4. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau American Community Survey 5-Year Estimates	2022	Comma-Separated Values (.csv) format
Building Inventory	U.S. Army Corps of Engineers, NSI	2022	Digital (GIS) format
Critical Facilities and Lifelines	City and County of Honolulu; State of Hawaiʻi; US Energy Atlas	2023, 2024; 2017, 2021, 2022, 2023, 2024; 2024	Digital (GIS) format
Land Use Districts	State Land Use Commission, Hawaiʻi Statewide GIS Program	2020	Digital (GIS) format
100-foot Contours	City and County of Honolulu	2023	Digital (GIS) format
10-Meter Digital Elevation Model	City and County of Honolulu	2023	TIFF
Dam Failure Inundation Evacuation Zone Data	City and County of Honolulu	2024	Digital (GIS) format
Dam Failure Inundation Hazard Area Data	City and County of Honolulu	2024	Digital (GIS) format
Hazardous Materials Release Data	City and County of Honolulu	2024	Digital (GIS) format
Sea Level Rise Data	SOEST, University of Hawai'i Coastal Geology Group, PacIOOS, Tetra Tech, Inc.	2022	Digital (GIS) format
SLOSH Categories 1-4 Data	NOAA	2018	Digital (GIS) format
Tsunami Evacuation Zone Data	City and County of Honolulu	2024	Digital (GIS) format
Tsunami Inundation Data	City and County of Honolulu	2024	Digital (GIS) format
Historic Sites Data	City and County of Honolulu	2024	Digital (GIS) format

Data	Source	Date	Format
New Development Data	City and County of Honolulu	2024	Digital (GIS) format

Note: NOAA = National Oceanic and Atmospheric Administration; PacIOOS = Pacific Islands Ocean Observing System; SOEST = University of Hawaiʻi School of Ocean and Earth Science and Technology

4.5 LIMITATIONS

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

- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- Unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed by the City
- Amount of advance notice residents have to prepare for a specific hazard event
- Uncertainty of climate change projections
- Complexity of regulatory oversight of dams

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential vulnerability and loss estimates are approximate. These results do not predict exact results and should be used to understand relative risk. Over the long term, the City will collect additional data and update and refine existing inventories to aid estimates of potential losses.

Potential economic loss is based on present value of the general building stock by use of best-available data. The City acknowledges significant effects may occur to critical facilities and infrastructure as a result of these hazard events, causing great economic loss. However, estimates of monetized damage to critical facilities and infrastructure, and economic effects were not quantified and require more detailed loss analyses. In addition, economic effects on industry such as tourism and the real estate market were not analyzed.

4.6 CONSIDERATIONS FOR MITIGATION AND NEXT STEPS

The following items are to be discussed for considerations pertaining to the next LHMP update to enhance the risk assessment:

- All Hazards

  - Create an updated user-defined general building stock dataset using up-to-date parcels, footprints, and RSMeans values.
  - Utilize updated and current demographic data.
- Climate Change and Sea Level Rise
  - As more current sea level rise data become available, run the vulnerability analysis on the updated hazard boundaries.
  - Develop a sea level rise flood depth grid and conduct a sea level rise (coastal) Hazus analysis.
- Earthquake
  - Identify unreinforced masonry in critical facilities and privately owned buildings (i.e., residences) by accessing local knowledge, tax assessor information, and/or pictometry/orthophotos. These buildings may not withstand earthquakes of certain magnitudes and plans to provide emergency response or recovery efforts at these properties can be developed.
  - Run the vulnerability analysis using current NEHRP Soils data.
- Infrastructure Failure
  - As more current dam failure inundation data become available, run the vulnerability analysis on the updated hazard boundaries.
- Landslides
  - Run the vulnerability analysis on the most current Landslide hazard data.
- Hurricane
  - As more current SLOSH data become available, run the vulnerability analysis on the updated hazard boundaries.
- Tsunami
  - As more current Tsunami data become available, run the vulnerability analysis on the updated hazard boundaries.
- Wildland Fire
  - General building stock inventory can be updated to include attributes such as roofing material, fire detection equipment, or distance to fuels as another measure of vulnerability.
  - Run the vulnerability analysis on the most current wildland fire data.
- Windstorm
  - The general building stock inventory can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.