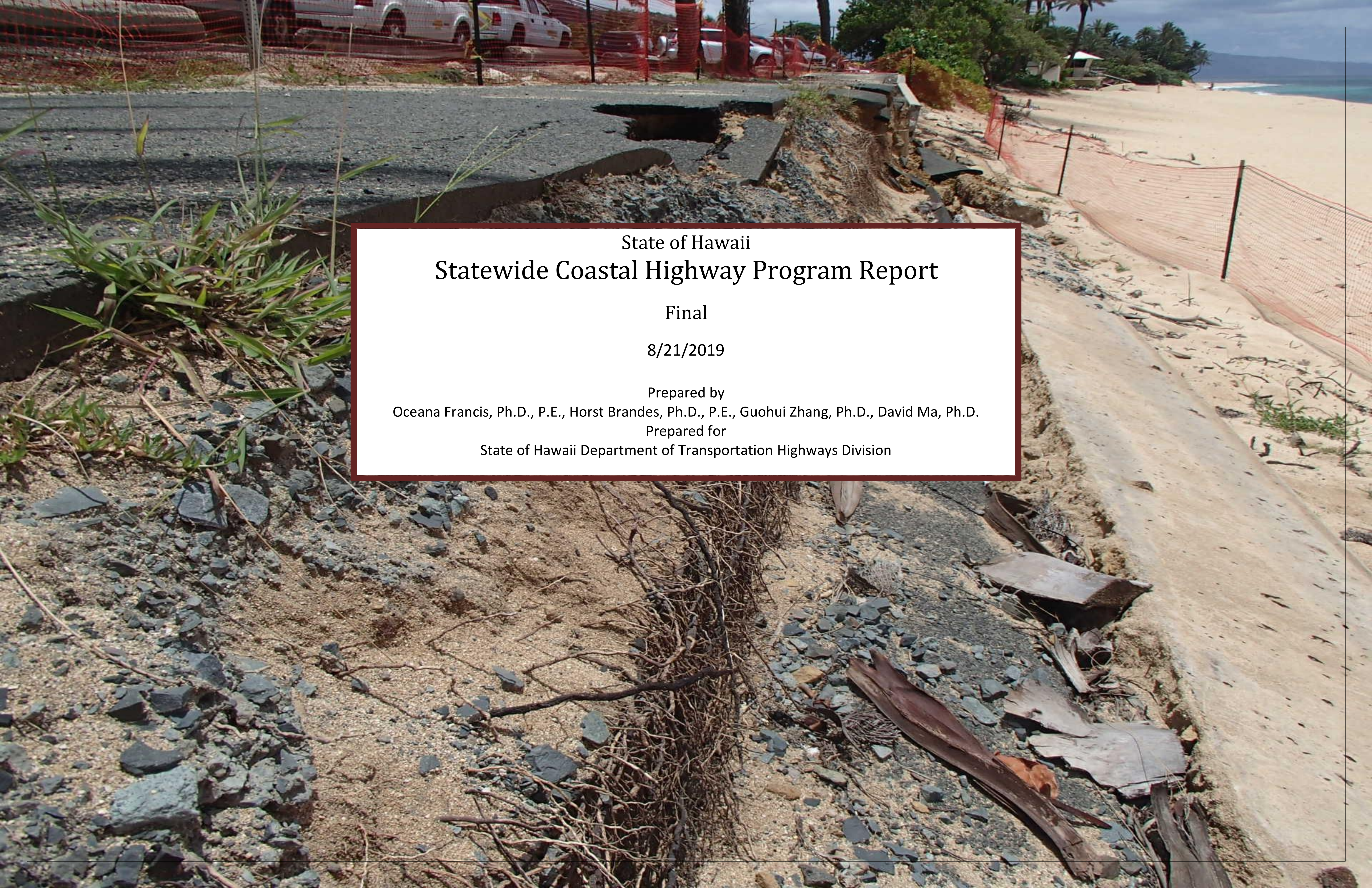

State of Hawaii

Statewide Coastal Highway Program Report

Final

8/21/2019

Prepared by
Oceana Francis, Ph.D., P.E., Horst Brandes, Ph.D., P.E., Guohui Zhang, Ph.D., David Ma, Ph.D.
Prepared for
State of Hawaii Department of Transportation Highways Division

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Photo Credit:
At Sunset Beach, Oahu, Hawaii along the Kamehameha Highway,
North Oahu on July 21, 2017 by Francis and Brandes.

State of Hawaii

Statewide Coastal Highway Program Report

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Executive Summary

The objective of this project is to develop a scientifically rigorous methodology to assess and rank the susceptibility of State of Hawaii coastal roads to erosion and structural degradation due to ocean hazards such as waves, currents, tides and sea level rise. On January 31, 2018, we issued an interim report containing the results of preliminary field investigations, rankings and recommendations focused on the need to undertake short-term remediation measures to prevent traffic interruptions and road closures during upcoming storm and hurricane seasons. Due to time constraints, this preliminary report relied on scientific understanding, a review of previous studies, input from field DOT personnel, and site visits to all the islands during the summer of 2017.

This final project report presents a new index methodology that considers the principal factors that determine coastal erosion and road degradation. The method is based on determination of the index CRESI (Coastal Road Erosion Susceptibility Index), which is described in Chapter 1. CRESI is evaluated at discrete locations along coastal roads in relatively close proximity to the ocean. Based on values of this index, coastal roads are segmented into lengths that are considered to have low, medium or high susceptibility to structural degradation. The 20 most critical road locations throughout the State of Hawaii are presented in Chapter 1.

In addition to the information in this report, we have assembled a comprehensive database of field observations, hazard quantities and other relevant parameters that represents an expanding inventory of coastal road assets across all the islands.

Results presented here reflect the conditions prevalent in the year 2019. However, the CRESI method can also be applied to future points in time since it incorporates the effects of sea level rise, climate change and potential changes in coastal layouts. We consider such assessments a valuable exercise for planning purposes and suggest that they be undertaken in a follow-up study.

CRESI was developed from prior studies that considered coastal erosion in general, but without a specific focus on road infrastructure itself. As such, it represents a novel engineering tool of specific relevance to those in charge of managing and maintaining coastal road networks, such as the Hawaii Department of Transportation. CRESI considers elements of vulnerability and hazards, but it does not yet represent a risk measure, at least not in the way that it is formulated at present. We envision further work toward this goal by incorporating consequential measures such as traffic, costs, and social and environmental implications. In addition, the particular hazard variables considered in CRESI, while based in part on previous studies, is amenable to improvement by taking into consideration a modified and more effective set of variables.

This report expands on specific ongoing efforts regarding traffic (Chapter 2) and ocean hazards (Chapter 3) that will lead to improved versions of the CRESI index. We expect to issue updated assessments of road vulnerability and risk as our scientific work and data collection continue.

This report also addresses the Federal Highway Administration (FHWA) Asset Management Plan, 23 CFR Part 515, a process proposed by the FHWA for developing a State asset management plan to improve or preserve the condition of the assets and the performance of the National Highway System (NHS) as they relate to physical assets. In this report, we address this by establishing a process for undertaking coastal road hazard analysis for assets. As part of this process, we help the State of Hawaii DOT to identify and assess hazards (e.g. sea level rise) that can affect asset condition or the effectiveness of the National Highway System (NHS) as it relates to physical assets. The process includes addressing the hazards to assets and to the highway system associated with current and future environmental conditions, including climate change and ocean hazards, in order to provide information for decisions about how to minimize their impacts and increase asset and system resiliency. The process for coastal road hazard management analysis also takes into account the results of the State DOT's evaluation of roads, highways, and bridges that have repeatedly required repair or reconstruction due to emergency events.

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Chapter 1 – CRESI

HI-DOT Road Network

1.1. CRESI: A Methodology to Prioritize Coastal Roads Threatened by Coastal Hazards and Climate Change

The network of Hawaii State roads includes significant stretches that are located in close proximity to the shoreline where they are vulnerable to ocean hazards such as waves, tides, storms surges and coastal erosion. In our preliminary field investigation we identified a number of specific locations where road degradation is ongoing or imminent. That initial assessment was limited in terms of its scope and depth and it relied significantly on observation, input from personnel at the various District offices, a review of previous studies and subjective judgment. The purpose was to provide an initial ranking of the most critical road sections for immediate repair prioritization.

The second phase of this project, which we report herein, involved the development of a more methodical and rigorous approach to achieve a more reliable ranking of critical road sections that takes into account environmental variables such as sea level rise and climate changes affecting the State of Hawaii. The ranking that is presented below is based on the development of a new index system referred to as CRESI (Coastal Road Erosion Susceptibility Index). We first provide an overview of the methodology, followed by its application to all the major islands to achieve the intended ranking. The vision of this project is to provide guidance to the HI-DOT on managing its system of roads at present and as climate change accelerates in the coming decades.

The CRESI approach involves characterization of coastal road locations by a single index that reflects the susceptibility of the road to erosion and structural collapse. A similar index approach has been developed and adopted by the HI-DOT for evaluating and ranking road locations susceptible to rock falls and soil slides. Methods for shoreline assessment and management have been developed by numerous researchers concerned with coastal processes, although none that we are aware of that focuses on a specific infrastructure component such as roads. Of these studies, it is worth mentioning what is perhaps the most widely used index method, known as the CVI (Coastal Vulnerability Index) and developed initially by Gornitz and coworkers (1990, 1991, 1992). It has since been adopted by the United States Geological Service. Our CRESI approach represents a significant modification of this earlier index for the purpose of addressing coastal roads in particular, instead of generic shorelines devoid of infrastructure as the CVI index does. Other index methods exist as well, such as the Coastal Sensitivity Index by Shaw et al. (1998), but they are far less commonly used. The CVI index was developed primarily for application along the East Coast of the United States, which is very different from the Hawaiian coastline. Its direct application to Hawaii does not make much sense. Our approach has been to consider the variables identified in the various methods, choose those that are applicable to this project, and add others that make scientific sense. Where we have adopted variables from other studies, we have in each case modified the criteria to adapt it to Hawaii conditions, as explained below.

Index methods such as CRESI or CVI represent a simplified approach to a problem that is ideally handled by probabilistic methods. In such a rigorous method, hazards are expressed in terms of probabilities and the performance of systems such as a cross section of road and its adjacent coastline are evaluated with reference to specific limit states (for example road erosion that makes it impassable by vehicles) and the cross section's inherent fragility. The outcome is then expressed in terms of the probability that such a limiting condition is approached over a given period of time. While ocean hazard probability density functions are available for waves, tides, sea level rise and even storm surges, fragility curves are unique to each location, complicated to derive, and therefore not available. An index method such as CRESI is the only alternative in this case.

While not entirely correct, the terms vulnerability, susceptibility and fragility are assumed to mean the same thing herein and a finer distinction is not necessary in the context of an index approach.

In the case of CRESI, a number of critical physical parameters are considered that affect the susceptibility of the road and the adjacent shoreline to erosion from the effects of environmental hazards originating from the ocean. A generic and simplified coastal profile is shown in Figure 1.1 that serves as the basis for defining the variables involved in the calculation of CRESI. It should be noted that most locations that we surveyed did not include one or more of the features indicated. In some cases there was no beach, in others the coast width was absent, and so on. As implied in Figure 1.1, CRESI is evaluated at distinct road locations with the relevant field information gathered from a cross section perpendicular to the road.

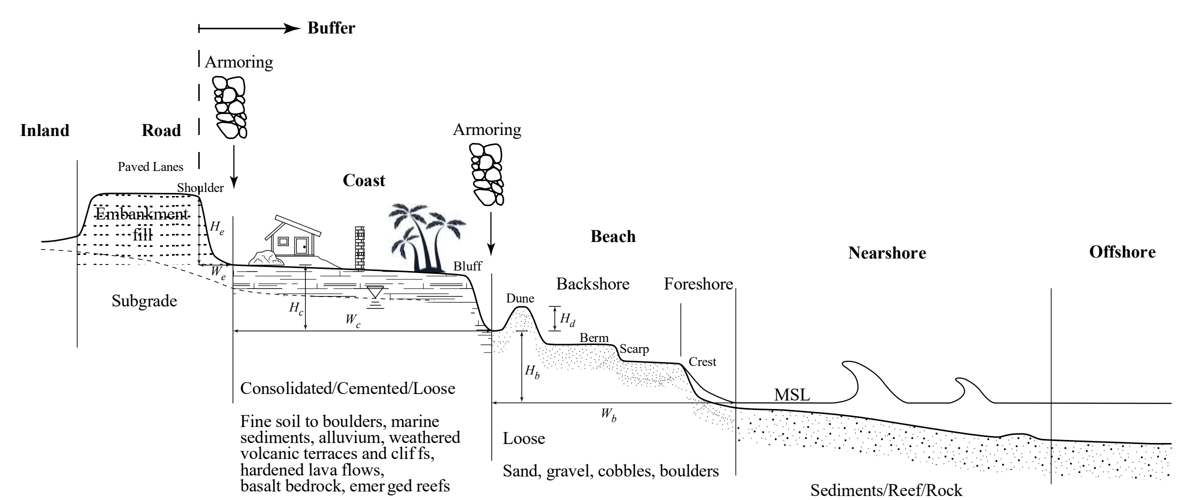


Figure 1.1. Generic road to ocean cross section

CRESI is based on the concept that the with of land between the road and the ocean acts as a buffer to erosion and therefore controls how vulnerable a particular location is to structural road damage and collapse. A road far inland would have a significant buffer protecting it from damage, whereas a road that is low and adjacent to the ocean is in much graver danger. With this in mind, the following variables are used in the calculation of CRESI (refer to Figure 1.1):

1. Beach geomorphology
2. Coast geomorphology
3. Erodible volume
4. Slope
5. Coastal ground cover and existing structures above ground
6. Road base and subgrade conditions
7. Armoring
8. Rate of sea level change
9. Shoreline accretion or erosion rate
10. Mean tidal change
11. Significant wave height

The first seven variables represent physical land characteristics and embody the vulnerability of the road and coastal buffer. The last four represent ocean hazards. Combining these eleven variables into a single index then yields a measure that reflects the probability of achieving a limit state characterized by structural road damage that affects the free flow of traffic. CRESI values are most useful for comparing and rating specific locations across the inventory of State roads.

Each of the variables needs to have a set of criteria specified on a sliding scale. We chose a scale of 1 to 5, with 1 representing a condition that reflects a very low susceptibility to road erosion and 5 indicating a very high susceptibility. The set of criteria for each of the eleven variables is shown in Table 1.1.

Table 1.1. CRESI criteria and scale – physical variables

Variable	**Susceptibility**				
	Very Low 1	**Low 2**	**Moderate 3**	**High 4**	**Very High 5**
1 Beach Geomorphology	Continuous hard basalt rock or carbonate reef; no loose volcanic soil or marine sediments	Semi-continuous basalt rock or carbonate reef; interlocked large boulders	Mixed medium to large boulders with some interlocking, >30% soil or sediment matrix	Medium-dense granular soil; well-graded sand through gravel	Loose or poorly-graded sand *or* no beach width
2 Coast Geomorphology	Continuous hard basalt rock or carbonate reef; no loose volcanic soil or marine sediments	Weathered volcanic lava flows with residual soil profile	Strongly consolidated or cemented volcanic soils or marine sediments, saprolite, highly weathered rock	Moderately consolidated or cemented volcanic soils or marine sediments, stiff or dense alluvium	Un-cemented marine sediments; soft/loose volcanic soil *or* no coast width
3 Erodible Volume	> 1076 ft^3/ft (100 m^3/m)	1076 to 538 ft^3/ft (100 to 50 m^3/m)	538 to 108 ft^3/ft (50 to 10 m^3/m)	108 to 54 ft^3/ft (10 to 5 m^3/m)	< 54 ft^3/ft (5 m^3/m)
4 Slope	< 1°	1° to 5°	5° to 15°	15° to 30°	> 30°

Table 1.1. (cont.). CRESI criteria and scale – physical variables

Variable	Susceptibility				
	Very Low 1	**Low 2**	**Moderate 3**	**High 4**	**Very High 5**
5 Coast Ground Cover & Structures	Continuous (~100%) impermeable above-ground structures, H>3'; extensive pavements	Partially continuous (>50%) above-ground structures, H>3'; some pavements	Discontinuous (<50%) above-ground structures; dense vegetation with deep and persistent root system	Low-density vegetation, some trees, grass	None or very little ground cover
6 Road Base/Subgrade	Engineered (DOT) pavement design, >4' thickness; highly erosion-resistant subgrade such as rock	Engineered pavement thickness 2' to 4'; moderately erosion-resistant subgrade such as weathered rock, saprolite or firmly cemented soil	Engineered pavement thickness < 2'; low to moderately erosion-resistant subgrade such as well-graded soil or moderately cemented soil	Engineered pavement thickness < 2'; low erosion-resistant subgrade such as decomposed soil, rubble	Engineered pavement thickness < 2'; highly erodible subgrade such as uncemented sand or soft silt/clay
7 Armoring	Continuous & impermeable retaining walls with good drainage; rock revetments with stable large boulders; no undermining; no wave overtopping	Same retaining walls as on left, but in poorer condition; somewhat deteriorated rock revetments; wave overtopping possible	Collapsed retaining walls or displaced rock revetments; substantial undermining and/or loss of backfill; insufficient height or width; poorly engineered fixes; sand bags	Partially continuous retaining walls or rock revetments (< 50%); highly deteriorated armoring; stacked rocks or other poorly engineered retention systems	No armoring

Table 1.1. (cont.). CRESI criteria and scale – ocean hazards variables

Variable	Susceptibility				
	Very Low 1	**Low 2**	**Moderate 3**	**High 4**	**Very High 5**
8 Relative Sea Level Change Rate	< 0.04 in/yr (1 mm/yr)	0.04 to 0.20 in/yr (1 to 5 mm/yr)	0.20 to 0.40 in/yr (5 to 10 mm/yr)	0.40 to 0.79 in/yr (10 to 20 mm/yr)	> 0.79 in/yr (20 mm/yr)
9 Shoreline Accretion (+) or Erosion (-) Rate	≥ 0 ft/yr (0 m/yr)	< 0 to -0.33 ft/yr (0 to -0.1 m/yr)	-0.33 to -0.66 ft/yr (-0.1 to -0.2 m/yr)	-0.66 to -1.6 ft/yr *or* active erosion line ≤ 19.7 ft from travel lane	< -1.6 ft/yr *or* active erosion line ≤ 9.8 ft from travel lane
10 Mean Tidal Change	< 1.6 ft (0.5 m)	1.6 to 3.3 ft (0.5 to 1.0 m)	3.3 to 6.6 ft (1.0 to 2.0 m)	6.6 to 16 ft (2.0 to 5.0 m)	> 16 ft (5.0 m)
11 Significant Wave Height	< 1.6 ft (0.50 m)	1.6 to 3.3 ft (0.5 to 1.0 m)	3.3 to 9.8 ft (1.0 to 3.0 m)	9.8 to 16 ft (3.0 to 5.0 m)	> 16 ft (5.0 m)

Compared to the CVI index, in CRESI the geomorphology criteria are drafted to address volcanic and carbonate shorelines typical in Hawaii. Erodible volume and slope criteria reflect the buffer concept inherent in CRESI. Ground cover, road base/subgrade and armoring address further potential impediments to erosion and are unique to CRESI. On the other hand, sea level change, shoreline accretion or erosion rate, tidal change and wave height are largely the same as in the CVI index but the ranges are significantly different.

CRESI can be used to evaluate road erosion susceptibility at some future time by selecting appropriate rates of sea level change, shoreline erosion rates and significant wave height (tidal change is unlikely to change). In this manner, the effects of climate change can be incorporated and would be reflected by increased values of the CRESI index. While projections of sea level change have been the subject of large-scale scientific studies by the National Oceanic and Atmospheric Administration (NOAA) and others, significantly less effort has been dedicated to the projections of wave heights that include the effects of climate change, shoreline rates of change or other related ocean hazards. These variables can be estimated relatively reliably for current conditions based on recent historical data. This study is therefore focused on estimating CRESI values at present time (i.e. year 2019). Application of CRESI to future points in time, say years 2050 or 2100, are of great interest but not the subject of this report. We recommend a follow-up study to address such projections.

While Table 1.1 lists the variables in the CRESI methodology, some additional manipulation of the raw quantities and/or scaled values is in order. For example, two variables describing geomorphology (coast and beach, respectively) would result in an overemphasis on geomorphology. Therefore the respective scaled ranks for the each of the coast and beach components are combined in a weighted manner as indicated in equation (1). This means that the effective number of variables used to determine CRESI is 10. Similar observations apply to volume and slope calculations (equations 2 and 3). A few more conditional assessments are necessary to address specific conditions that can lead to misleading values (equations 4 through 6, and 7). The variable R in the following equations refers to the ranked integer value 1, 2, 3, 4 or 5.

$$R_{Geo} = \frac{R_{Beach-Geo} * W_b + R_{Coast-Geo} * W_c}{W_b + W_c} \tag{1}$$

$$R_{Vol} = R\_(BeachVol + CoastVol + EmbVol) \tag{2}$$

$$R_{Slope} = R\_\left(\frac{BeachSlope * BeachLength + CoastSlope * CoastLength + EmbSlope * EmbLength}{BeachLength + CoastLength + EmbLength}\right) \tag{3}$$

If $R_{Armor} = 1$, then $R_{Slope} = 1$ and $R_{Shoreline\ Accretion/Erosion} = 3$ (4)

If $R_{Armor} = 2$, then $R_{Slope} = 2$ (5)

If Cross Section ends at sheltered inland water way, $R_{WaveHeight} = 1$ (6)

At each road location where CRESI was determined, a perpendicular cross section was established either by surveying with a transect if the coastline was accessible, or from Lidar topographic digital elevation models (DEM) if inaccessible. These cross sections were used to determine the slopes, lengths, widths and volumes referred to in the above equations.

Variables 1, 2, 5, 6 and 7 were assessed in the field and variables 3 and 4 were calculated from the respective cross sections using the above set of equations. Sea level change rate for the year 2019 (variable 8) was determined from historical trends, while mean tidal change (variable 9) and significant wave height (variable 11) were obtained from published ocean meteorological data. Finally, historical shoreline accretion/erosion rates were obtained from published estimates by the Coastal Geology Group at the University of Hawaii (Coastal Geology Group, 2016). For the islands of Molokai and Hawaii there are no published results. Instead, we estimated rates using historical maps embedded in the Google Earth software.

With the full set of variables determined, the CRESI index is calculated by the following equation:

$$\text{CRESI} = \sqrt{\frac{(Variable\ 1 * Variable2 * \ldots\ldots\ldots Variable10)^{0.7154}}{10}} \tag{7}$$

This is the simplest type of expression conceivable and it is similar to the one used to determine the CVI index. Many other expressions could be considered and this is an interesting subject for further research. In equation (7), the exponent 0.7154 was chosen to yield a convenient range of potential CRESI values from 0 to 100. The higher the value of CRESI, the more susceptible a particular location is to reaching the limit state described earlier, i.e. structural road damage that makes it impassable by vehicular traffic.

A final condition is implemented in the algorithm to calculate CRESI that forces the value to 0 if the buffer volume and the elevation of the road pavement above the ocean exceed certain thresholds:

If $(ErodibleVolume > 10594\ ft^3 (300m^3))$ and $(H_b + H_c + H_e > 33\ ft\ (10m))$, then $CRESI = 0$ by default (8)

This is a convenient way to reflect that certain road locations are not susceptible to structural collapse from ocean hazards if located a sufficient distance from the ocean and their elevation exceeds the stated amount.

While the mathematical formulation for CRESI allows for values from 0 to 100, in reality the range of actual values determined for Hawaii is much smaller. Typically, values do not exceed 40. This has to do with the criteria in Table 1.1. It is improbable that any one location will have all 10 variables ranked at a value of 5, especially given the difficulty of determining some of the variables (in particular Variable 6, road base/subgrade).

1.2. Development of an Inventory of Coastal Road Characteristics and Ocean Hazards

This study addressed the network of State roads throughout all the major islands. Following our preliminary assessment, we chose for data collection portions of roads that are known to, or conceivably can be considered to, be susceptible to the effects of ocean hazards. Sections of State roads traversing stretches that are far inland clearly do not need to be assessed. As stated, field data was collected at a number of specific locations throughout the State:

Oahu: 125 stations
Maui: 75 stations
Molokai: 55 stations
Kauai: 35 stations
Big Island: 13 stations

These stations typically included full milepost (MP) locations and intermediate stations where we felt additional data was necessary. Each of these stations was geo-referenced in the field and located on Google Earth maps. The conditions on the ground were examined carefully, as access permitted, to determine the predominant beach and coast morphology, coastal ground cover, road base and subgrade materials (where visible), and armoring, if any. Where access was possible, we obtained cross sections of elevation versus distance. The boundary between the coast and the beach was also identified, along with a few other details such as pavement shoulder with, date and time, and general comments. The date and time data was used to correct transects to mean tidal height.

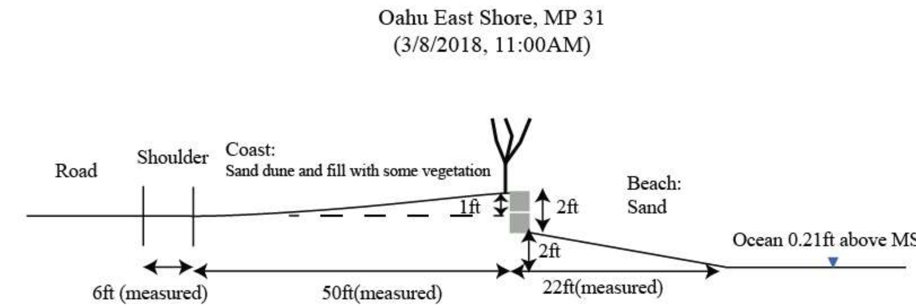
Where access was restricted due to private land ownership, we relied heavily on aerial Google Earth imagery to assess these features. In these cases, topographic information was obtained from the 2013 USACE NCMP topo-bathymetry Lidar data set with Local Mean Sea Level (LMSL) as the vertical reference. Horizontal accuracy is 100 cm with a 95% confidence level. Vertical accuracy is 19.6 cm with a 95% confidence level.

For some areas not covered by this data set, we used the 2006 FEMA Lidar data set, which has an accuracy of 30 cm in the horizontal direction. Vertical accuracy is 22.5 cm for Oahu, 26.8 cm for Kauai and 21.0 cm for the Big Island, each at the 95% confidence limit.

The master database currently includes 60 fields of information per station that are searchable and amenable to mathematical manipulation. While the database is not included in this report due to its volume, it is accessible by request and it will be made available online in the near future along with relevant maps of the type presented below. A portion of a typical data set for one particular location is shown in Figure 1.2.

Erodible volume and slope were determined from the cross section for each location using Matlab and the results were entered into the database, along with the cross section itself. Programming was added to the database to automatically calculate the CRESI index for each location so that the effect of changes in the relevant input quantities could be quantified automatically. Changes in the CRESI methodology can also be implemented with ease, if necessary.

It is hoped that this inventory of coastal road locations and its attributes will serve as a master database for general coastal reference and that it will see expansion in the future by addition of further intermediate locations and additional attributes such as drone video, traffic characteristics, repair and maintenance records, and much more. Data can also be entered for future surveys so that changes in coastal and road conditions can be evaluated.



Partial Database Information:

Road:	Coast:	Armoring:	Beach:
Height = 0 ft	Height = 0 ft	Height = 2ft	Width = 22ft
Shoulder width = 6 ft	Width = 50 ft	Type = CRM	Height = 0
Base/Subgrade = TBD	Soil/sediment/rock type = Sand and fill	Condition = medium	Soil/sediment/rock type = Sand
Drainage = 6	Ground cover = Some vegetation, grass, tree		Ground cover = N/A

Figure 1.2. Sample data collection, Oahu East Shore, MP 31

1.3. Mapping: Susceptibility to Road Erosion Based on CRESI Values

The same method was used to calculate CRESI at over 300 stations throughout the State. Locations and values of CRESI are shown in Figures 1.3 through 1.29. Based on these values, road segments were identified with one of three levels of susceptibility to structural collapse that impedes the free flow of traffic, as follows:

- Low susceptibility, CRESI between 0 and 9 – yellow segments
- Medium susceptibility, CRESI between 10 and 19 – blue segments
- High susceptibility, CRESI equal to or larger than 20 – red segments

In developing the segments shown in Figures 1.30 through 1.52, we relied on computed CRESI values first and foremost, and to a lesser extent on our familiarity with each stretch of road. The beginning and end of each segment was based on our observations of the overall character of the shoreline, the location and condition of the road, and common sense.

The assessment inherent in Figures 1.3 through 1.52 represents our best judgment based on our current scientific assessment and methodology. As our understanding of the underlying processes improves, particularly with regard to ocean hazards, traffic impacts, and other variables, the assessment that is presented herein will be updated to reflect new knowledge and additional field data.

It is also important to note that the results reflect current conditions, i.e. the year 2019. As already mentioned, the CRESI methodology can be applied to consider what are deemed to be more serious scenarios in the future. Common years that might be of interest to planners and managers are 2050 and 2100. No projections are included here for those points in time and significant challenges remain to assess how all the factors affecting CRESI might change because of the effects of climate change, sea level rise, intensifying ocean hazards, traffic patterns and coastal development trends. While carrying out future projections is difficult, it is not impossible. We recommend that such a study be undertaken as soon as possible.

1.4. Prioritization of Road Sections for Planning and Management

Beyond the segmentation of critical roads based on the CRESI index shown in Figures 1.30 through 1.52, we offer the following prioritization of specific road sections that are deemed most critical (Table 1.2). The ranking locations are also shown in the respective segmentation maps (Figures 1.30 through 1.52).

The ranking is based in large measure on CRESI values, but it also takes into account subjective traffic and network connectivity, ongoing or planned repair work, and other intangibles beyond the variables currently included in CRESI. This ranking is meant to assist managers, planners and legislators in prioritizing medium to long-term repairs and improvement of coastal roads under the jurisdiction of the HI-DOT. It does not include County roads, which are planned to be addressed in follow-up studies.

Remediation alternatives listed in Table 1.2 are meant to suggest broad alternatives that are likely the most reasonable approaches to improve road resilience. Harden refers to installing or repairing revetments, sea walls or other similar physical barriers. Relocation implies road realignment, wherever this is feasible. Of course, what is feasible will depend on land ownership, public acceptance and costs.

Table 1.2. Statewide Coastal Highway Prioritized Road Sections (Page 1 of 5)

Final Prioritized Listing (6/30/19)						6-Month Preliminary Report (1/31/18)		
Final Rank	**Island**	**Name**	**Milepost(s)[1]**	**CRESI Values**	**Remediation Alternatives[2]**	**Index**	**Priority Level**	**Initial Ranking**
1	Oahu	Hauula	22 22+0.45[1]	29 34	Harden	Oahu 7	1	1
2	Maui	Mopua	14+0.30 14+0.32 14+0.43 14+0.49	16 22 44 22	Harden Relocate	Maui 4	1	3
3	Oahu	Kaaawa South	28+0.38 28+0.82	29 25	Harden	Oahu 4	1	4
4	Kauai	Waikoko	4+0.11 4+0.25 4+0.39 4+0.51	26 30 22 24	Harden Relocate	Kauai 2	1	9
5	Oahu	Waimanalo	5+0.93 6 6+0.19	30 28 26	Relocation Harden	Oahu 17	2	-
6	Molokai	Kalua'aha	14+0.70	37	Relocate Elevate	Molokai 2 Molokai 3	1 1	6 7
7	Molokai	Puko'o	16+0.27	37	Relocate Elevate	N/C	N/C	N/C
8	Oahu	Kaaawa to Kahana	27+0.25 27+0.79	29 21	Harden	Oahu 6 Oahu 5	1, 2 1	2 8
9	Oahu	Kualoa	30+0.54	28	Harden Relocate	Oahu 1	2	-
10	Oahu	Kualoa to Kaaawa	29+0.71	26	Harden Relocate	Oahu 3	1	5

N/C – Not considered in Preliminary Report [1]Format: Milepost 22+0.45 = Milepost 22.45
[2]The estimated cost for delaying improvements for the top 20 sites until severe damage develops may be 50 times or higher than the cost of implementing preventive measures now, not to mention traffic interruption, inconvenience, safety concerns and business losses. Recommendations for hardening take surrounding geomorphology into account and unless the hardening takes place in a location that is currently armored, will not be undertaken without community discussions.

Table 1.2. (cont.). Statewide Coastal Highway Prioritized Road Sections (Page 2 of 5)

Final Prioritized Listing (6/30/19)						6-Month Preliminary Report (1/31/18)		
Final Rank	**Island**	**Name**	**Milepost(s)[1]**	**CRESI Values**	**Remediation Alternatives[2]**	**Index**	**Priority Level**	**Initial Ranking**
11	Maui	Ukumehame	11+0.64	11	Elevate Relocate	Maui 7	3	-
12	Maui	Punahoa	12+0.97 13 13+0.11 13+0.72	22 19 22 21	Relocate Elevate Harden	Maui 6 Maui 5	2 3	- -
13	Oahu	Keaau Stream Bridge	16+0.41	30	Harden Relocate	Oahu 12	1	13
14	Kauai	Kekaha	27	22	Relocate	Kauai 5	3	-
15	Maui	Kealia Pond	1+0.92 2 2+0.04 2+0.11	19 17 21 21	Relocate	Maui 9	4	-
16	Molokai	Pauwalu SW	18+0.20	33	Harden Relocate	N/C	N/C	N/C
17	Molokai	Pauwalu NE	18+0.71	32	Harden Relocate	N/C	N/C	N/C
18	Oahu	Laniakea	3+0.30	23	Relocate Harden	Oahu 10	3	-
19	Maui	Lahaina South	19 19+0.07 19+0.09	21 21 23	Relocate	N/C	N/C	N/C
20	Molokai	Waialua	19+0.62 19+0.77 19+0.91 20	26 27 28 27	Relocate Harden	Molokai 5 Molokai 6 Molokai 7 Molokai 8	2 2 1 1	- - 11 12

N/C – Not considered in Preliminary Report [1]Format: Milepost 22+0.45 = Milepost 22.45
[2]The estimated cost for delaying improvements for the top 20 sites until severe damage develops may be 50 times or higher than the cost of implementing preventive measures now, not to mention traffic interruption, inconvenience, safety concerns and business losses. Recommendations for hardening take surrounding geomorphology into account and unless the hardening takes place in a location that is currently armored, will not be undertaken without community discussions.

Table 1.2. (cont.). Statewide Coastal Highway Prioritized Road Sections (Page 3 of 5)

Final Prioritized Listing (6/30/19)					6-Month Preliminary Report (1/31/18)		
Island	**Name**	**Milepost(s)[1]**	**CRESI Values**	**Remediation Alternatives[2]**	**Index**	**Priority Level**	**Initial Ranking**
Level 1 Sites in Preliminary Report							
Molokai		19+0.36	26	Relocate Elevate Harden	Molokai 4	1	10
Level 2 Sites in Preliminary Report							
Oahu		31+0.09	22	Harden	Oahu 1	2	-
Oahu		21+0.47 22	16 29	Repair	Oahu 8	2	-
Oahu		7+0.68	24	Harden	Oahu 16	2	-
Maui		15+0.76	25	Harden	Maui 3	2	-
Kauai		4+0.51	24	Harden	Kauai 3	2	-
Molokai		5+0.38	13	Relocate Elevate	Molokai 1	2	-
Hawaii		2+0.11 2+0.25	20 14	Relocate	Hawaii 1	2	-

N/C – Not considered in Preliminary Report [1]Format: Milepost 22+0.45 = Milepost 22.45
[2]The estimated cost for delaying improvements for the top 20 sites until severe damage develops may be 50 times or higher than the cost of implementing preventive measures now, not to mention traffic interruption, inconvenience, safety concerns and business losses. Recommendations for hardening take surrounding geomorphology into account and unless the hardening takes place in a location that is currently armored, will not be undertaken without community discussions

Table 1.2. (cont.). Statewide Coastal Highway Prioritized Road Sections (Page 4 of 5)

Final Prioritized Listing (6/30/19)					6-Month Preliminary Report (1/31/18)		
Island	Name	Milepost(s)[1]	CRESI Values	Remediation Alternatives[2]	Index	Priority Level	Initial Ranking
Level 3 Sites in Preliminary Report							
Oahu		29+0.71	26	Repair	Oahu 2	3	-
Oahu		12+0.74	21	Relocate	Oahu 13	3	-
Oahu		8+0.67 8+0.80	14 14	Relocate	Oahu 9	N/A	-
Maui		11+0.64	24	Elevate Relocate	Maui 8	3	-
Maui		8+0.42	23	Slope Protection	Maui 11	3	-
Molokai		20+0.51 20+0.55	24 26	Beach Nourishment	Molokai 9	3	-
Maui		17	14	Harden	Maui 2	3	-
Maui		18+0.65	7	Harden	Maui 1	3	-
Maui		0+0.27 0+0.48	14 14	Harden Beach Nourishment	Maui 10	3	-
Kauai		-	N/E	Slope Protection	Kauai 4	3	-

N/E – Not evaluated with CRESI approach [1]Format: Milepost 22+0.45 = Milepost 22.45
[2]The estimated cost for delaying improvements for the top 20 sites until severe damage develops may be 50 times or higher than the cost of implementing preventive measures now, not to mention traffic interruption, inconvenience, safety concerns and business losses. Recommendations for hardening take surrounding geomorphology into account and unless the hardening takes place in a location that is currently armored, will not be undertaken without community discussions.

Table 1.2. (cont.). Statewide Coastal Highway Prioritized Road Sections (Page 5 of 5)

Final Prioritized Listing (6/30/19)					6-Month Preliminary Report (1/31/18)		
Island	Name	Milepost(s)[1]	CRESI Values	Remediation Alternatives[2]	Index	Priority Level	Initial Ranking
Level 3 Sites in Preliminary Report - continued							
Hawaii		4	0	Re-evaluate with drone	Hawaii 2	3	-
Hawaii		-	N/E	Re-evaluate with drone	Hawaii 3	3	-
Hawaii		-	N/E	Slope Protection	Hawaii 5	3	-
Level 4 Sites in Preliminary Report							
Oahu		14 14+0.13 14+0.21 14+0.26	11 11 12 14	Beach Nourishment	Oahu 14	4	-
Oahu		8+0.31 8+0.49	11 17	Bridge Repairs	Oahu 15	4	-
Oahu		19	15	Slope Protection	Oahu 11	4	-
Kauai		6 6+0.15	11 13	Beach Nourishment	Kauai 1	4	-
Hawaii		-	N/E	Re-evaluate with drone	Hawaii 4	4	-

N/E – Not evaluated with CRESI approach [1]Format: Milepost 22+0.45 = Milepost 22.45
[2]The estimated cost for delaying improvements for the top 20 sites until severe damage develops may be 50 times or higher than the cost of implementing preventive measures now, not to mention traffic interruption, inconvenience, safety concerns and business losses. Recommendations for hardening take surrounding geomorphology into account and unless the hardening takes place in a location that is currently armored, will not be undertaken without community discussions.

1.5. References

Coastal Geology Group, SOEST (2016). *Hawaii Coastal Erosion website.* University of Hawaii School of Ocean Earth Science and Technology, http://www.soest.hawaii.edu/coasts/erosion/

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Shaw, J., Taylor, R. B., Solomon, S., Christian, H. A., & Forbes, D. L. (1998). Potential impacts of global sea-level rise on Canadian coasts. *Canadian Geographer/Le Géographe canadien*, *42*(4), 365-379.

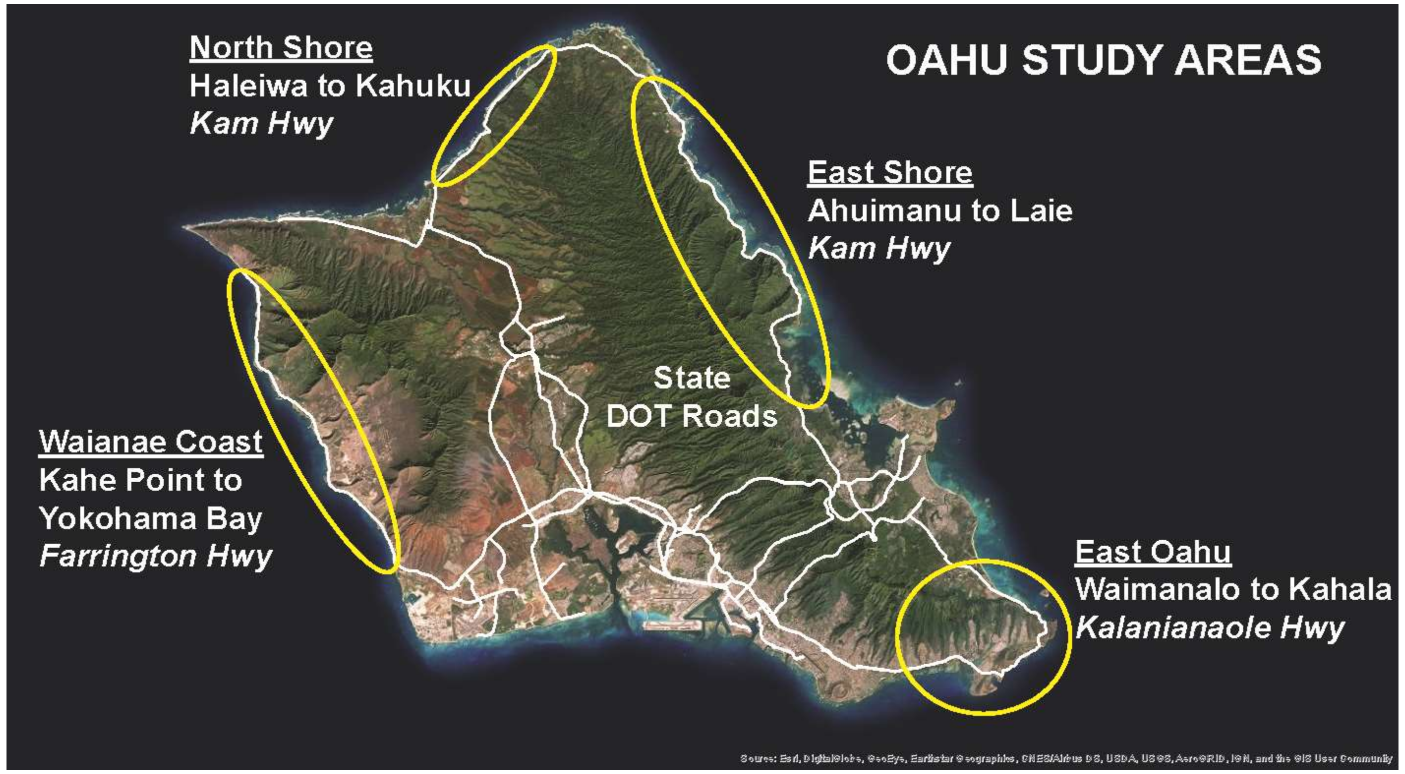


Figure 1.3. Oahu study areas

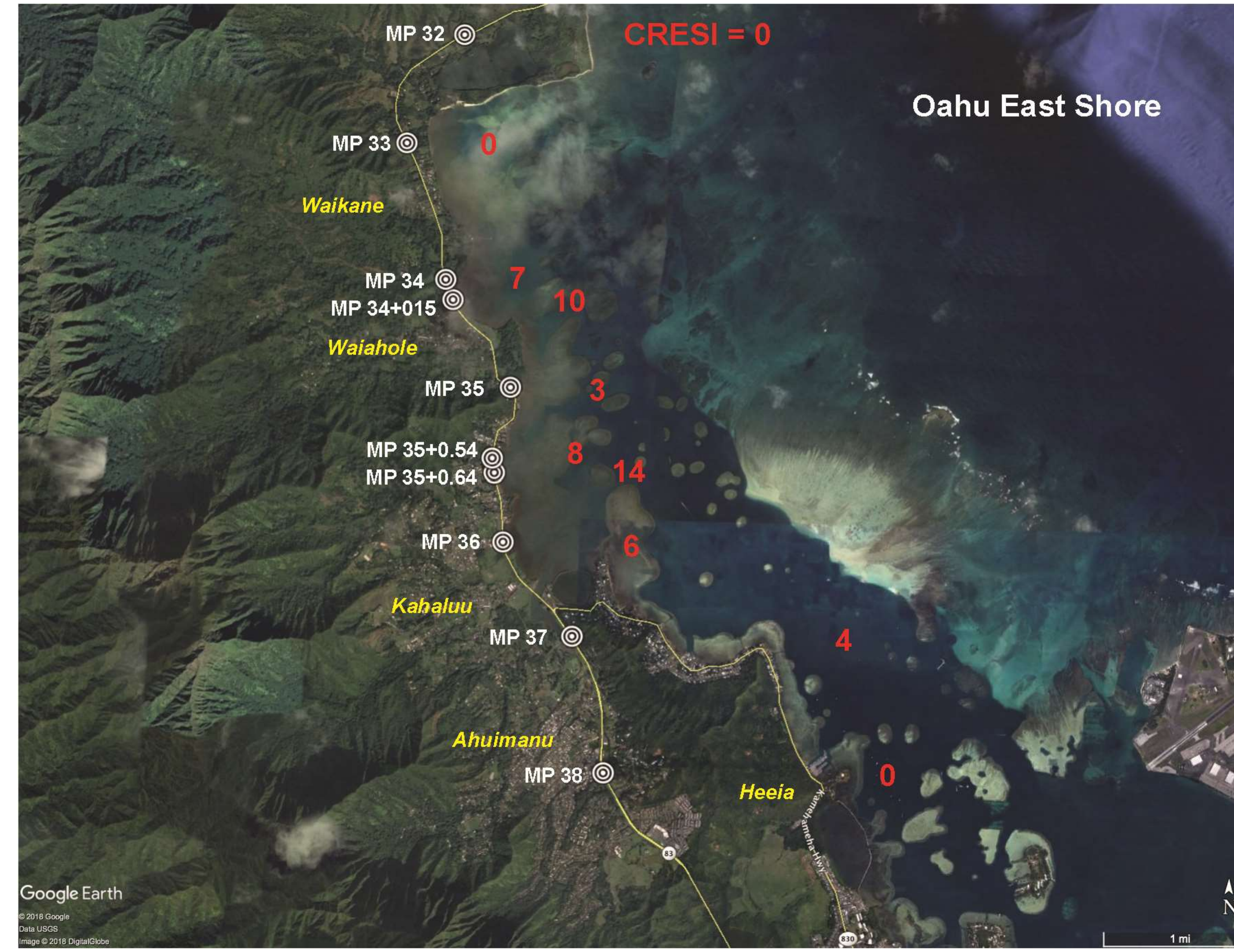


Figure 1.4. CRESI values: Heeia to Kualoa (Segmentation Map: Fig. 1.30)

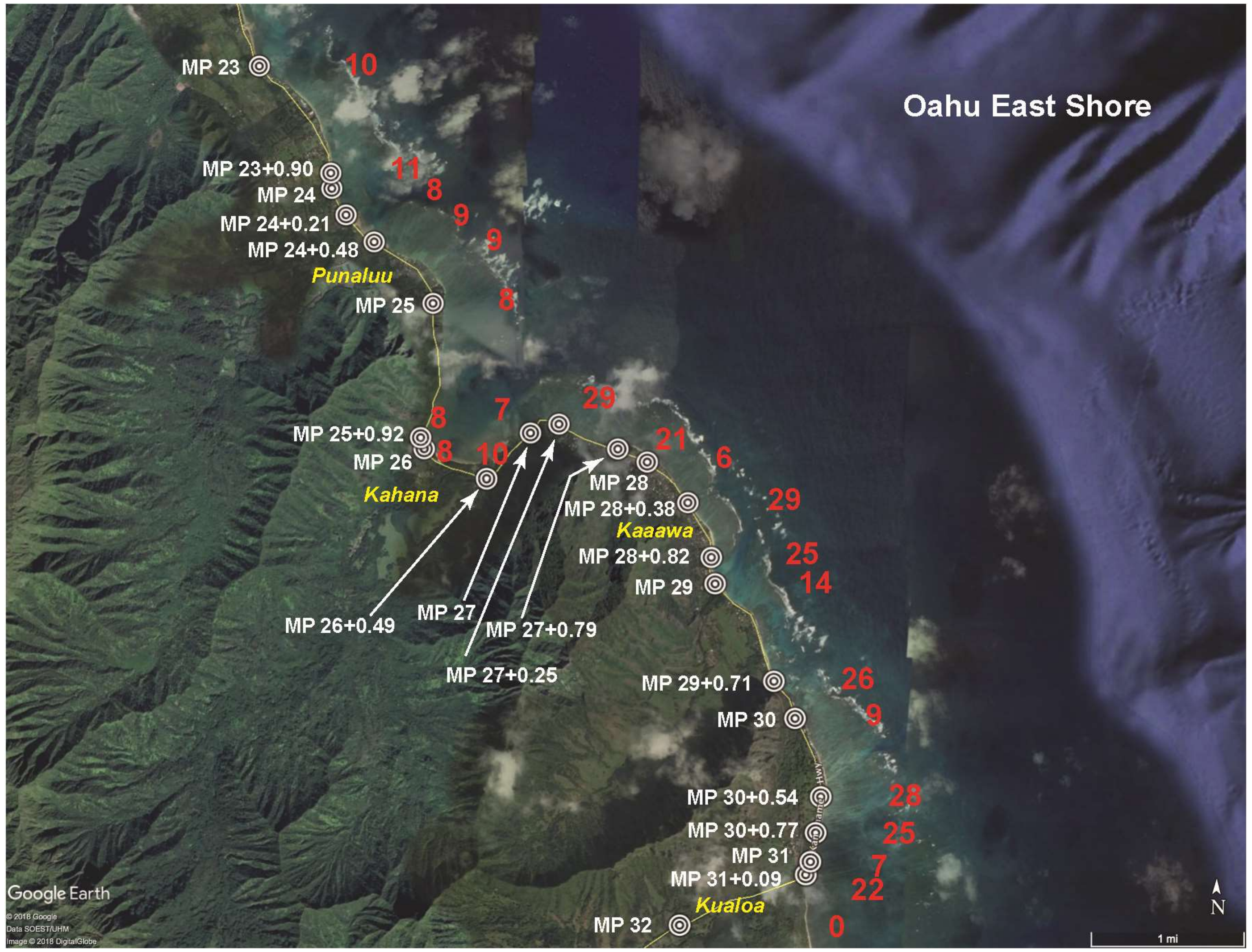


Figure 1.5. CRESI values: Kualoa to Punaluu (Segmentation Map: Fig. 1.31)

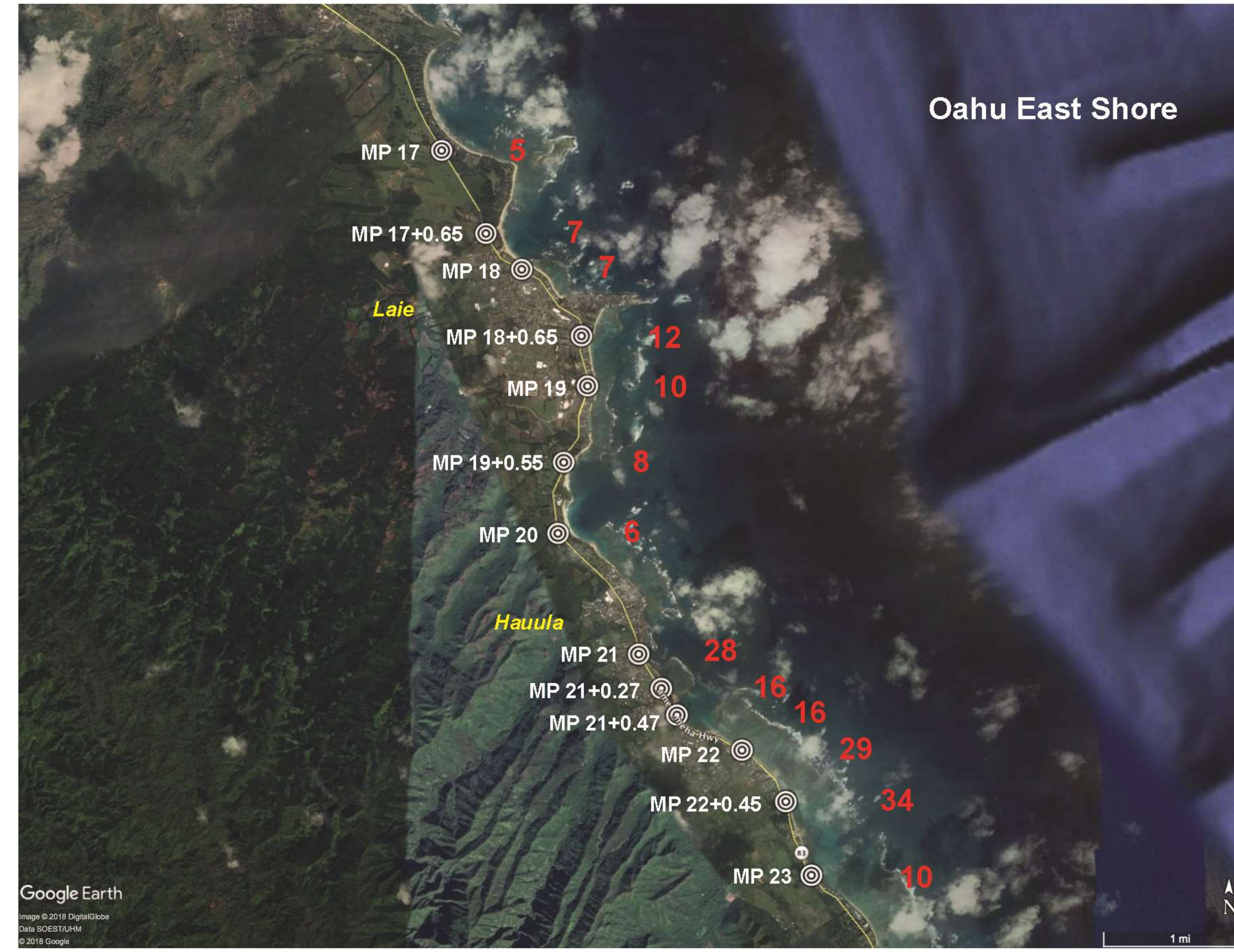


Figure 1.6. CRESI values: Hauula to Laie (Segmentation Map: Fig. 1.32)

Figure 1.7. CRESI values: Waimanalo to Makapuu (Segmentation Map: Fig. 1.33)

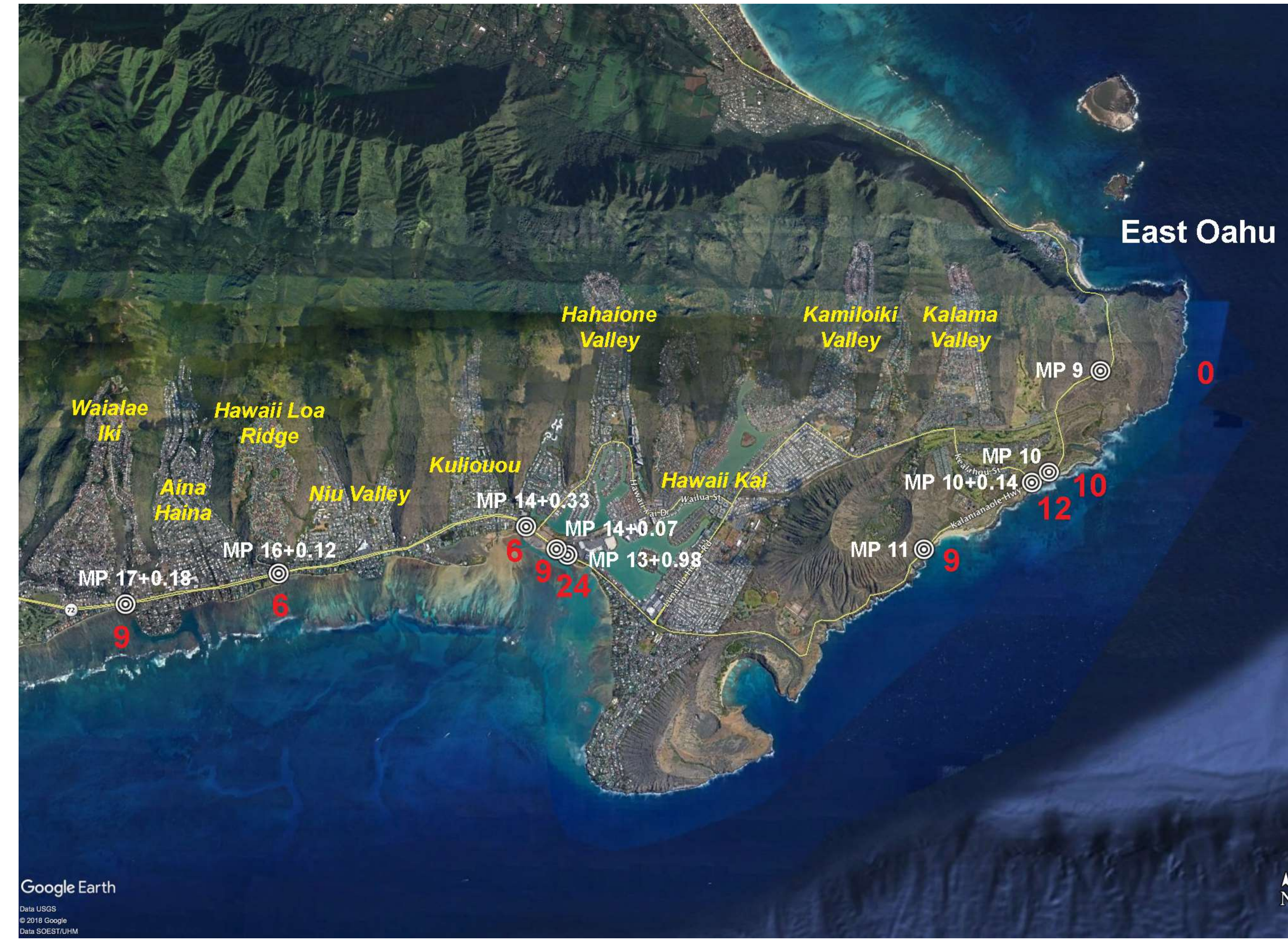


Figure 1.8. CRESI values: Makapuu to Kahala (Segmentation Mag: Fig. 1.34)

Figure 1.9. CRESI values: HECO Plant to Nanakuli (Segmentation Map: Fig. 1.35)

Figure 1.10. CRESI values: Lualualei to Makaha (Segmentation Map: Fig. 1.36)

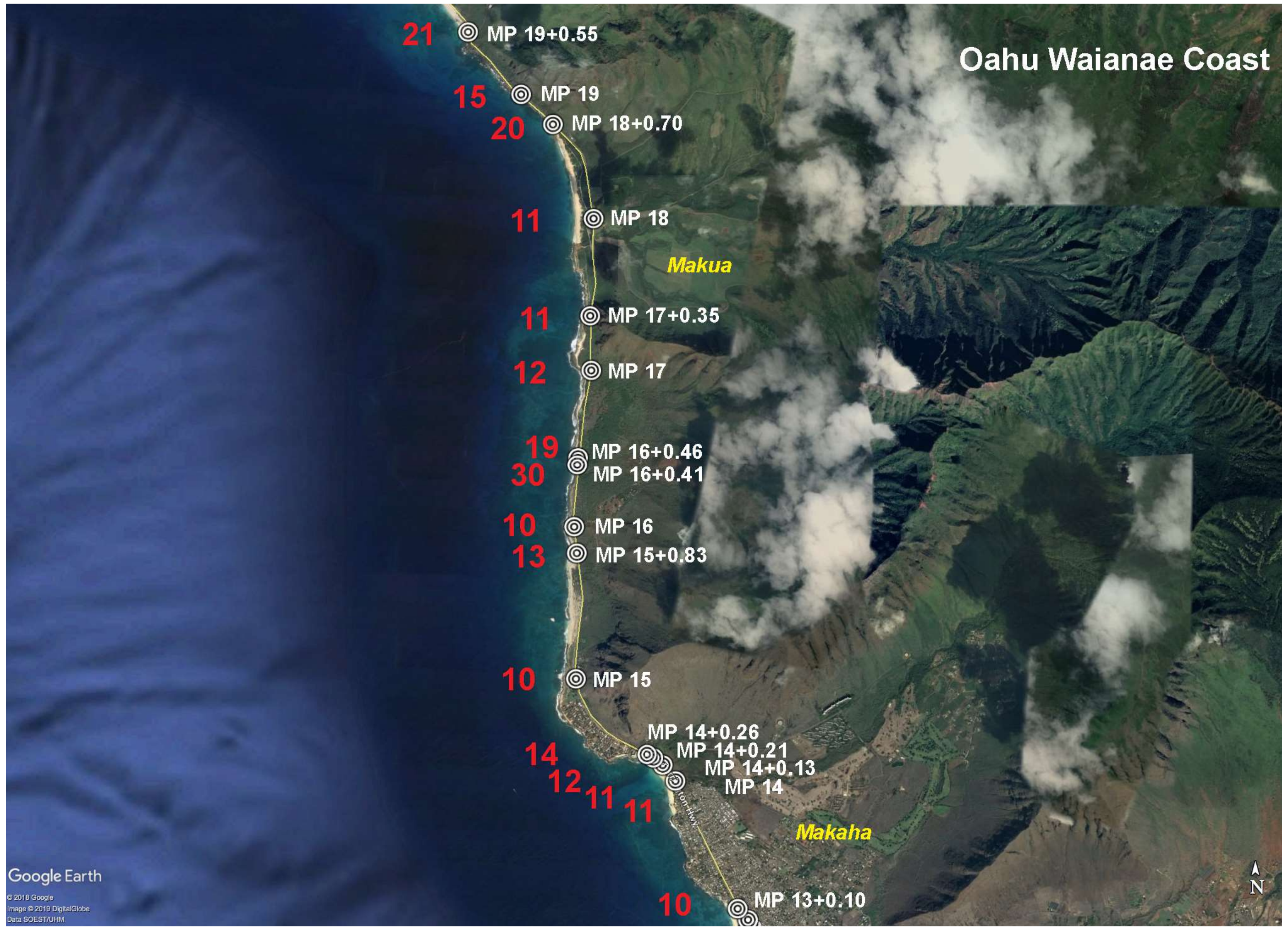


Figure 1.11. CRESI values: Makaha to Makua (Segmentation Map: Fig. 1.37)

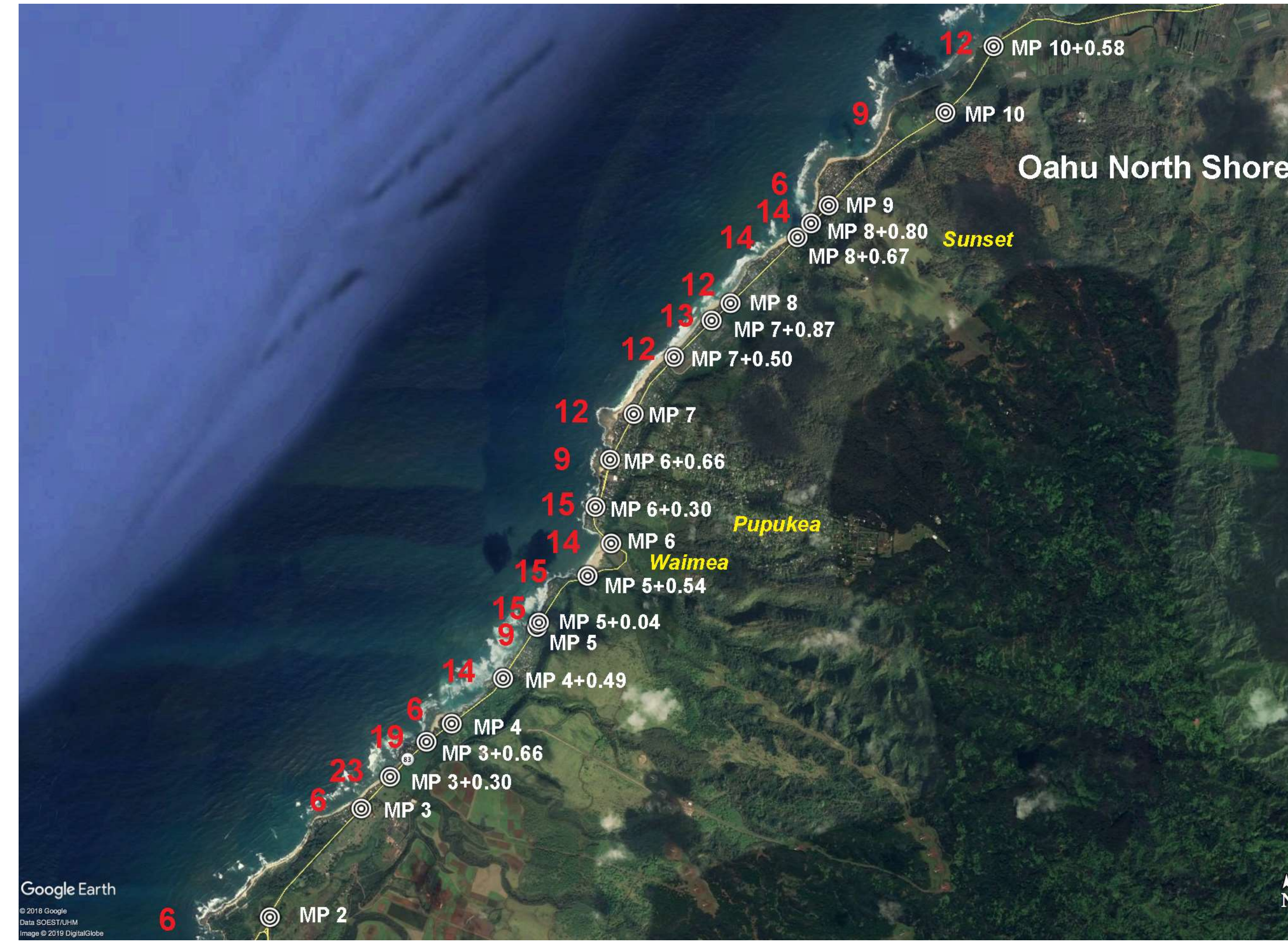


Figure 1.12. CRESI values: Oahu North Shore (Segmentation Map: Fig. 1.38)

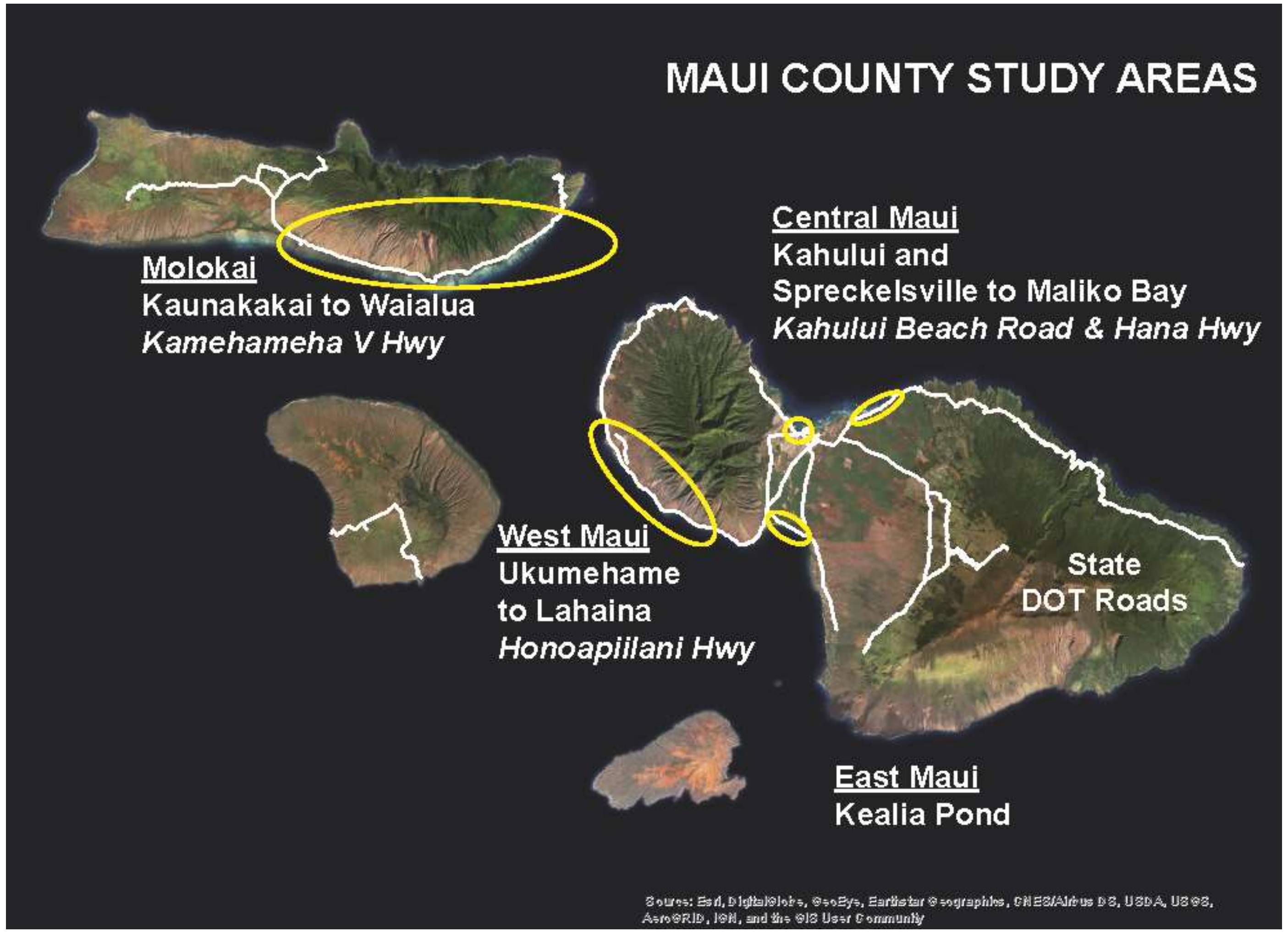


Figure 1.13. Maui study areas

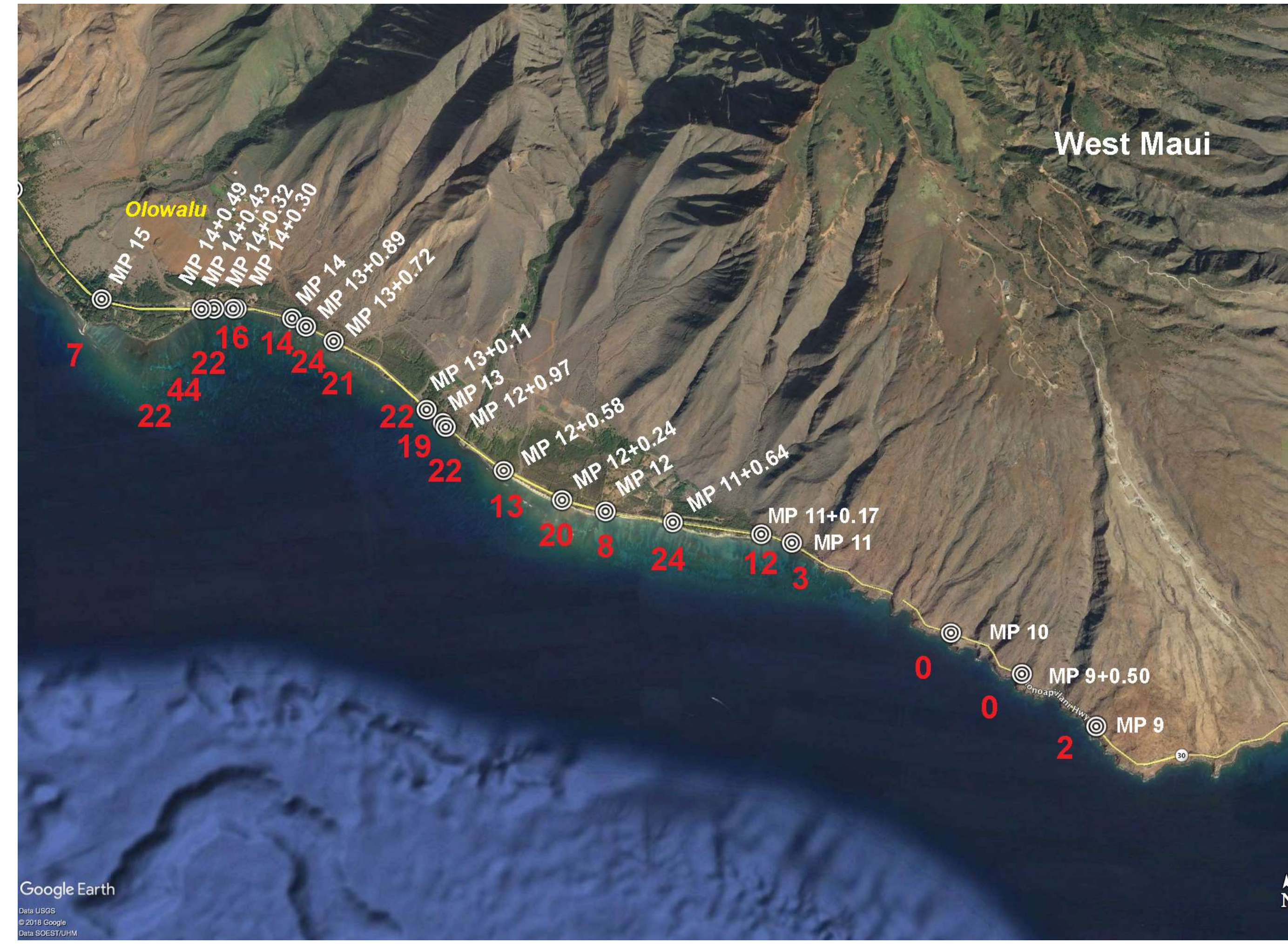


Figure 1.14. CRESI values: Maalaea to Olowalu (Segmentation Map: Fig. 1.39)

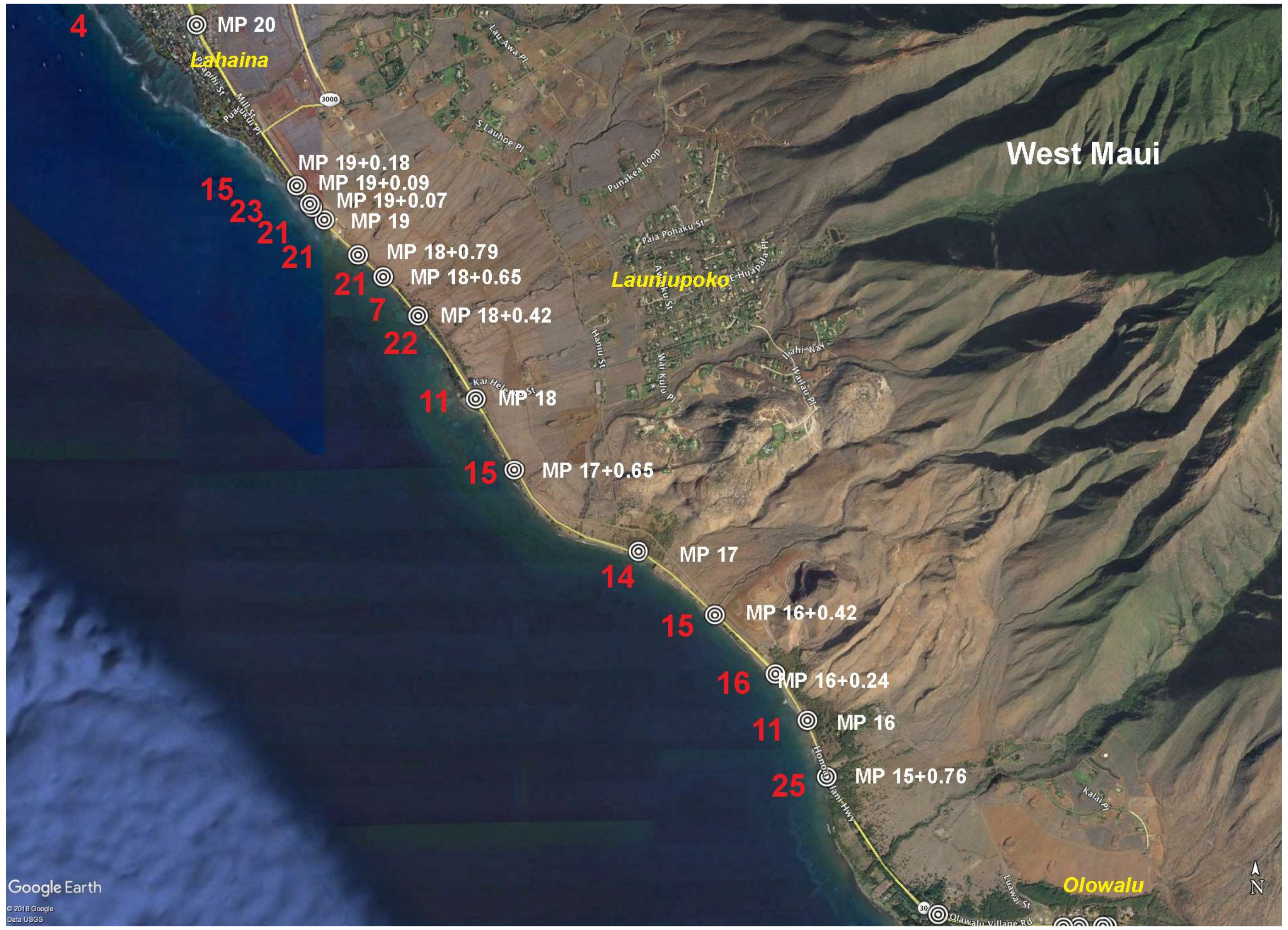


Figure 1.15. CRESI values: Olowalu to Lahaina (Segmentation Map: Fig. 1.40)

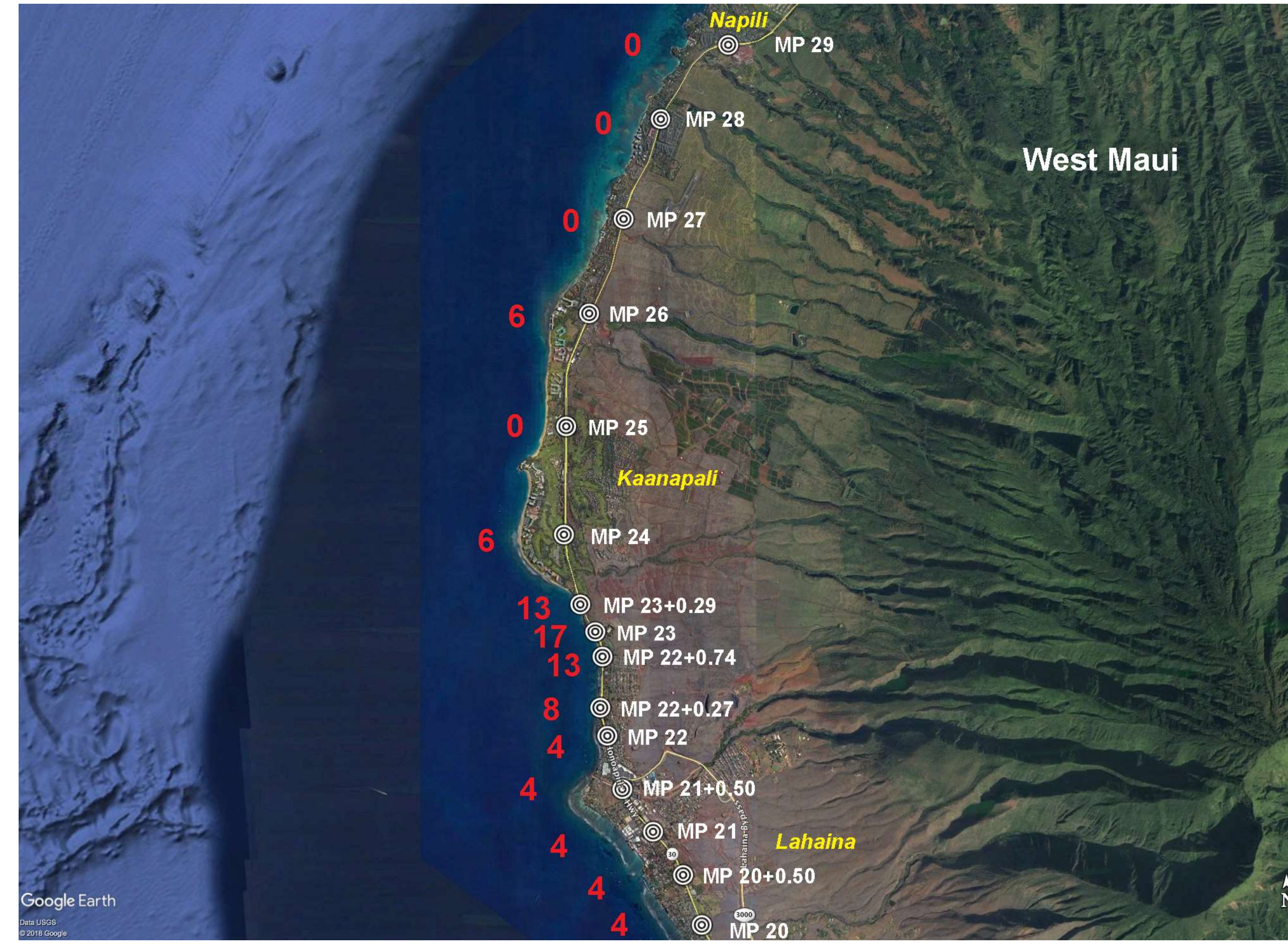


Figure 1.16. CRESI values: Lahaina to Napili (Segmentation Map: Fig. 1.41)

Figure 1.17. CRESI values: Maalaea to Kihei (Segmentation Map: Fig. 1.42)

Figure 1.18. CRESI values: Kahului Harbor (Segmentation Map: Fig. 1.43)

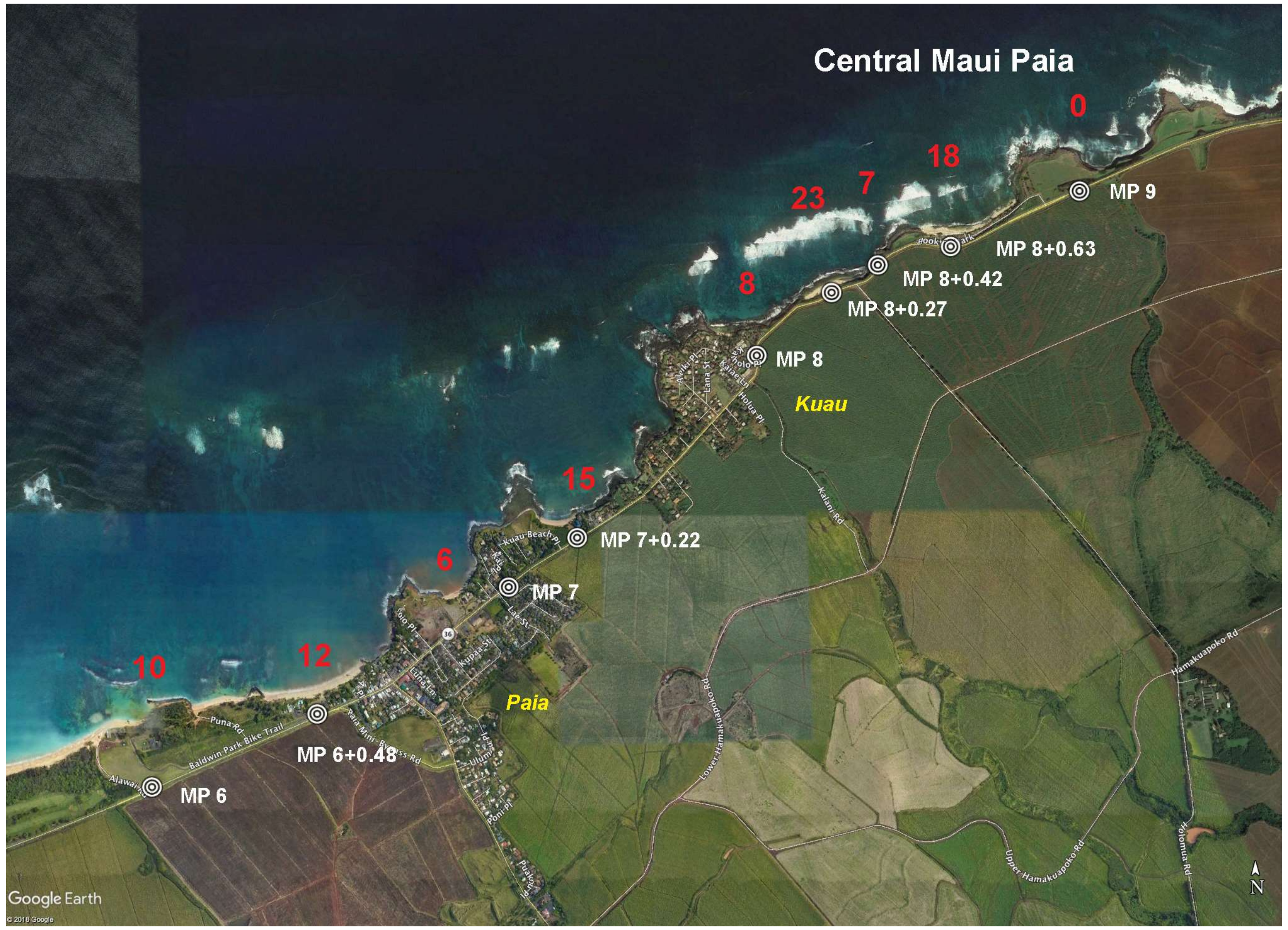


Figure 1.19. CRESI values: Paia to Kuau (Segmentation Map: Fig. 1.44)

Figure 1.20. CRESI values: Kaunakakai area (Segmentation Map: Fig. 1.45)

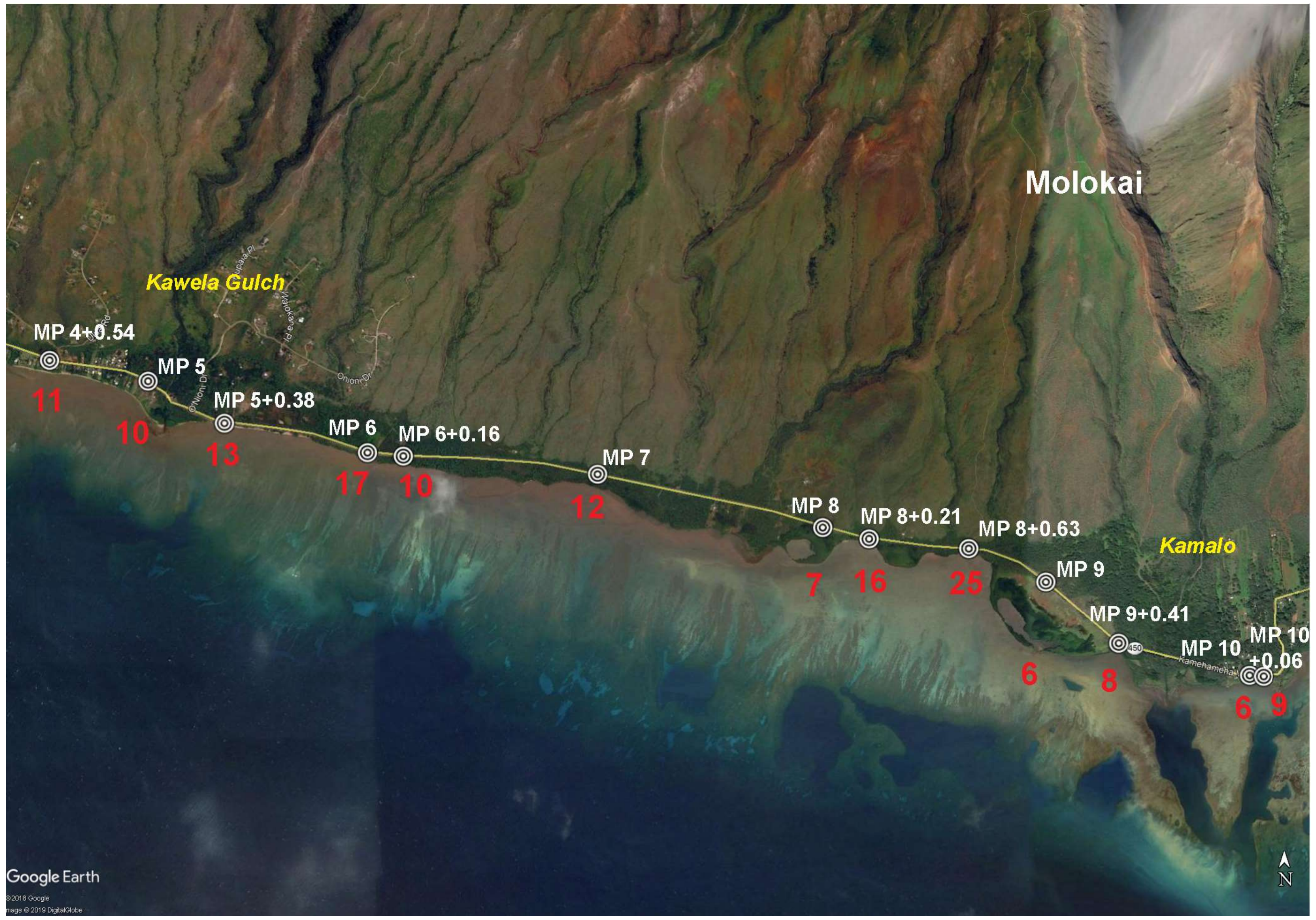


Figure 1.21. CRESI values: Kawela Gulch to Kamalo (Segmentation Map: Fig. 1.46)

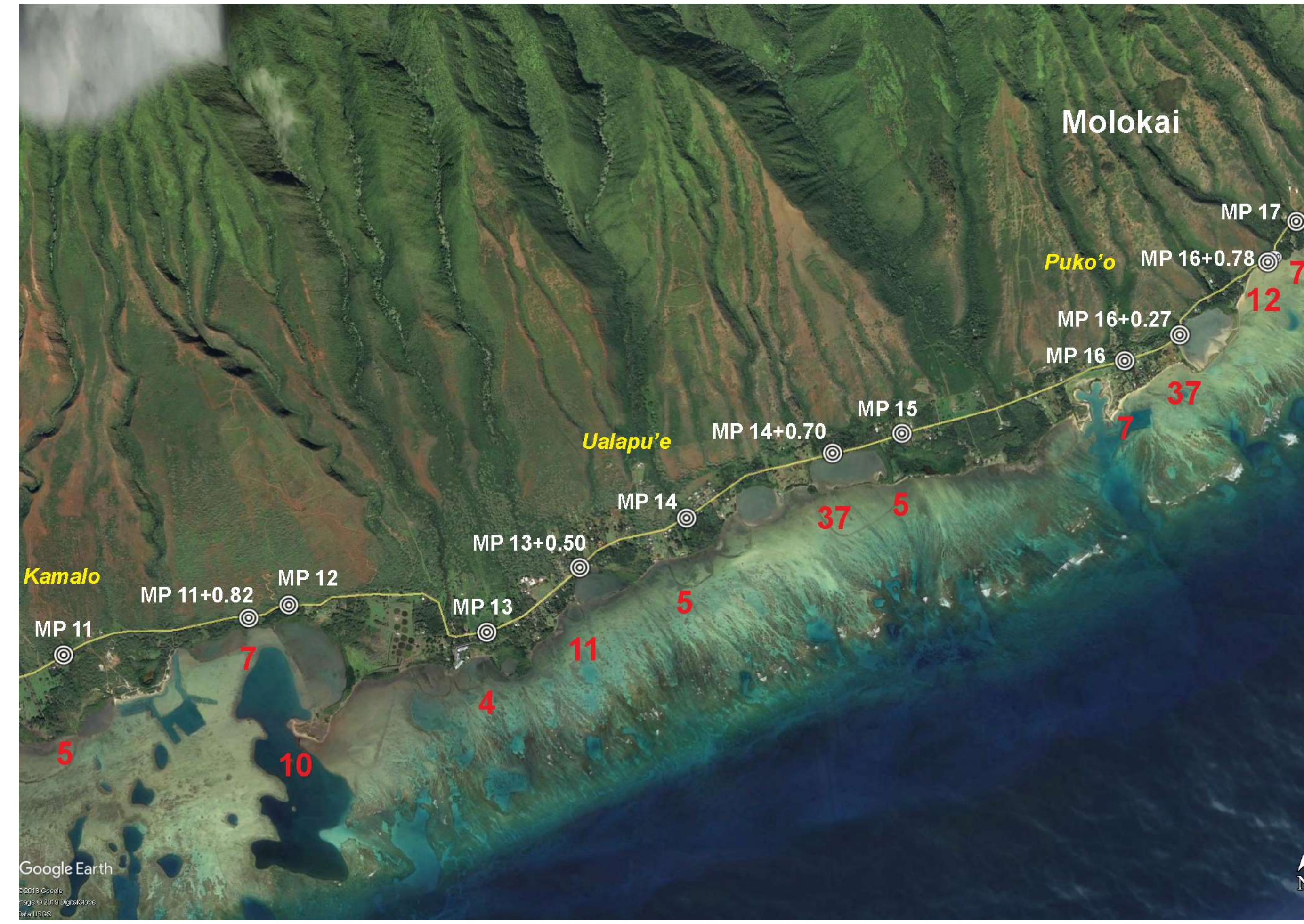


Figure 1.22. CRESI values: Kamalo to Puko'o (Segmentation Map: Fig. 1.47)

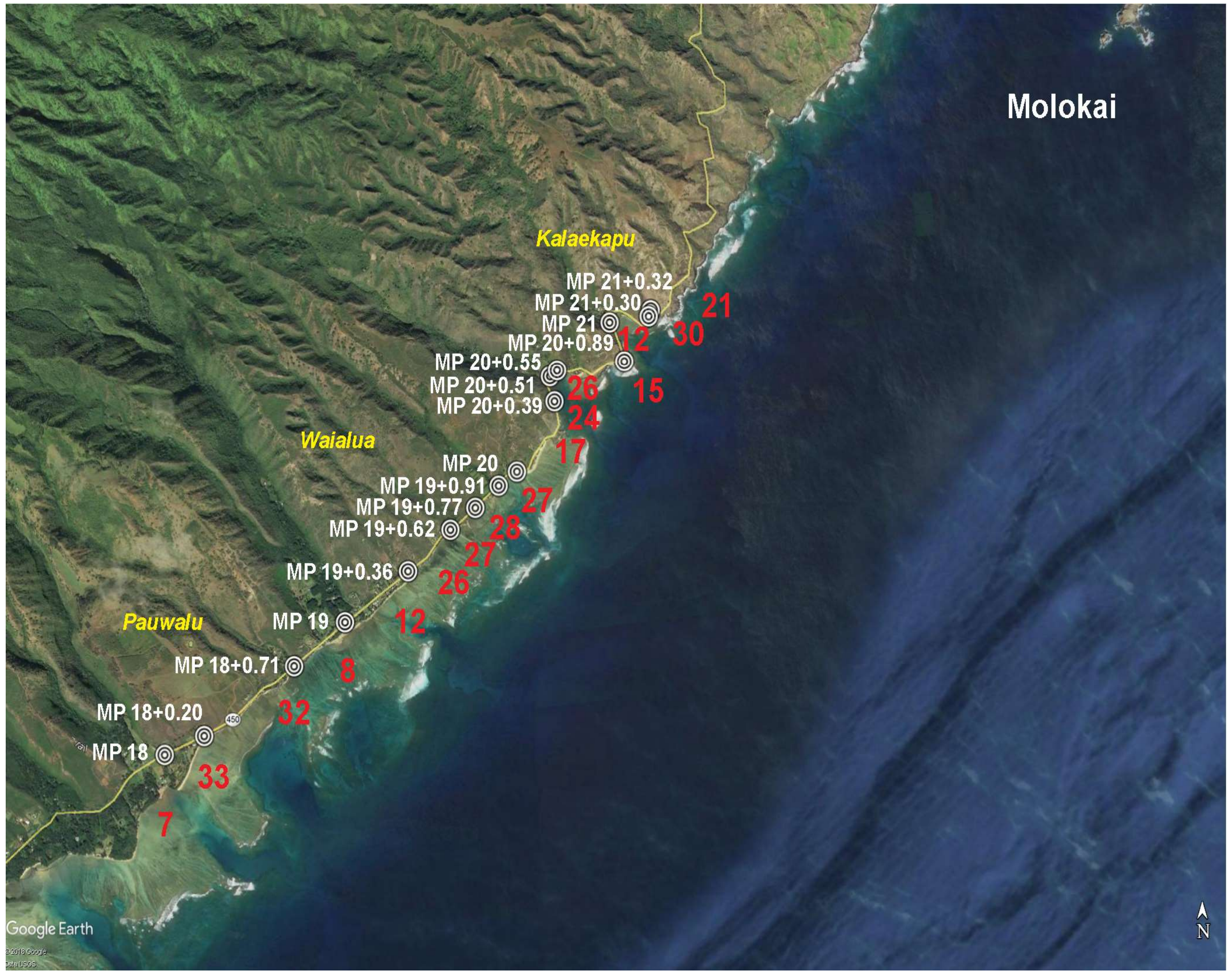


Figure 1.23. CRESI values: Pauwalu to Kalaekapu (Segmentation Map: Fig. 1.48)

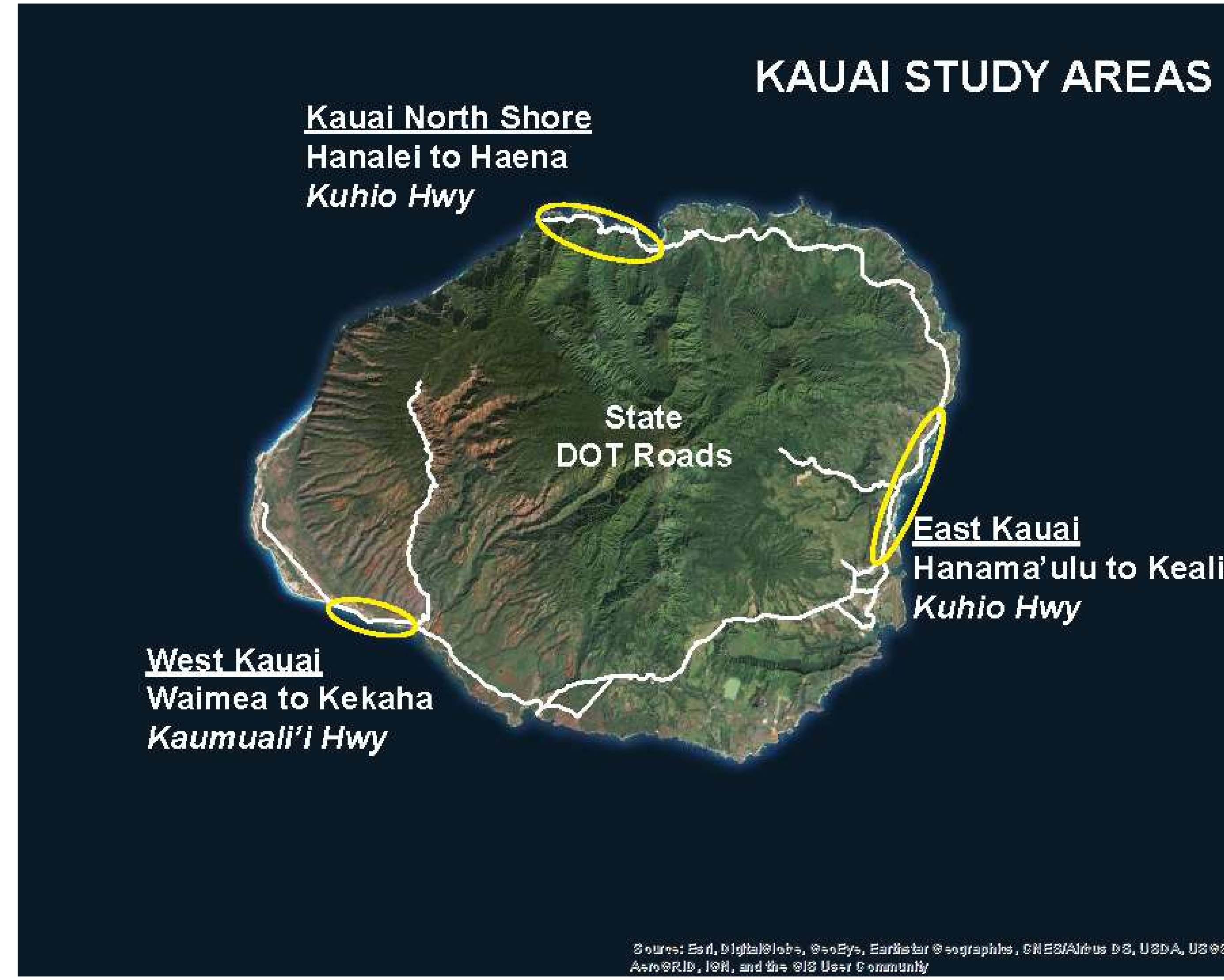


Figure 1.24. Kauai study areas

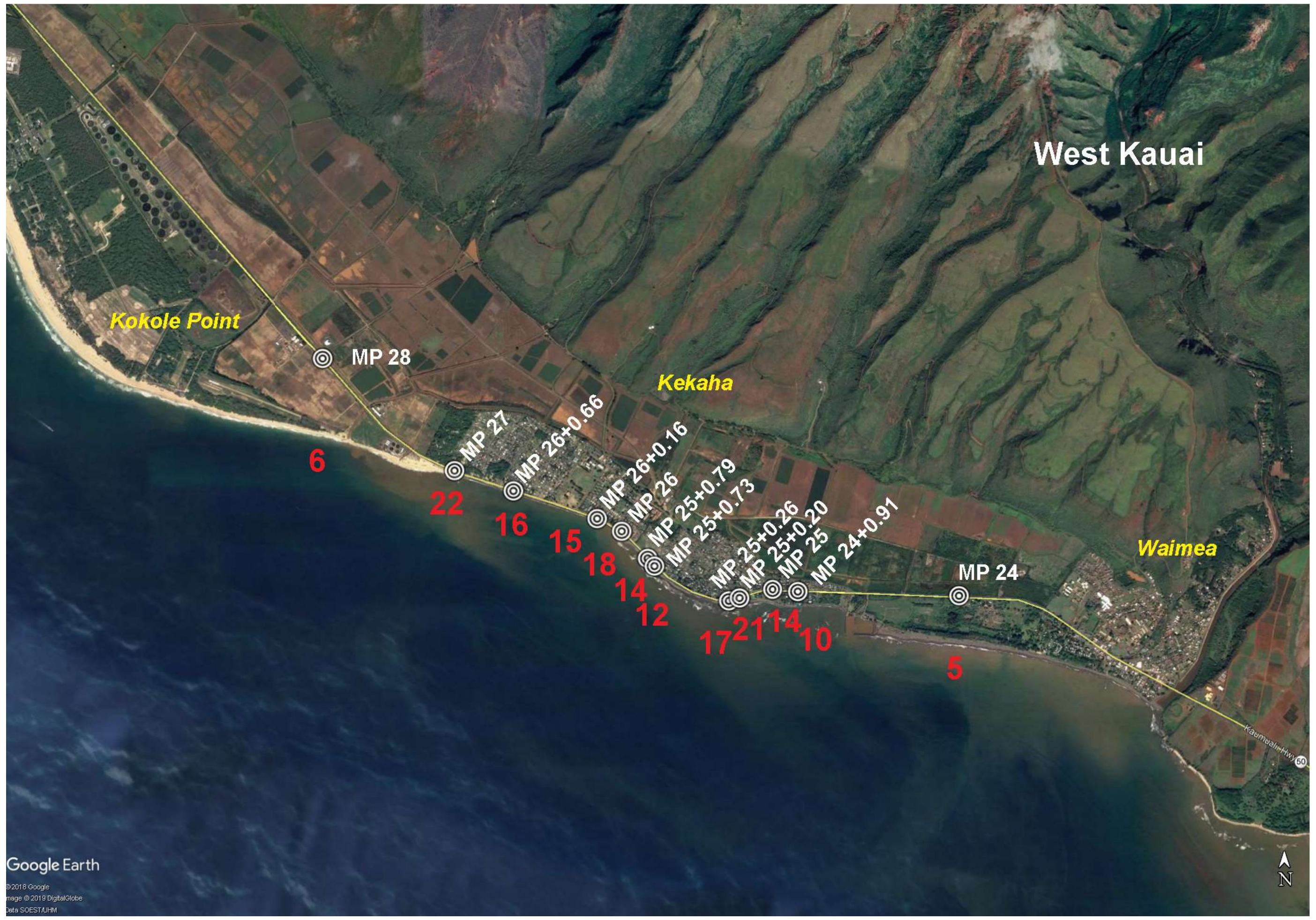


Figure 1.25. CRESI values: Waimea to Kokole Point (Segmentation Map: Fig. 1.49)

Figure 1.26. CRESI values: Wailua to Kealia (Segmentation Map: Fig. 1.50)

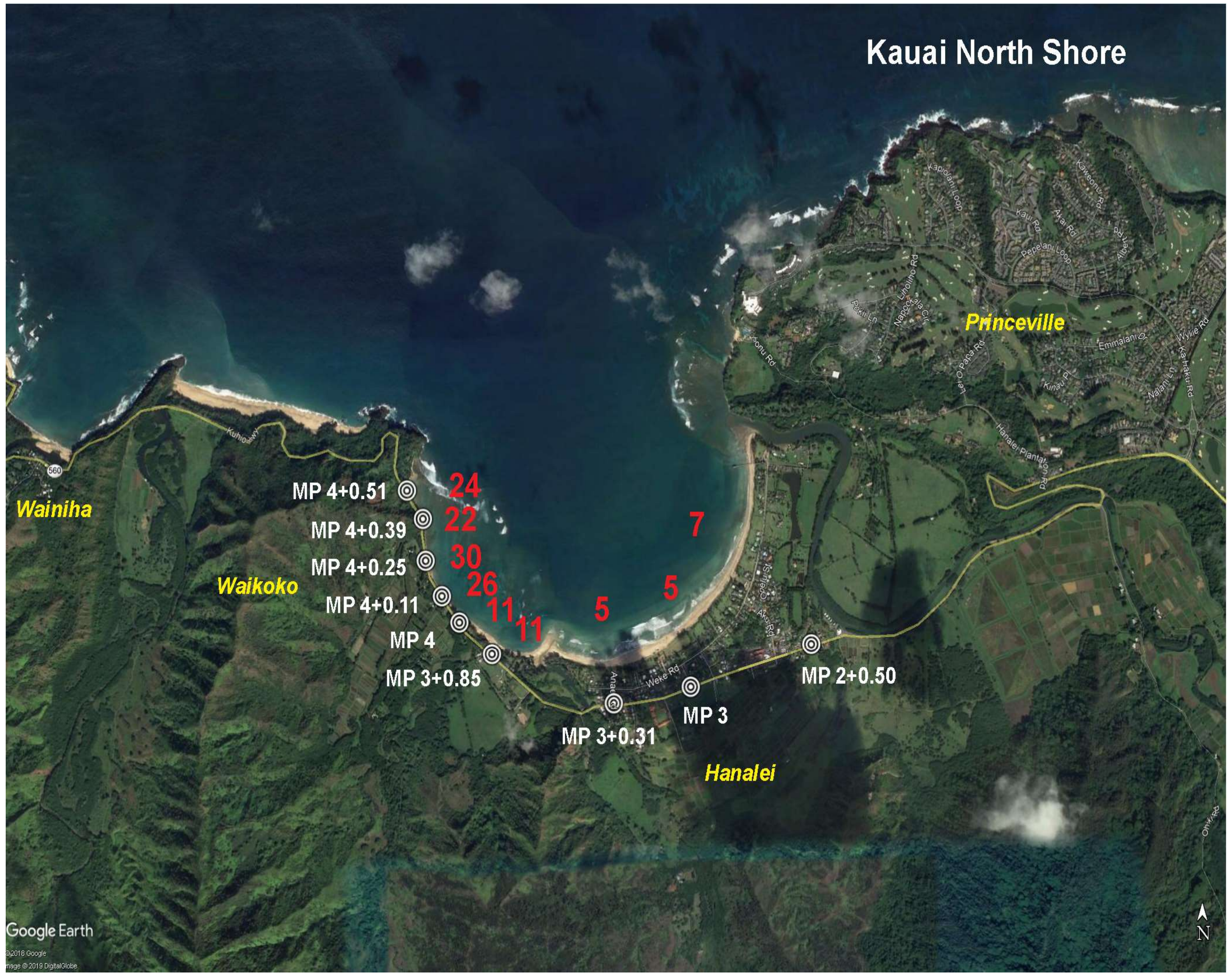


Figure 1.27. CRESI values: Hanalei to Waikoko (Segmentation Map: Fig. 1.51)

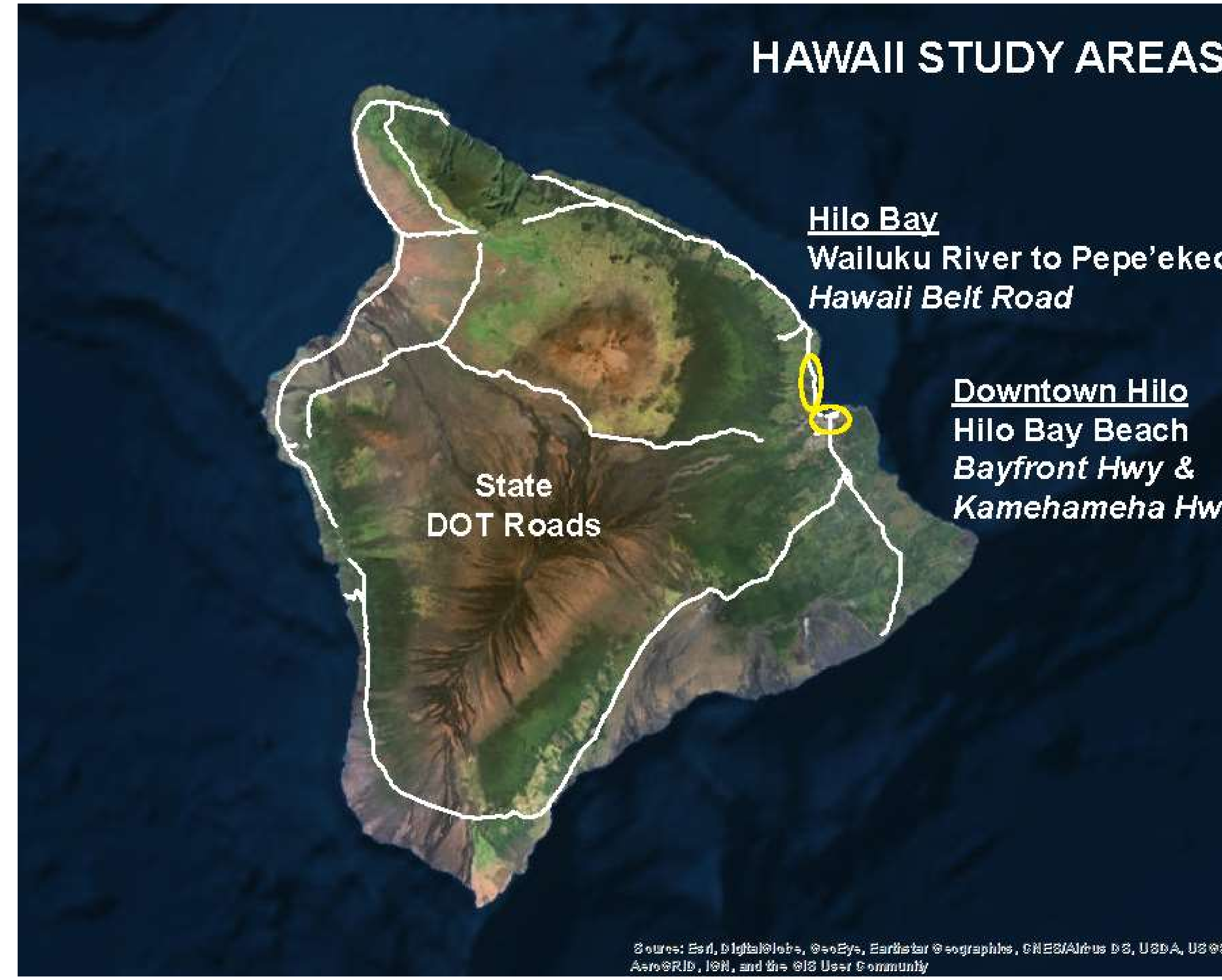


Figure 1.28. Hawaii study areas

Figure 1.29. CRESI values: Hilo Bay area (Segmentation Map: Fig. 1.52)

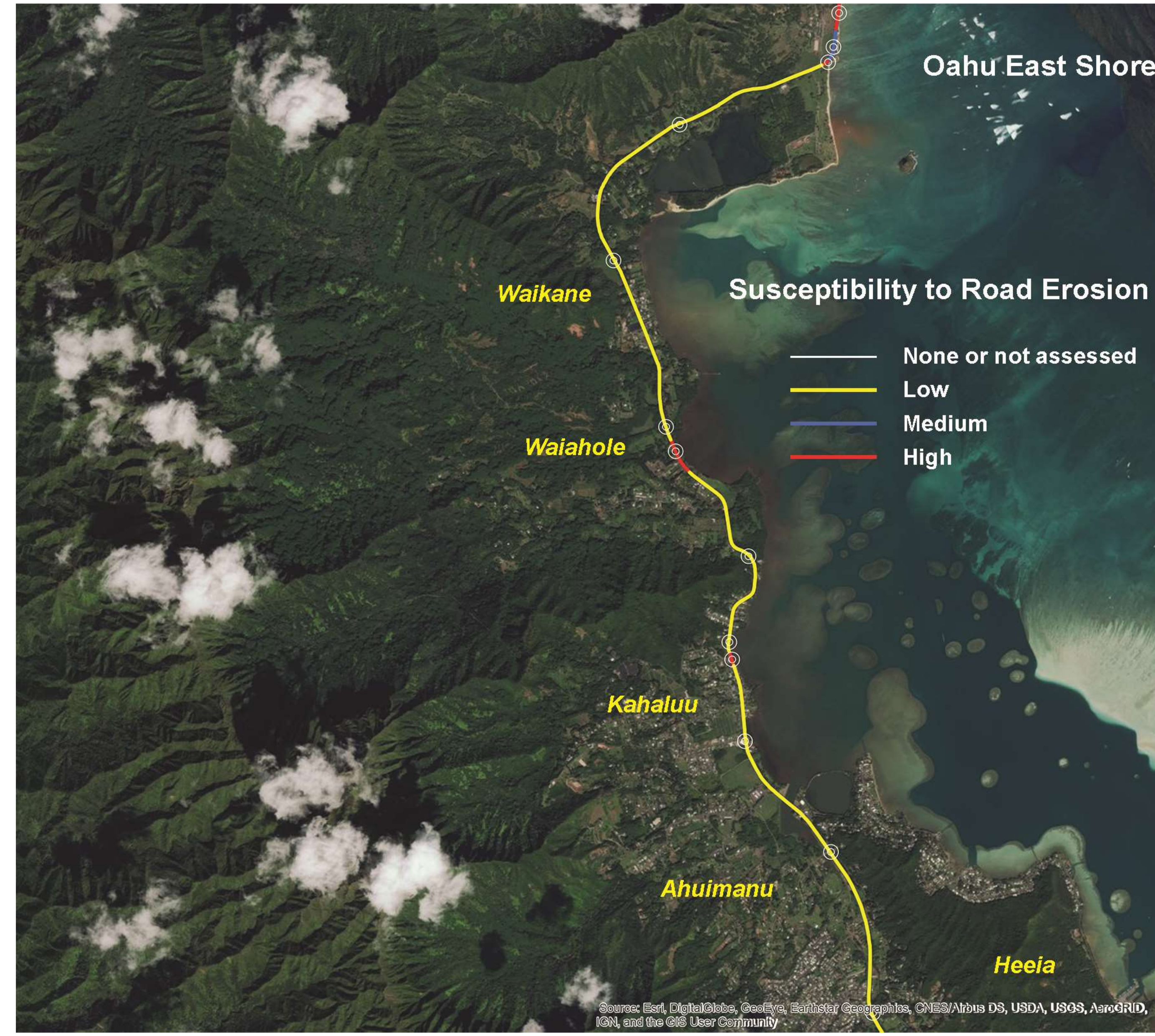


Figure 1.30. Segmentation Map: Heeia to Kualoa

Figure 1.31. Segmentation Map: Kualoa to Punaluu

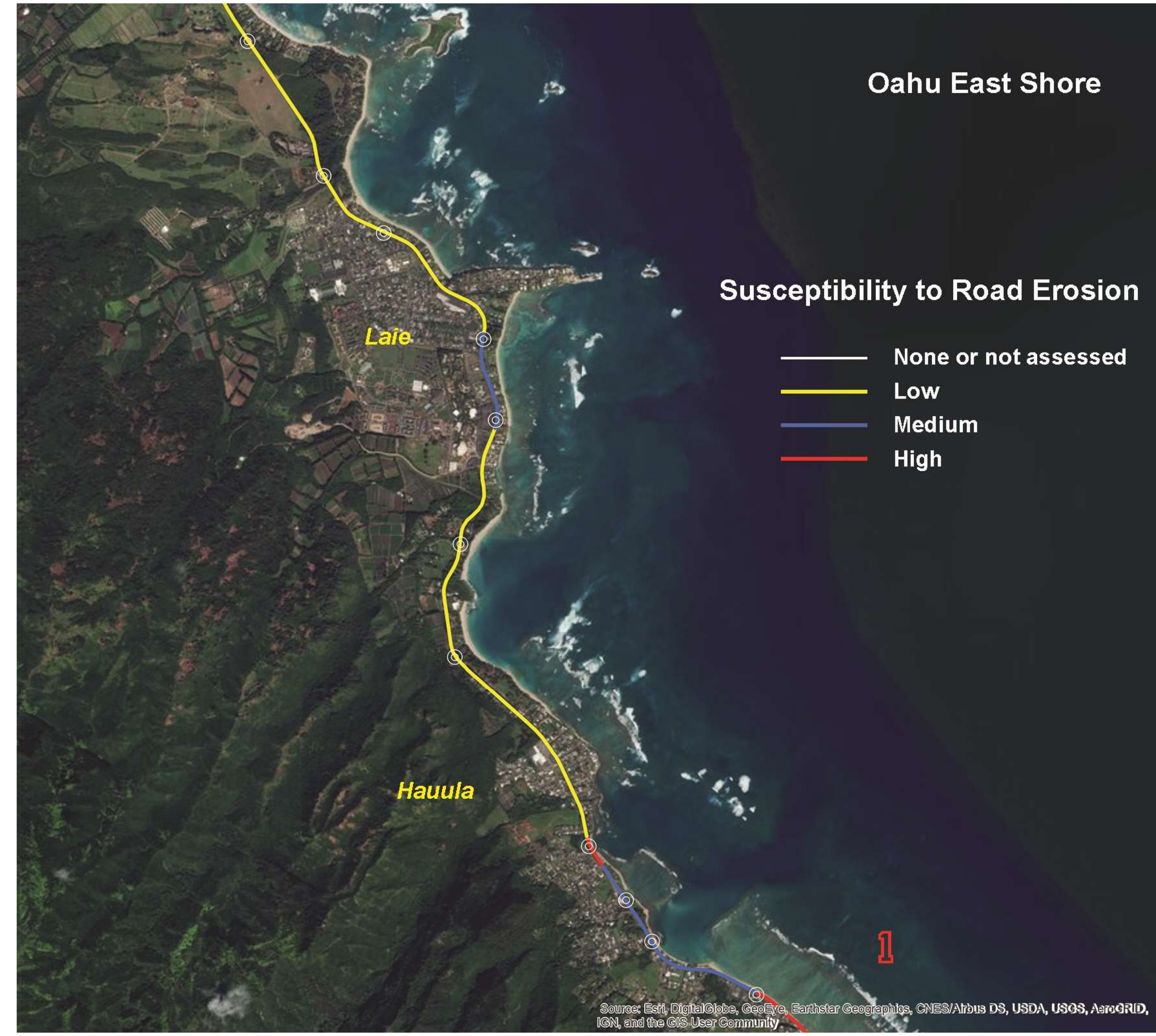


Figure 1.32. Segmentation Map: Hauula to Laie

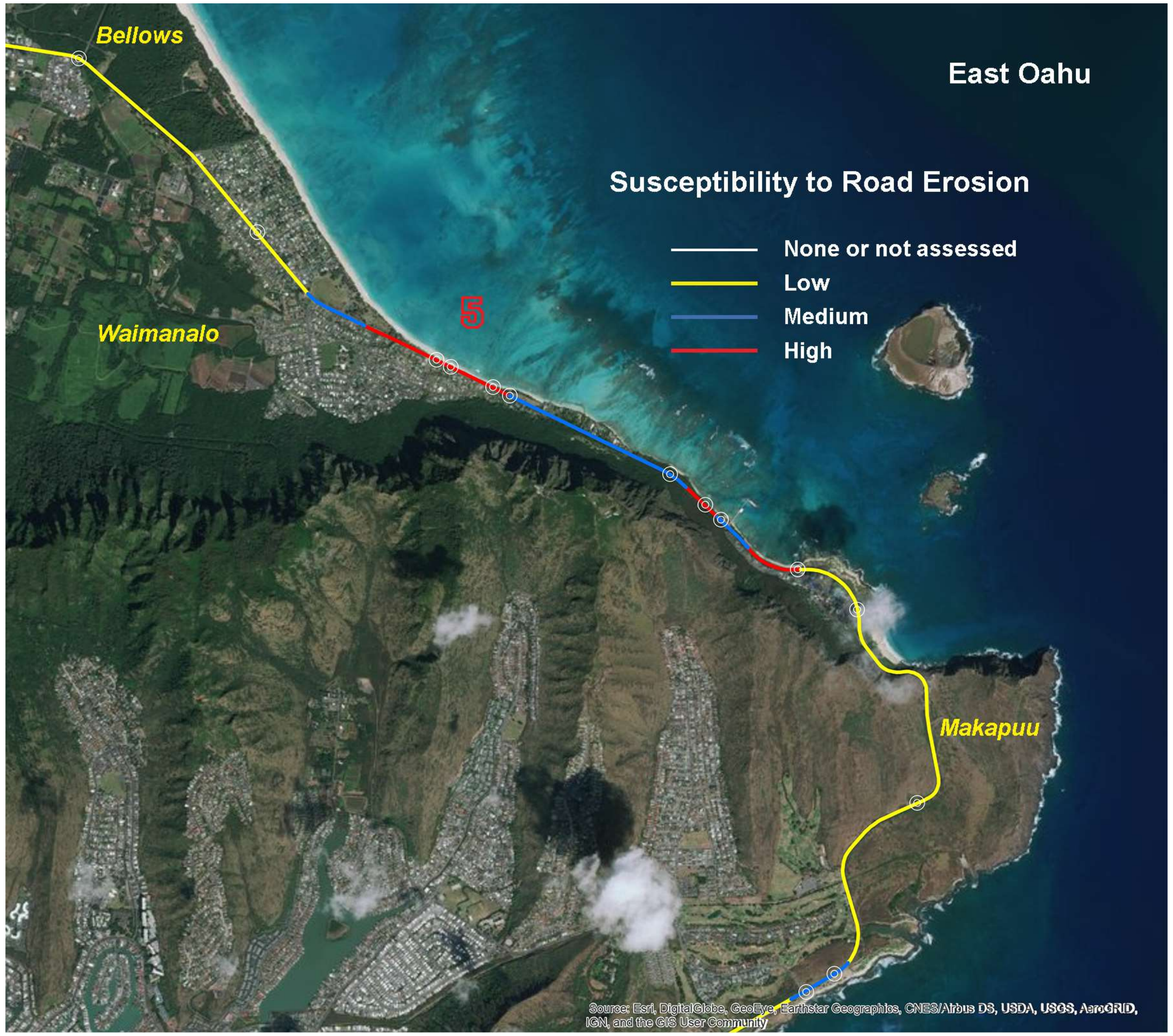


Figure 1.33. Segmentation Map: Waimanalo to Makapuu

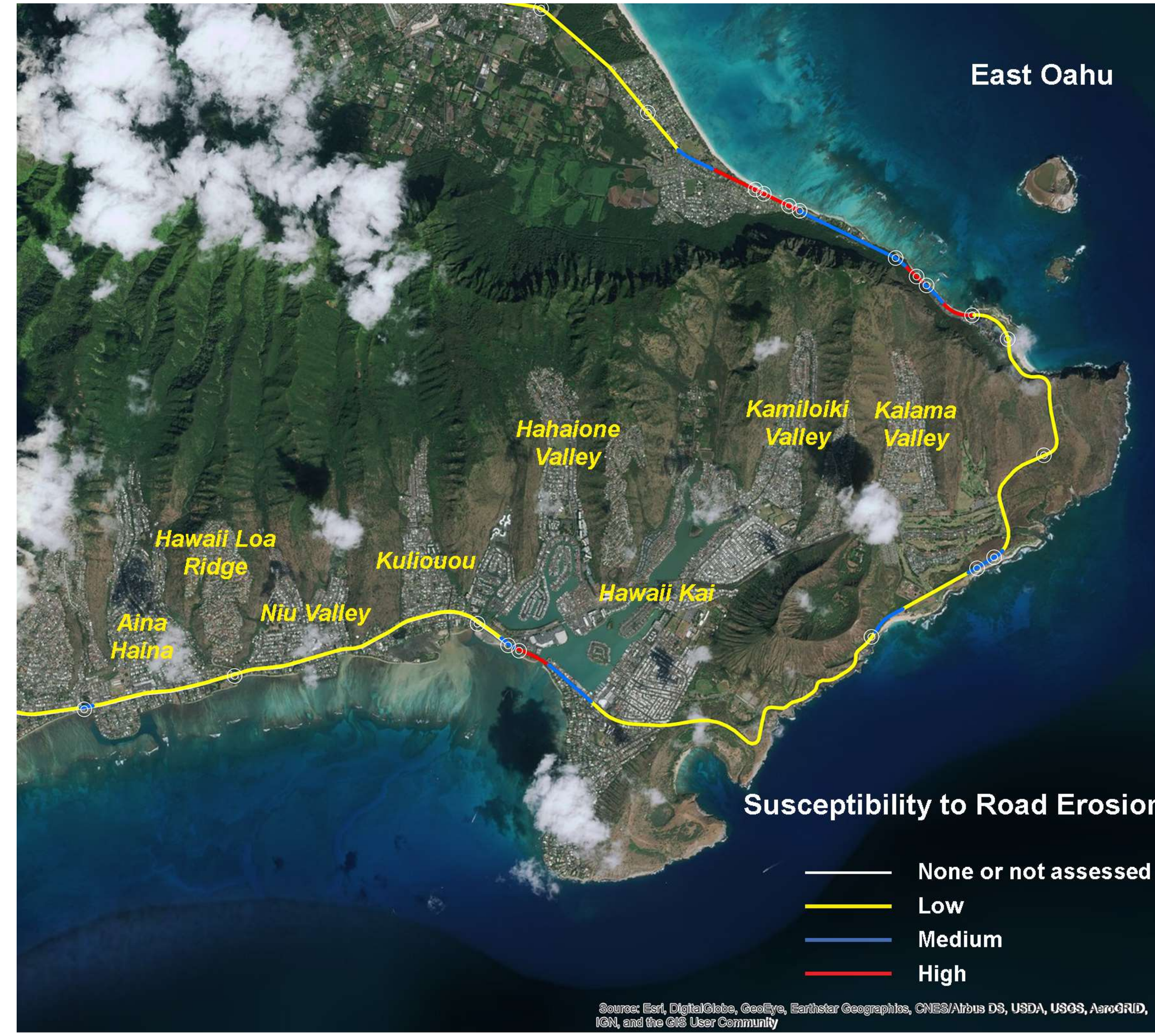


Figure 1.34. Segmentation Map: Makapuu to Kahala

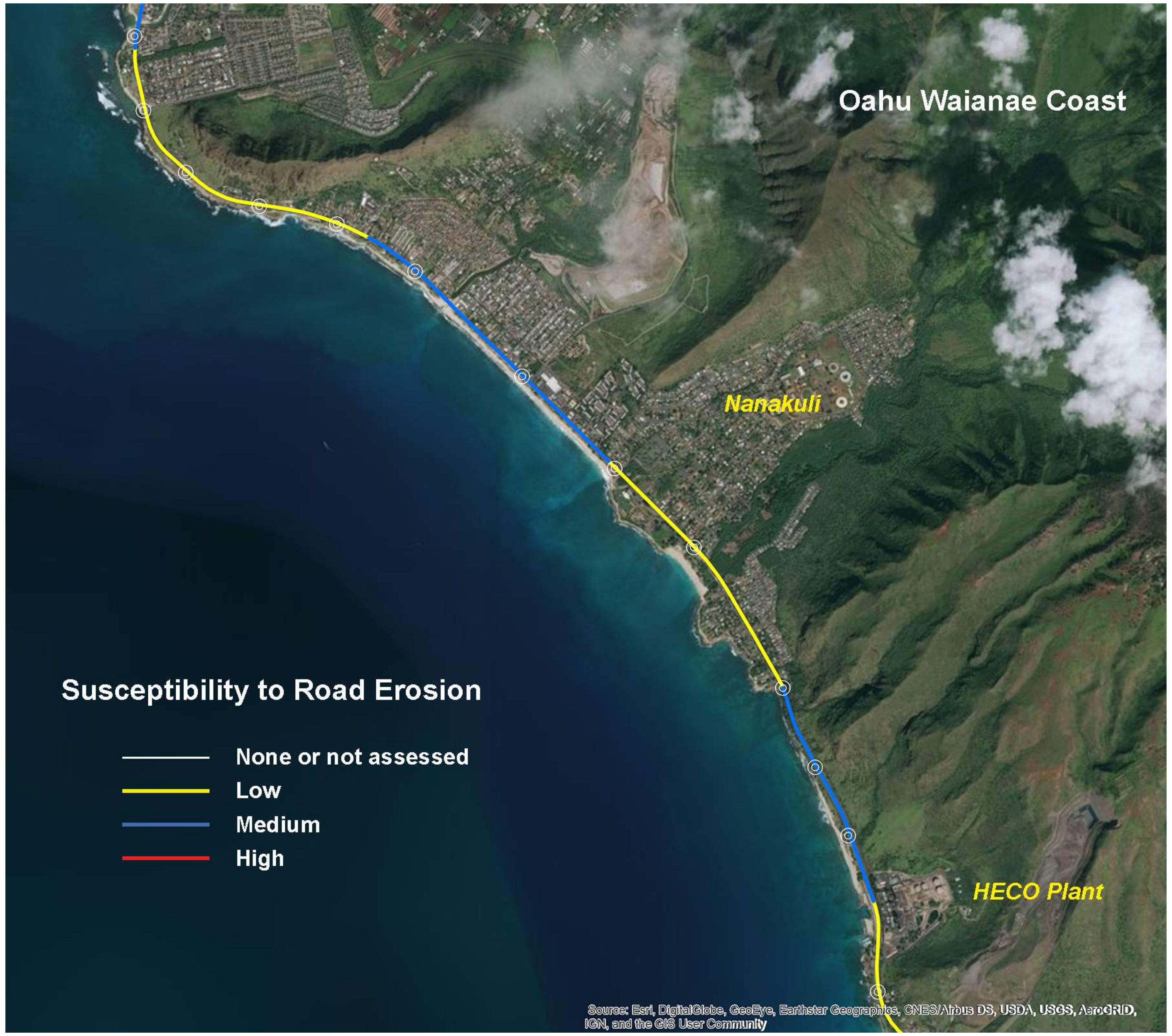


Figure 1.35. Segmentation Map: HECO Plant to Nanakuli

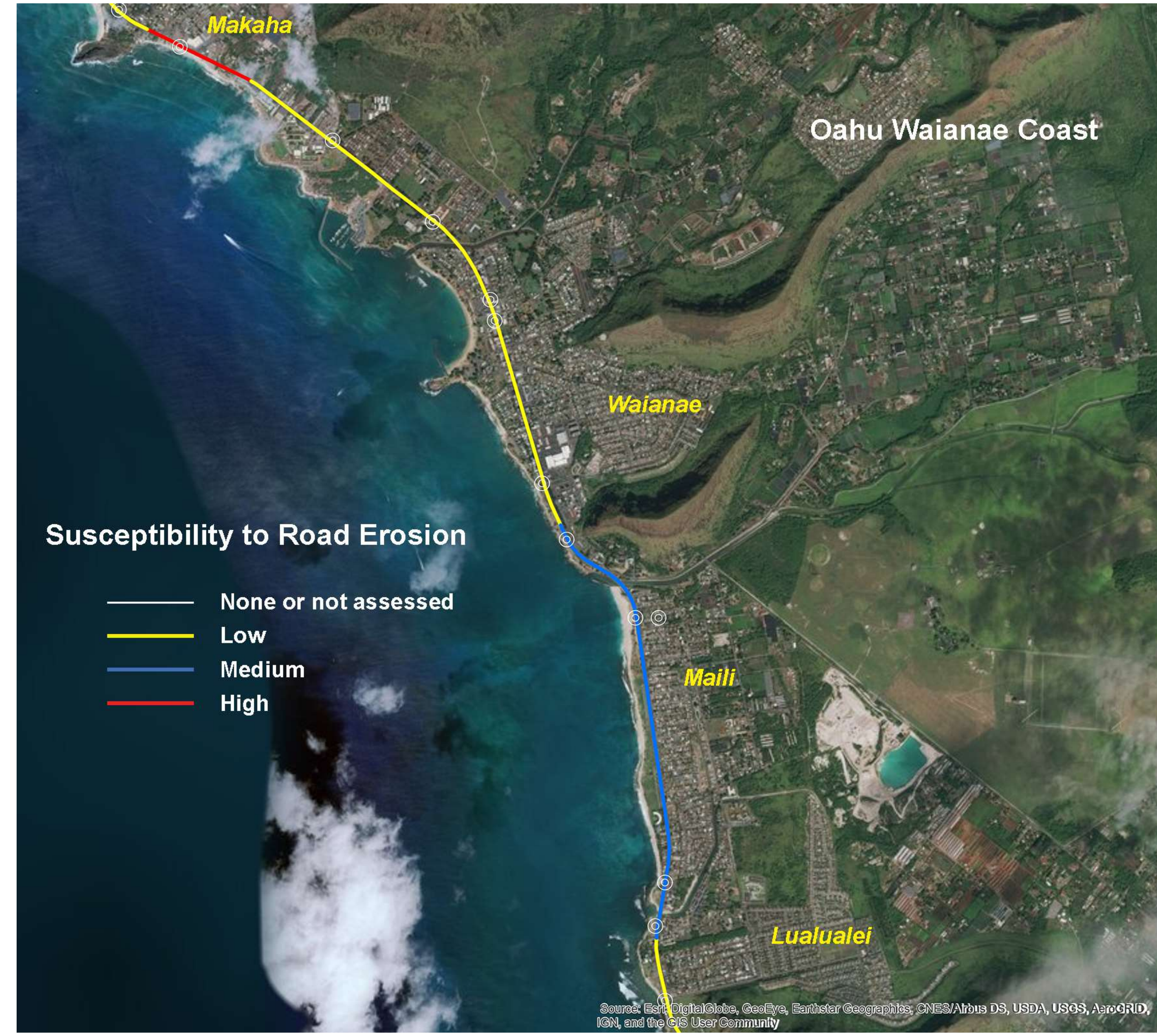


Figure 1.36. Segmentation Map: Lualualei to Makaha

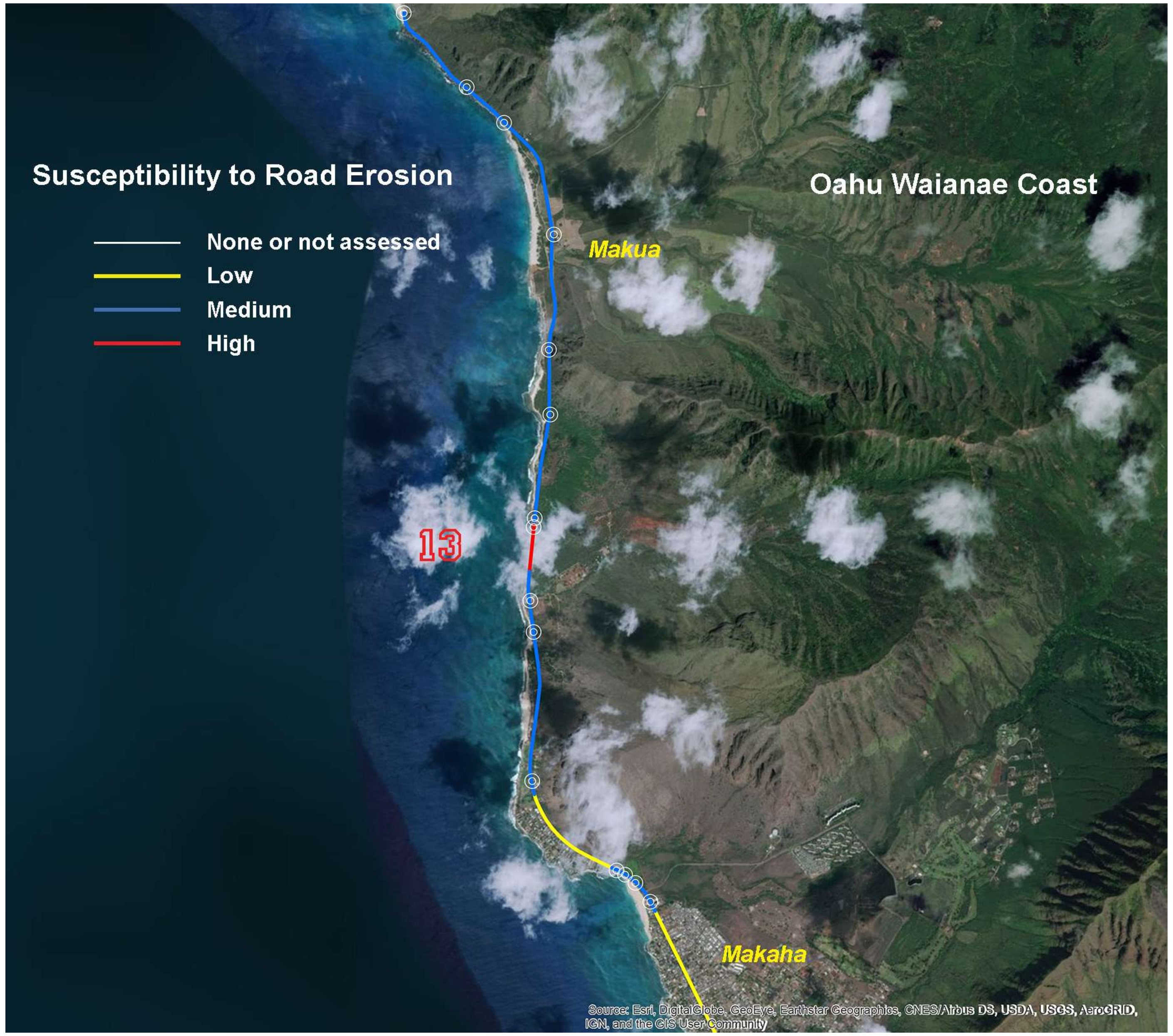


Figure 1.37. Segmentation Map: Makaha to Makua

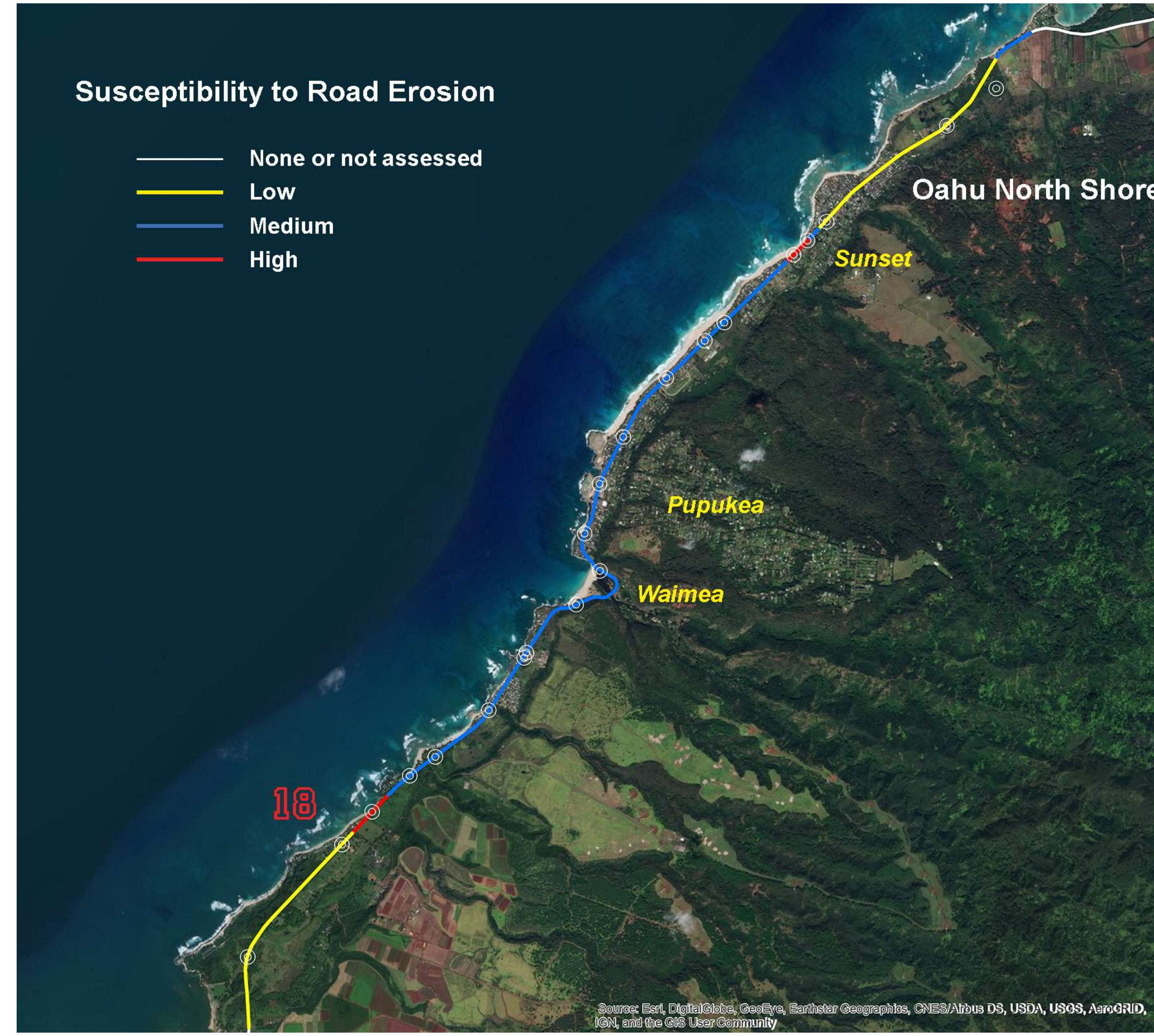


Figure 1.38. Segmentation Map: Oahu North Shore

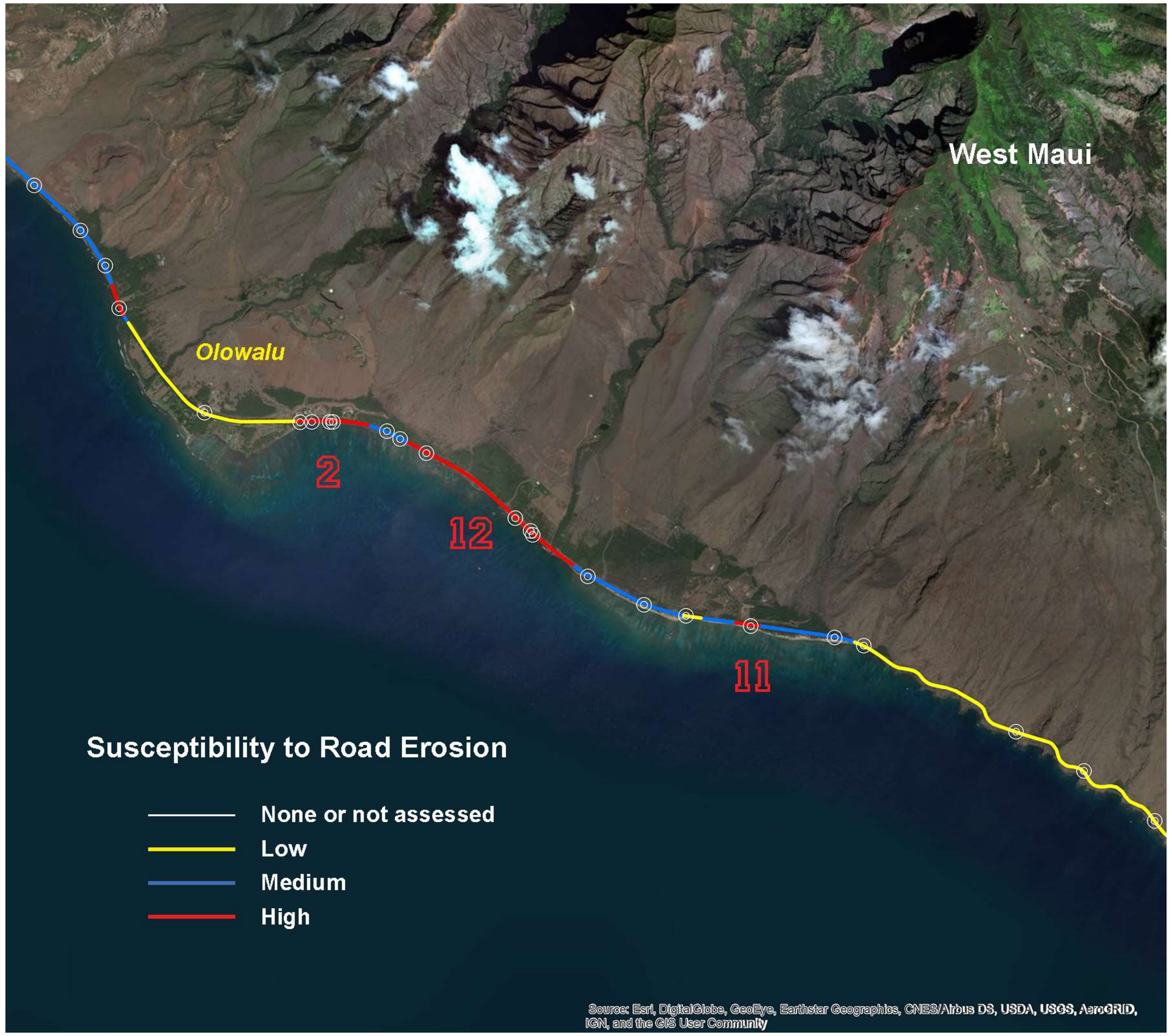


Figure 1.39. Segmentation Map: Maalaea to Olowalu

Figure 1.40. Segmentation Map: Olowalu to Lahaina

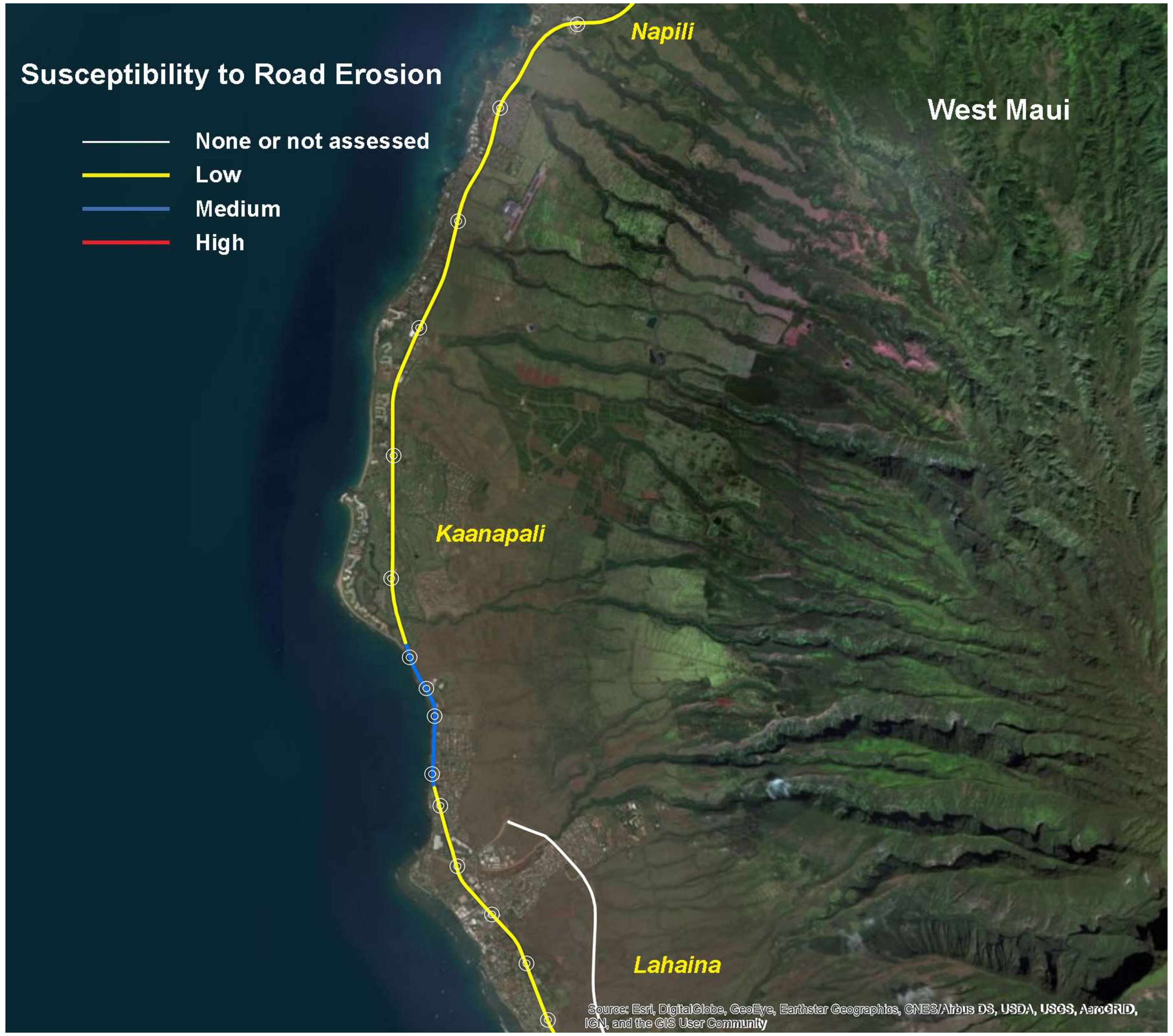


Figure 1.41. Segmentation Map: Lahaina to Napili

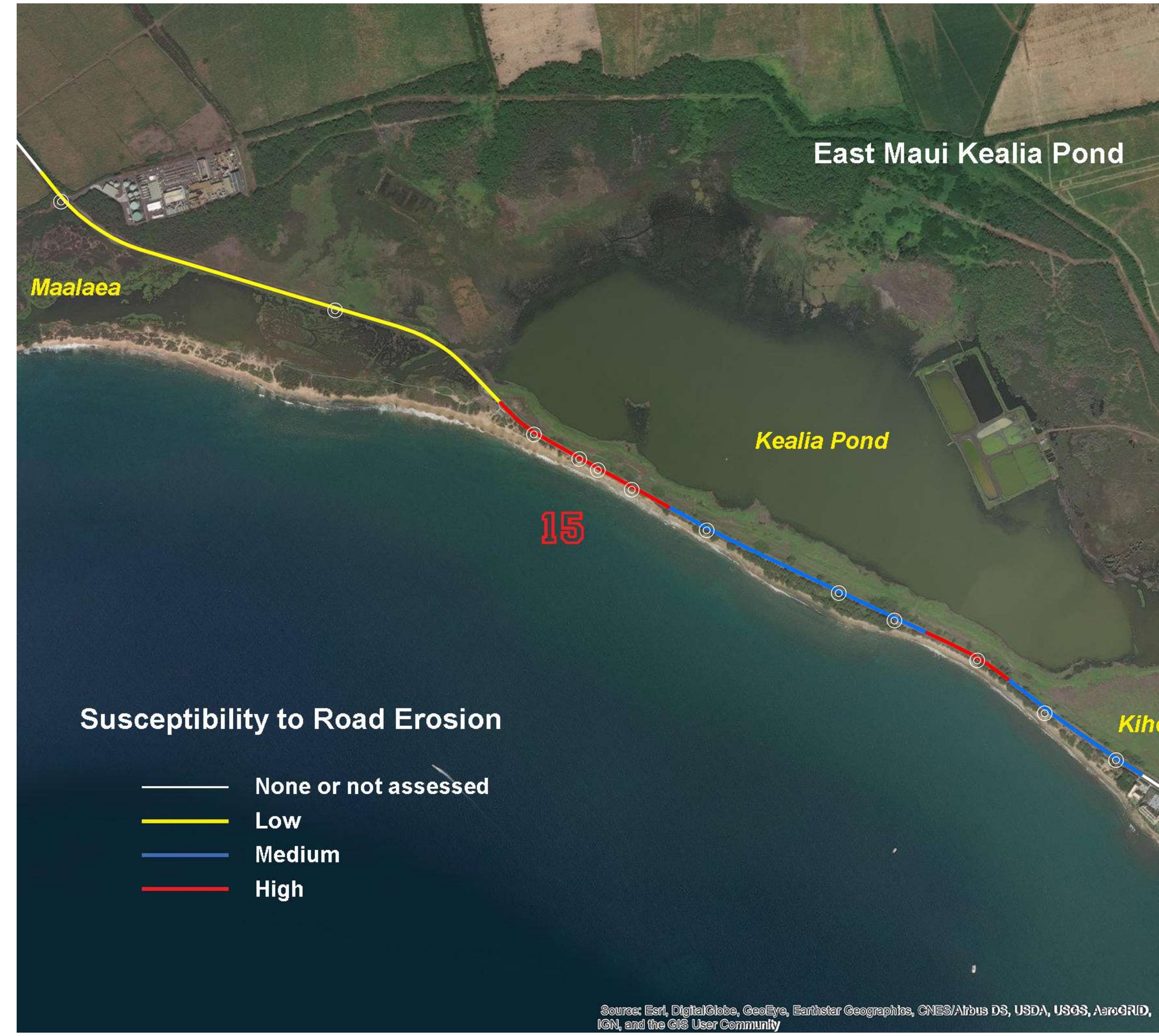


Figure 1.42. Segmentation Map: Maalaea to Kihei

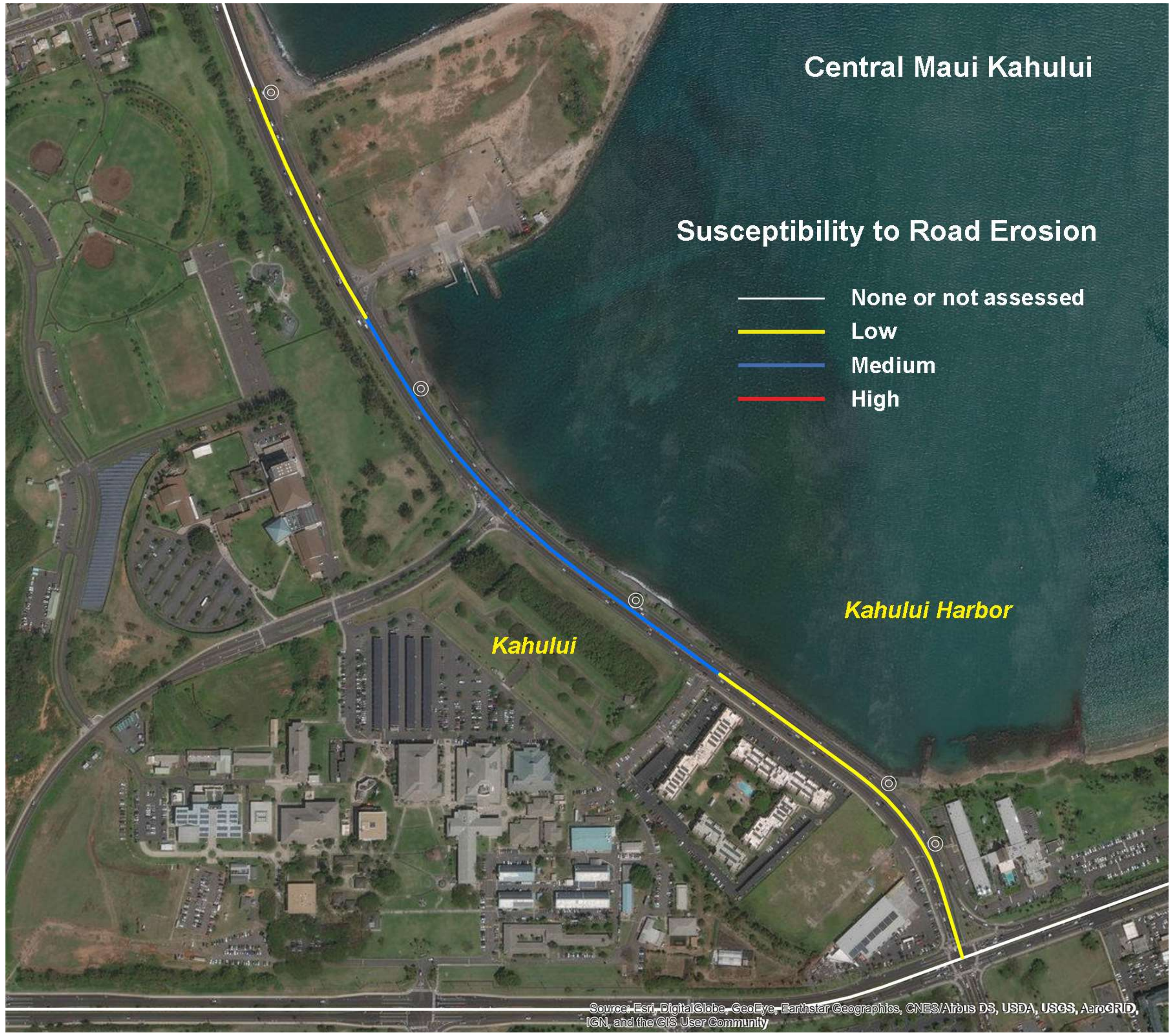


Figure 1.43. Segmentation Map: Kahului Harbor

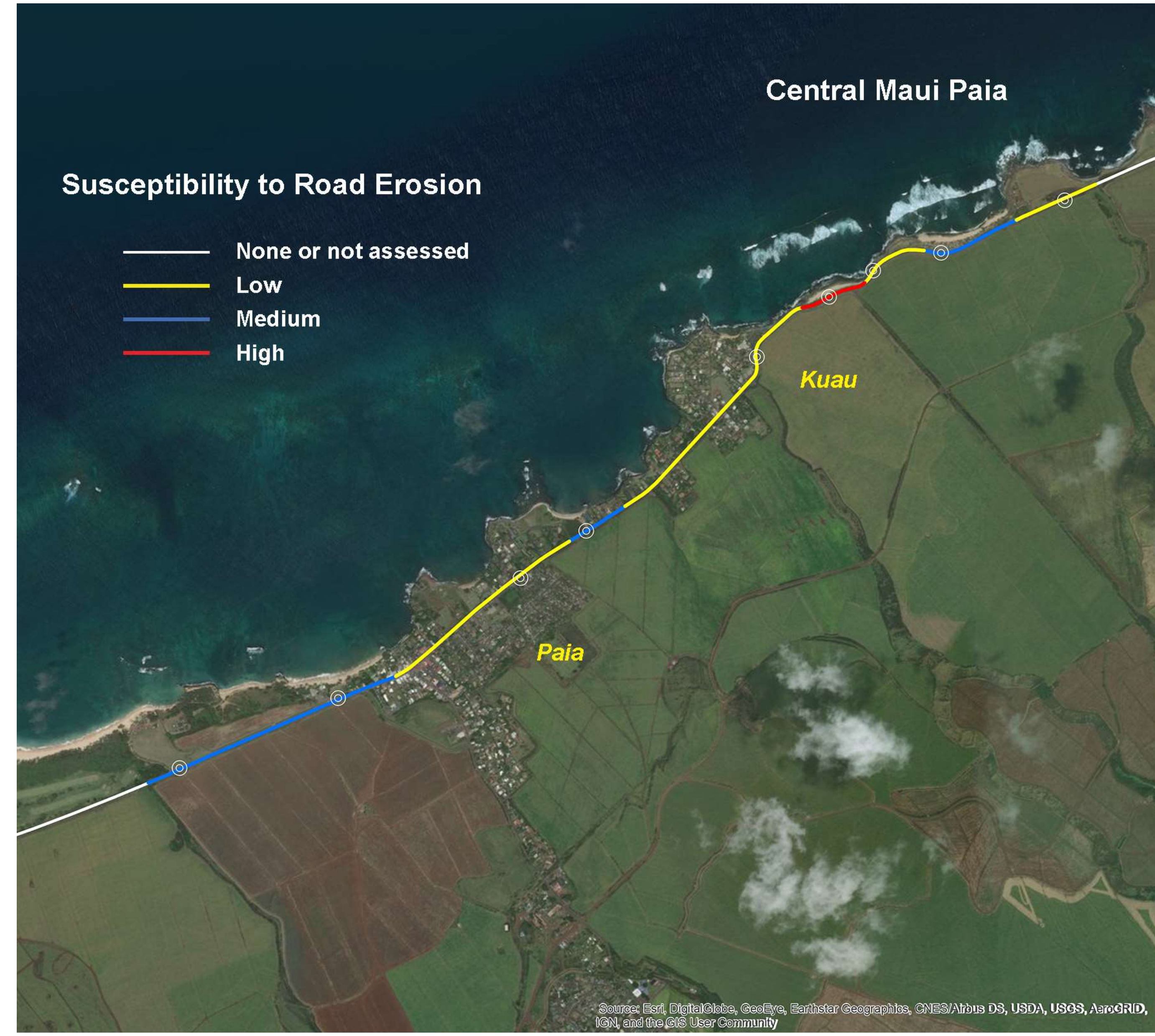


Figure 1.44. Segmentation Map: Paia to Kuau

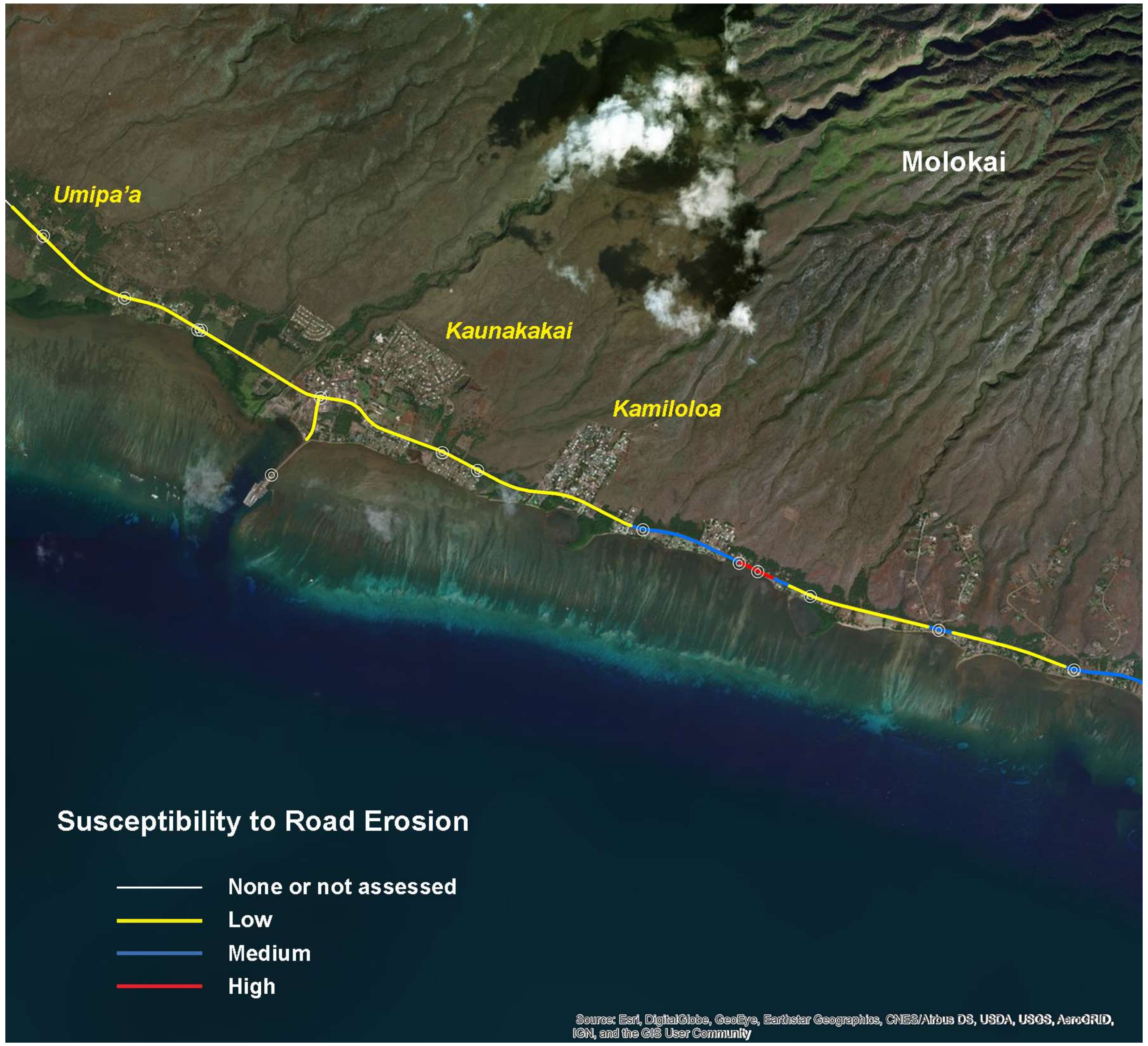


Figure 1.45. Segmentation Map: Kaunakakai area

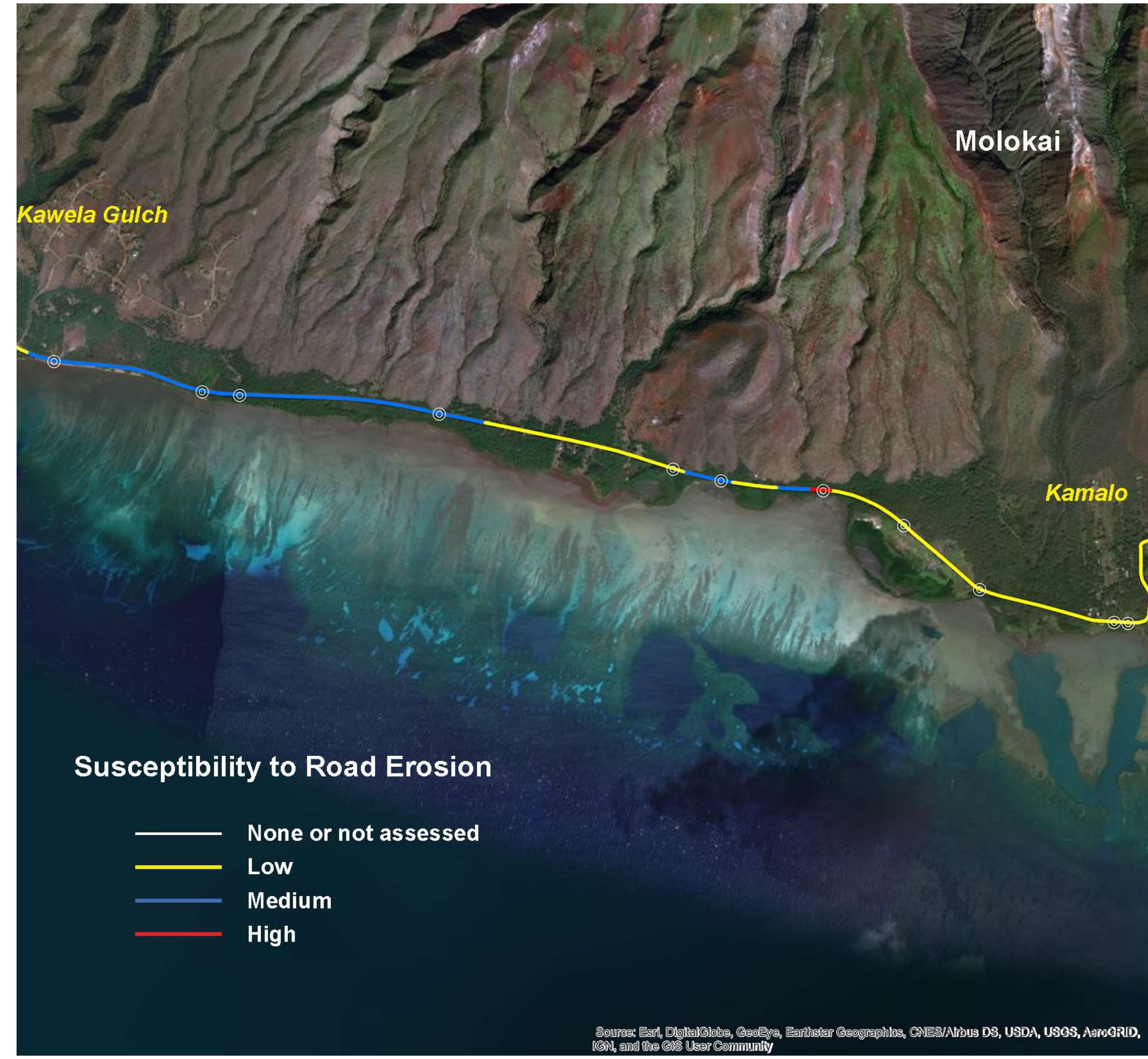


Figure 1.46. Segmentation Map: Kawela Gulch to Kamalo

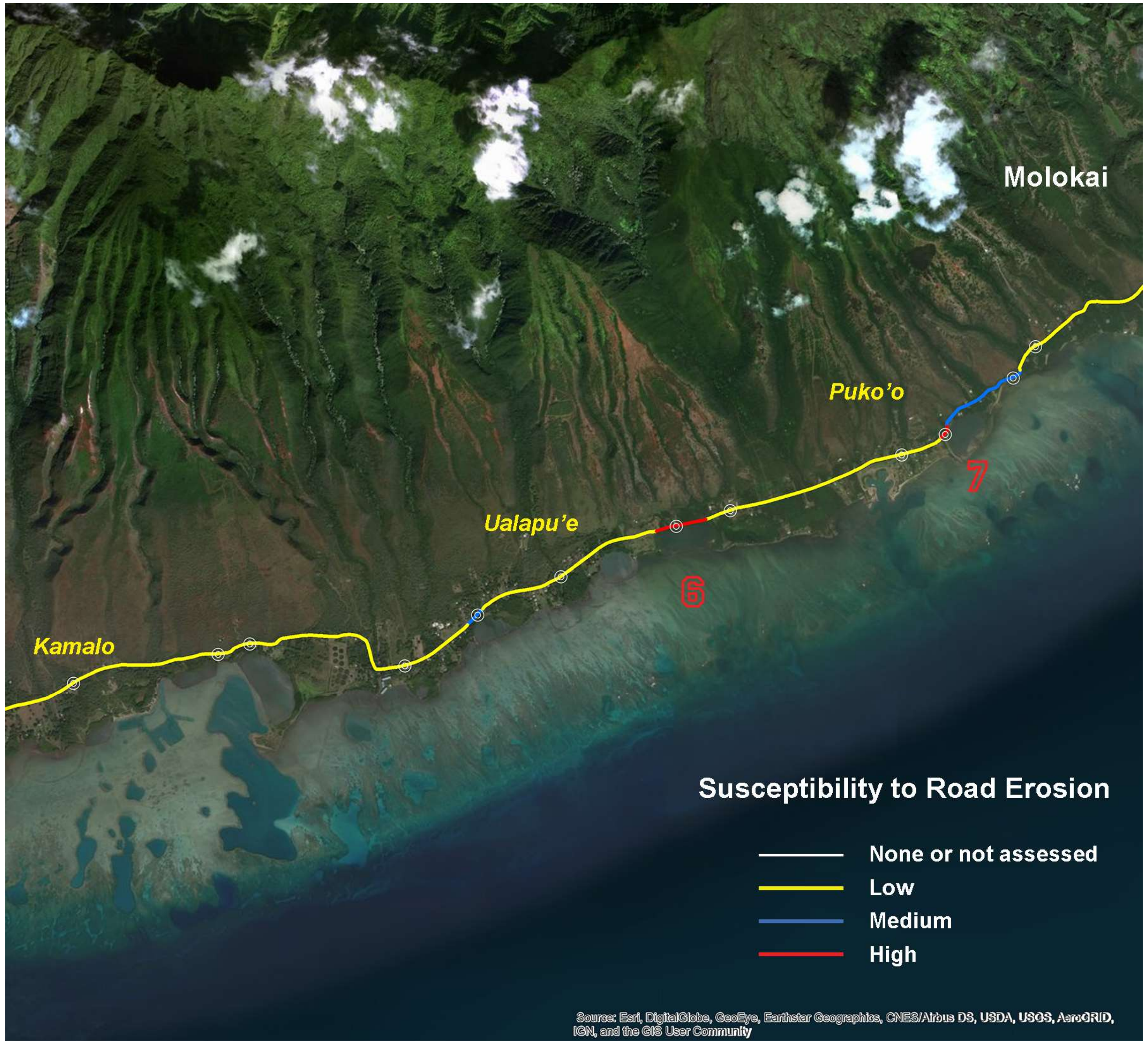


Figure 1.47. Segmentation Map: Kamalo to Puko'o

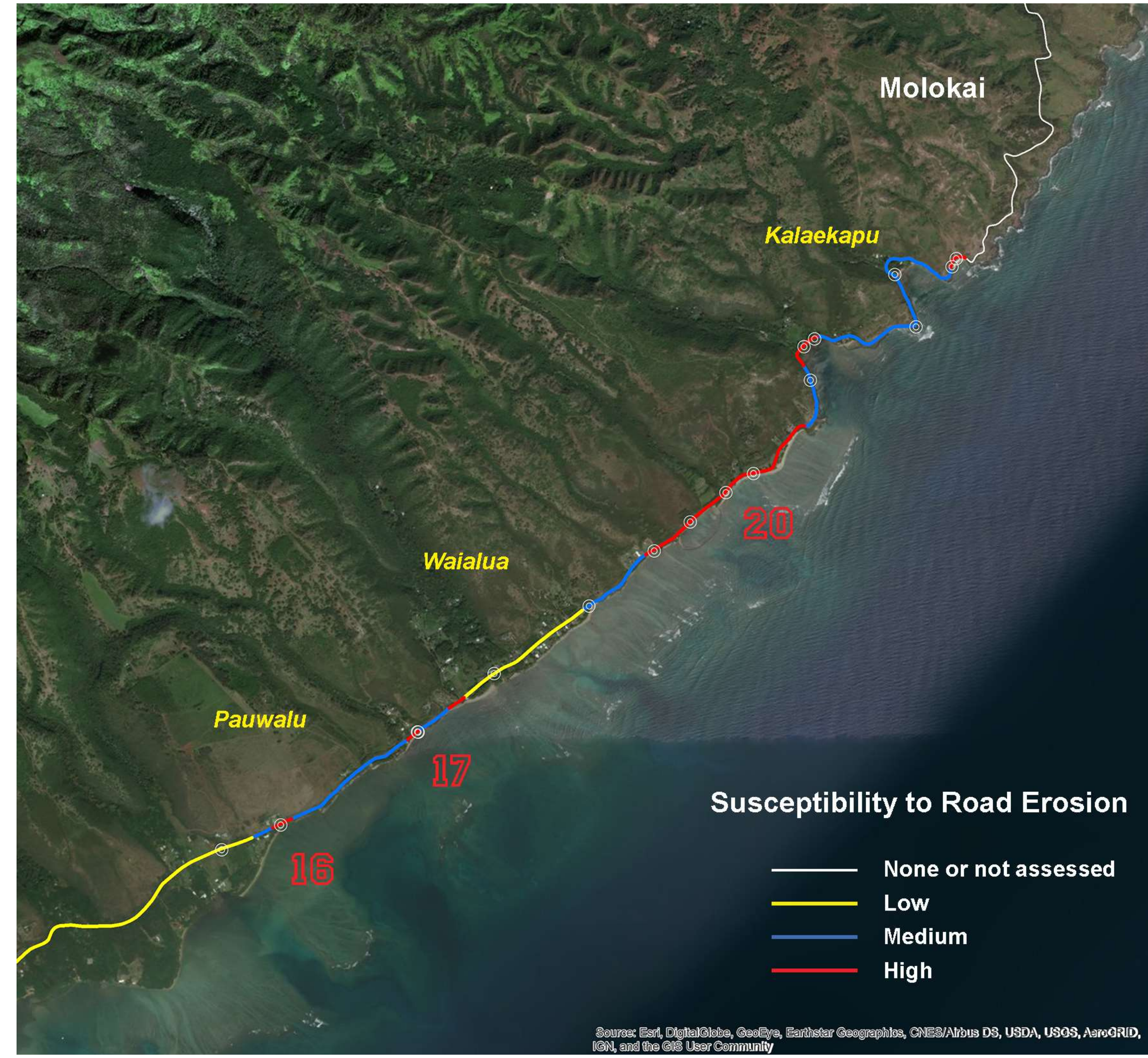


Figure 1.48. Segmentation Map: Pauwalu to Kalaekapu

Figure 1.49. Segmentation Map: Waimea to Kokole Point

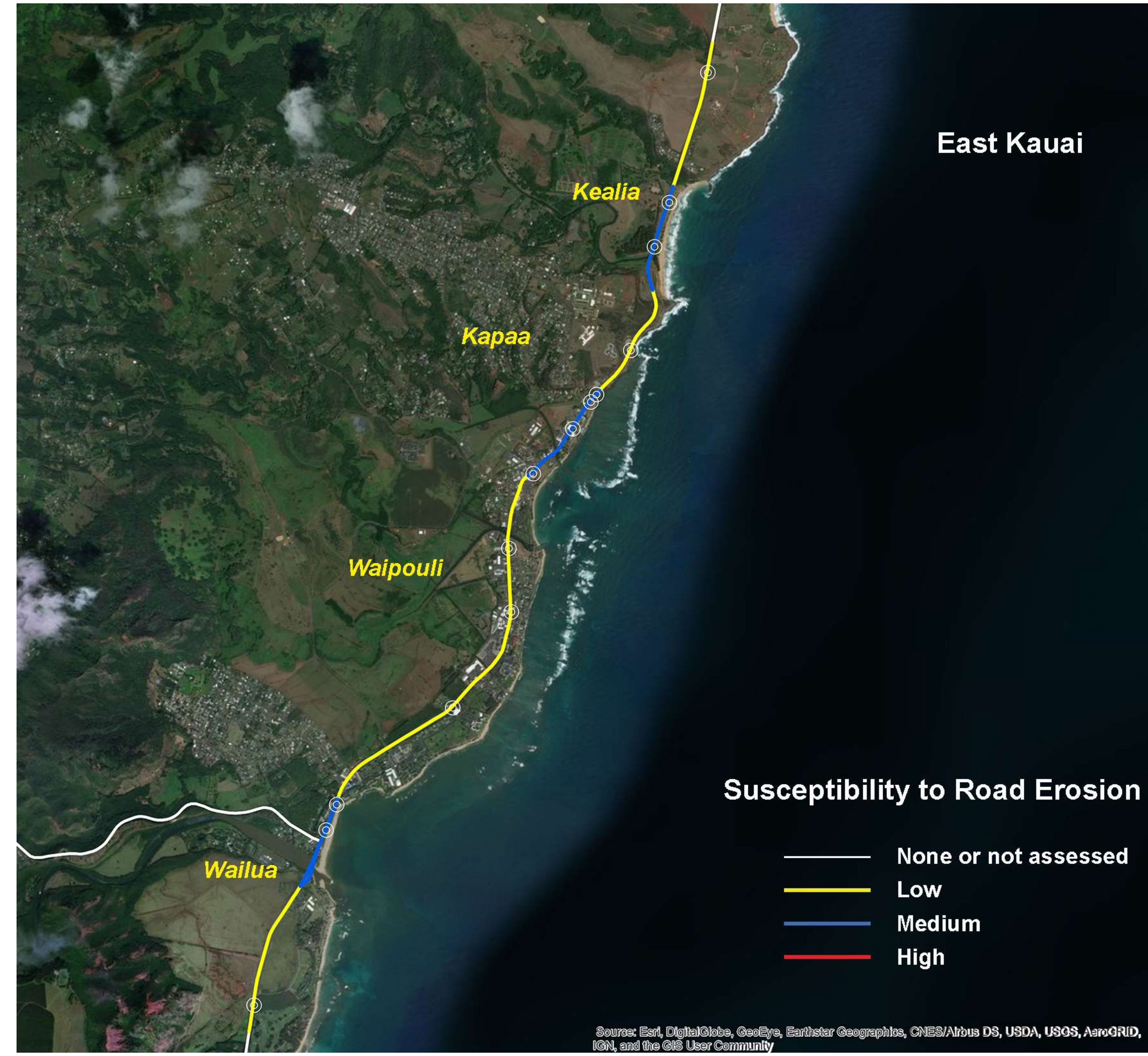


Figure 1.50. Segmentation Map: Wailua to Kealia

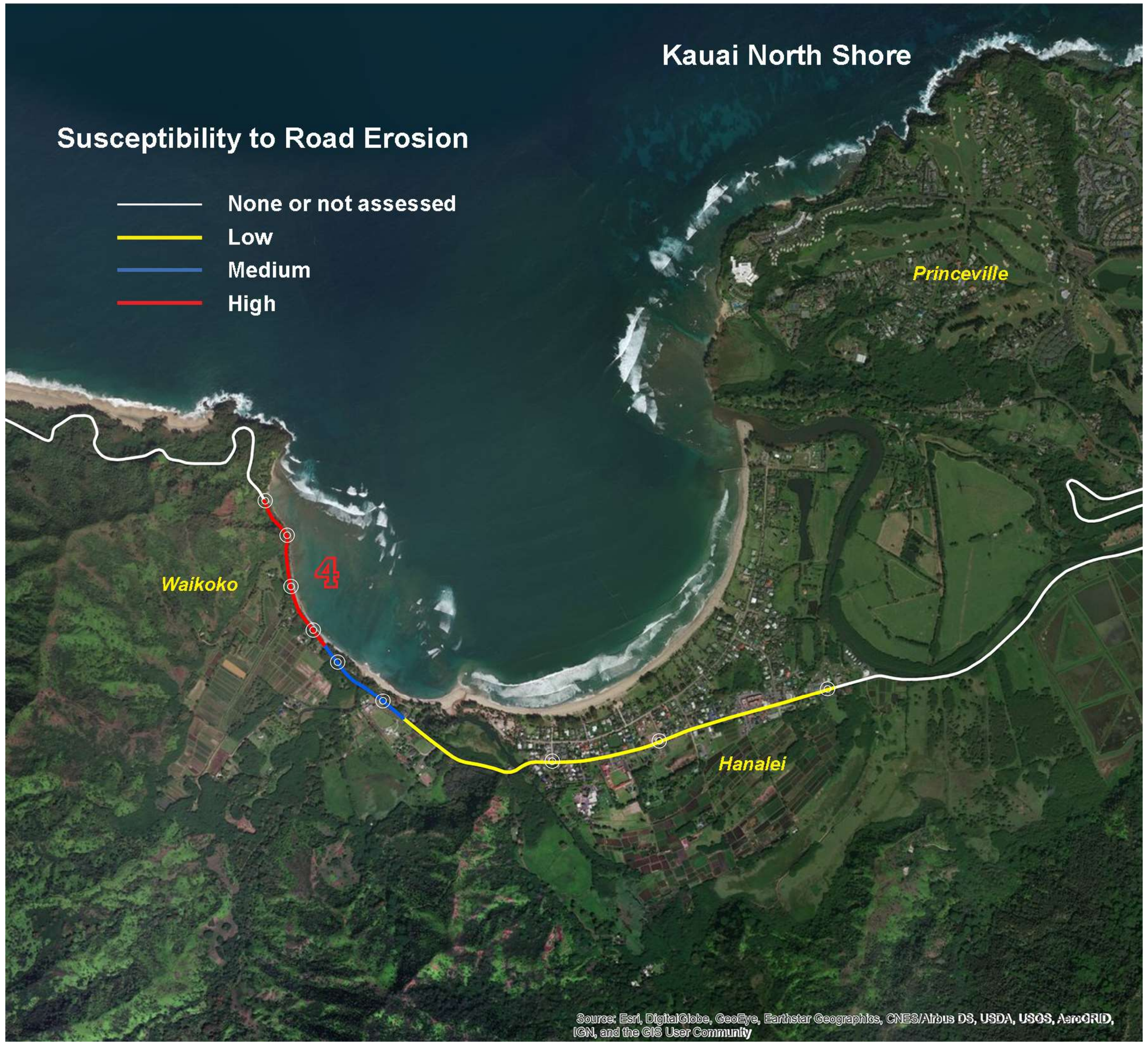


Figure 1.51. Segmentation Map: Hanalei to Waikoko

Figure 1.52. Segmentation Map: Hilo Bay area

Chapter 2 – Traffic-Prioritized Road Segment Significance and Criticality Identification

2.1. Introduction

When road systems are damaged in ocean hazards such as waves, tides, storms surges and coastal erosion, the ensuring losses are substantial and disproportionately large. Collapse of a single major road, for example, can disrupt traffic flow over a broad region and impede emergency evacuation, response, economic recovery, and freight movement. In light of the different significance of road segments, a traffic-related priority index is constructed involving a range of traffic demand patterns, roadway topological characteristics, and socioeconomic factors. The proposed traffic-related priority index can be easily added to the CRESI as a new variable. Of course, the exponent parameter in equation (7) (Chapter 1) shall be updated accordingly.

Basically, road segments with more substitutability and low attraction is associated with lower priority. In summary, following characteristics are considered:

1. Annual Average Daily Traffic (AADT)
2. Directional peak traffic volume
3. Directional non-peak traffic volume
4. Traffic composition
5. Network redundancy
6. Connectivity
7. Accessibility
8. Capacity
9. Reliability
10. Impacted population groups
11. Trip generation
12. Function and social impact

The first four variables represent traffic demand dynamics. The next five represent roadway network topology structure, while the last three variables represent land use information. A set of criteria for each variable is pre-specified, as shown in Table 2.1. As a consequence, each variable is clustered into a scale of 1 to 3. A scale value of 1 represents condition that reflects a low importance in natural hazard evacuation and a scale value of 3 represents a high importance.

Table 2.1. Criteria and scale for traffic-related variables

Impact Factor		Importance and Criticality		
		Low 1	**Moderate 2**	**High 3**
Traffic Demand Dynamics	**1 AADT**	<7000 vpd	Between 7000 to 18000 vpd	>18000 vpd
	2 Directional peak traffic	<1300 vpdpl	Between 1300 to 1900 vpdpl	>1900 vpdpl
	3 Directional non-peak traffic	<300 vpdpl	Between 300 to 700 vpdpl	>700 vpdpl
	4 Traffic composition	<5% heavy vehicles	5% to 15% heavy vehicles	>15% heavy vehicles
Roadway Network Topology	**5 Network redundancy**	Single roadway segment	Limited alternative detour paths available	Multiple alternative detour path available
	6 Connectivity	No connecting to other roadway segments	Connected a limited number of roadway segments	Connected multiple roadway segments
	7 Accessibility	No accessible through other roadways	Accessible through a limited number of other roadways	Accessible through other multiple roadway segments
	8 Capacity	<1500 vphpl	1500 to 2000 vphpl	>2000 vphpl
	9 Reliability	Unreliable roadway	Reliable roadways	Highly reliable roadway
Land Use	**10 Impacted population groups**	Small community (<5000)	Median community (5000 to 20000)	Large community (>20000)
	11 Trip generation	<500 daily trips	500 to 2000 daily trips	>2000 daily trips
	12 Function and social impact	Recreational activities	Regular activities	Emergency responses

2.2. Traffic Related Characteristics Collection

Traffic related priority index can be integrated to the CRESI index for road erosion susceptibility evaluation or used to assess the significance and criticality of each roadway segment in the transportation network in Hawaii. The associated characteristics are collected both in the fields and using Google Earth software, as well as historical data.

2.2.1. Island-wide Data Collection and Data Characteristics Analysis

Our current study focused the state roads in Oahu, HI. As stated in Chapter 1, sections of state roads that are far inland do not need to be assessed. Being consistent with the data collection points for CRESI, state roads, that are susceptible to the effects of ocean hazards, 84 homogeneous road segments are divided in the state rout network in Oahu. The homogeneous road segments expressed herein are briefly identified according to roadway geometric design characteristics including number of lanes, median types, shoulder types, intersection-or-not, and horizontal and vertical curve designs. The length of the road segments considered in this study varies from 0.15 mile to 1.55 mile with an average length of 0.706 mile. Each of these segments was geo-referenced in the field via the median line and was located on Google Earth maps. While the characteristics dataset is not included in this report due to its volume, it is accessible by request.

2.2.1.1. Traffic demand dynamics

Traffic demand dynamics represent the traffic volumes directly impacted by ocean hazards. For each road segments, the historical AADT and traffic composition data was obtained from Hawaii Department of Transportation highway division. And the most recent traffic volume data was collected in the field.

Common traffic count techniques include manual counts, pneumatic road tubes, piezoelectric sensors, magnetic loops, microwave radar, and video image detections. In this study, the pneumatic road tube technique was applied for data collection. Rubber tubes are placed across the road lanes to detect vehicles from pressure changes that are produced when a vehicle passes over the tube. The pulse of air that is created is recorded and processed by a counter located on the side of the road. The pneumatic tubes are benefit for quick installment, low power usage, and low cost. Please refer to Leduc (2008) for a comprehensive comparison of recent traffic count techniques. Figure 2.1 shows a typical data collection point using pneumatic road tubes.

For each road segment, one data collection point is carefully selected considering both assembly and security. That's to say, the selected point is suitable for installing and reinforcing the tubes, and there is fixed object to which the traffic count recorder can be locked. Two-week traffic counts were recorded for each segment before we retrieved the recorders. Raw traffic counts were output via the corresponding software for the traffic count recorder and the records were then aggregated per hour for each direction. In this case, average peak and non-peak traffic volume per lane were obtained.

Figure 2.1. Typical traffic data collection using pneumatic road tubes collection, Oahu East Shore

2.2.1.2. Roadway Network Topology

Network topology information, including network redundancy, connectivity, accessibility, capacity, reliability, alternative travel mode, indicate the importance of each specific roadway segment in the associated sub-network.

Network redundancy refers to the number of alternative detour paths. As illustrated in Figure 2.2, multiple detour paths can be observed for target road segment (black solid line). In order to avoid irrational detour behavior, we define that a detour path shall no longer than twice the origin path, i.e., a maximum distance ratio of detour path and origin path is set to 2. The connectivity and accessibility characteristics for each segment are quantified using the number of out-going and coming-in links to arbitrary detour paths. As the sample segment shown in Figure 2.3, the connectivity is represented using the number of out-going links, i.e., red dash lines, and the accessibility is represented by the coming-in links, i.e., blue dash lines.

The capacity of each road segment is calculated following Highway capacity manual (2010). Generally, deductions, considering heavy vehicle weights, lane width, and right side lateral clearance, are applied to free flow speed based link capacity. Detailed calculation steps are specified in Highway Capacity Manual (2010). Required information is obtained from Google Earth Software and confirmed in the field.

In the present study, road segment reliability refers to the road surface infrastructure condition, i.e., pavement condition index (PCI). More specifically, pavement distress data was required by Hawaii Department of Transportation, and pavement management software PAVER was applied to calculate PCI value for each segment. A PCI value lower than 55 indicates the unreliable road segment, and a PCI value between 55 and 75 indicates the reliable road segment, and a PCI value higher than 75 indicates the highly reliable road segment.

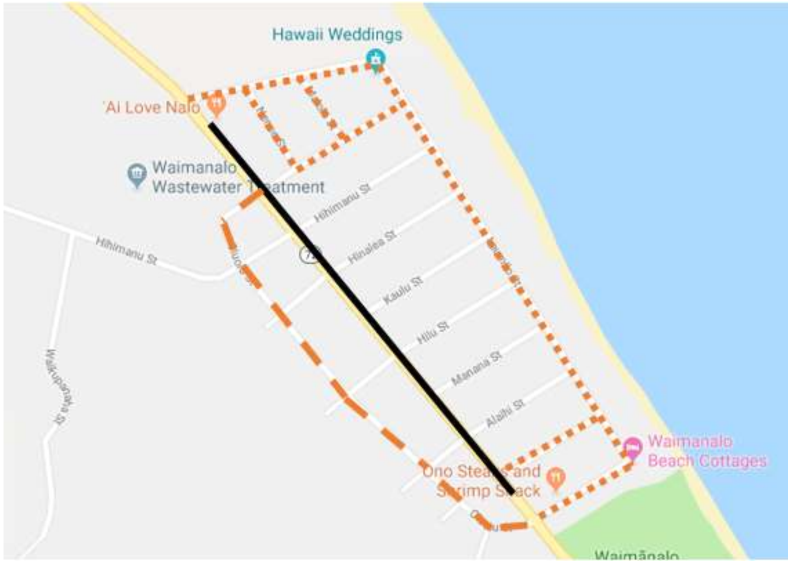


Figure 2.2. Alternative detour paths sample

Figure 2.3. Segment connectivity and accessibility

2.2.1.3. Land use

A number of efforts have been made on the relationship between land use and natural hazards. In this study, the number of residents, commercial tenants, hospitals, police stations, educational agencies, and fire stations were collected through internet. Accordingly, the impacted population community, trip generation, and function and social impact are quantified based on Trip Generation Manual (2018). Although the population size or the trip generation counts might not be exactly estimated, the rough estimations provide enough accuracy to generate a scale value (from 1 to 3) for each road segment.

2.2.2. Multinomial Logit Model Analyze

A multinomial logit (MNL) model was chosen to classify traffic related priority index because it has been shown to fit well in studies in which the target variable is discrete and categorical, which is the case of the traffic related variables. To facilitate the model calibration, a set of 30 road segments which received unanimous identification results from four independent experts were used as model input data. The dependent variables were the scale values for AADT, directional peak traffic volume, directional non-peak traffic volume, traffic composition. network redundancy, connectivity, accessibility, capacity, reliability, impacted population groups, trip generation, function and social impact. The dependent variable is the traffic related priority level, scaled from 1 to 5.

The probability that ith road segment be assigned with a priority level j (P_{ij}) is given as follows.

$$P_{ij} = P\left(U_{ij} > U_{ik}\right), \forall k \neq j, j = 1,2,3,4,5 \tag{1}$$

where U_{ij} is the utility value for ith road segment if it is of the jth priority level, and

$$U_{ij} = \beta_j X_i + \varepsilon_{ij} \tag{2}$$

where X_i is the vector of dependent variables associated with ith road segment; β_j is a vector of coefficients of each dependent variables for jth priority level. Assuming the stochastic error term ε_{ij} is independent and follows Gumbel distribution, the multinomial logit model is given as follows.

$$P_{ij} = \frac{\exp\left(\beta_j X_i\right)}{\sum_j \exp\left(\beta_j X_i\right)} \tag{3}$$

The parameters (β_j) are estimated by maximizing the log of the likelihood function, as shown in Table 2.2. Since we tried to involve as much information as possible from those explanatory variables, variables rejected in significance test were still kept in the model. The estimated coefficients presented the varying weights for different variables in each priority level. Moreover, the elasticity analysis was conducted to evaluate the impacts of variables on the probability of different priority levels. The elasticity of a variable x_{ik} is given as follows (Washington et al., 2010).

$$E_{x_{ik}}^{P_{ij}} = \frac{\partial P_{ij}}{\partial x_{ik}} \frac{x_{ik}}{P_{ij}} \tag{4}$$

where $E_{x_{ik}}^{P_{ij}}$ is the elasticity outcome for ith road segment; x_{ik} is the value of kth variable for ith road segment. The analysis result of average elasticity is presented in Table 2.3.

Table 2.2. Coefficients for Different Traffic Related Priority levels

Impact	Factor	Coefficient				
		1	2	3	4	5
Traffic Demand Dynamics	AADT	0.0768	0.8098	0.8806	0.5999	0.2105
	Directional Peak Traffic	0.5861	0.9205	0.9271	0.8945	0.6465
	Directional Non-peak Traffic	0.5160	0.7606	0.4540	0.6537	0.1816
	Traffic Composition	0.7751	0.8458	0.0448	0.5309	0.6085
Roadway Network Topology Structure	Network Redundancy	0.8830	0.5226	0.2707	0.6687	0.1344
	Connectivity	0.7086	0.7888	0.6309	0.1787	0.1221
	Accessibility	0.5815	0.4096	0.2192	0.0927	0.2608
	Capacity	0.7939	0.4283	0.1983	0.4054	0.2978
	Reliability	0.1556	-0.0529	0.9267	0.5901	0.7443
Land Use	Impacted Population groups	0.4872	0.3292	0.2128	0.4344	0.1780
	Trip Generation	0.2275	0.6503	0.8022	0.9908	0.9425
	Function and Social Impact	0.7366	0.1437	0.8690	0.8721	0.4088

Table 2.3. Elasticity of Variables on Each Traffic Related Priority levels

Impact	Factor	Elasticity				
		1	2	3	4	5
Traffic Demand Dynamics	AADT	1.4519	2.0981	0.8564	1.2870	0.5859
	Directional Peak Traffic	1.8983	1.6402	1.1118	0.8869	0.6591
	Directional Non-peak Traffic	1.0309	0.1788	0.0579	1.0744	1.7290
	Traffic Composition	0.0266	1.4348	2.1352	1.5997	0.1657
Roadway Network Topology Structure	Network Redundancy	-0.6208	-0.0073	-0.0534	-0.1205	-0.9922
	Connectivity	-0.4774	-1.9094	-1.5887	-1.3824	-2.2471
	Accessibility	-2.0315	-0.8550	-1.3938	-1.4360	-1.4235
	Capacity	0.2245	2.0735	0.1597	1.8786	2.1255
	Reliability	1.2945	0.9550	1.6981	1.7186	1.1489
Land Use	Impacted Population groups	2.2481	1.2194	1.2830	1.2611	0.3960
	Trip Generation	2.0739	0.0803	1.3547	0.4720	1.7892
	Function and Social Impact	0.0668	2.0426	1.2041	1.5137	0.2701

2.2.3. Data Collection and Significance Level Computation on One Test Site

The proposed data collection and data analysis effort is illustrated using the roadway section in Oahu as follows. Five roadway segments are used and defined in the CRESI calculation procedure. Figure 2.4 shows these five roadway segments and its relative geo-locations. These five segments are numbered in Figure 2.4 to facilitate the following data collection and analysis. The field data were collected and the specific data collection locations and Scenes are illustrated in Figures 2.5 to 2.9.

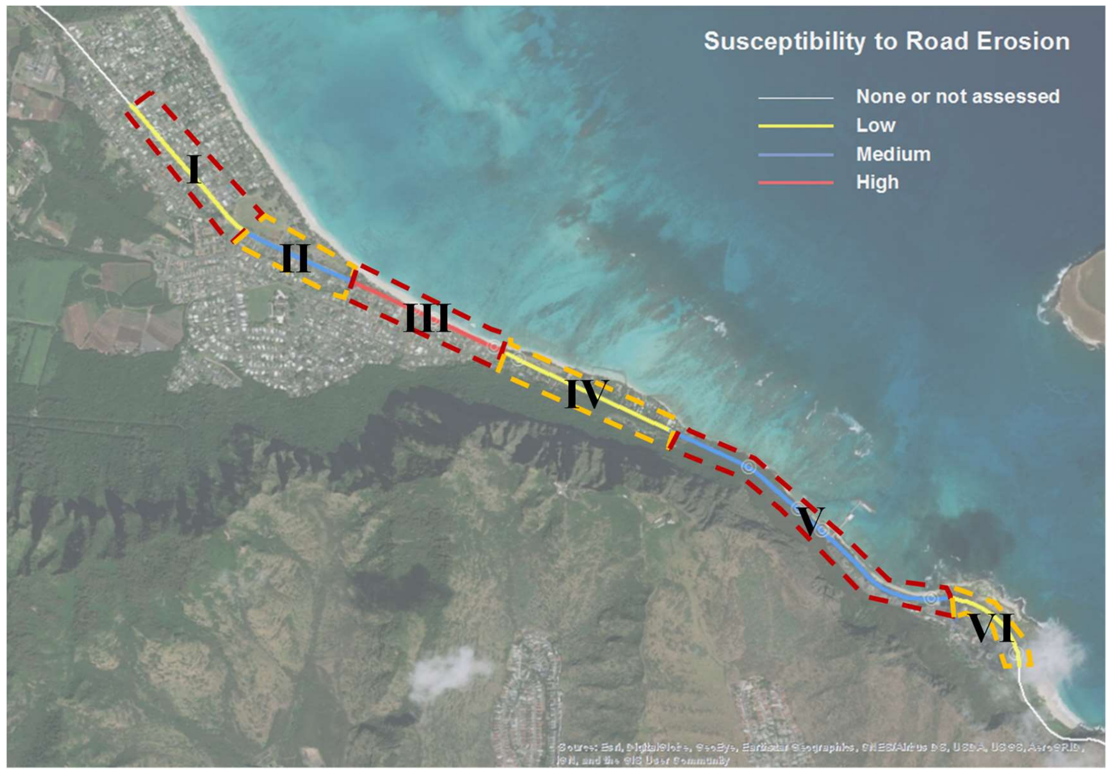


Figure 2.4. Illustrative Roadway Segmentation and Their Locations

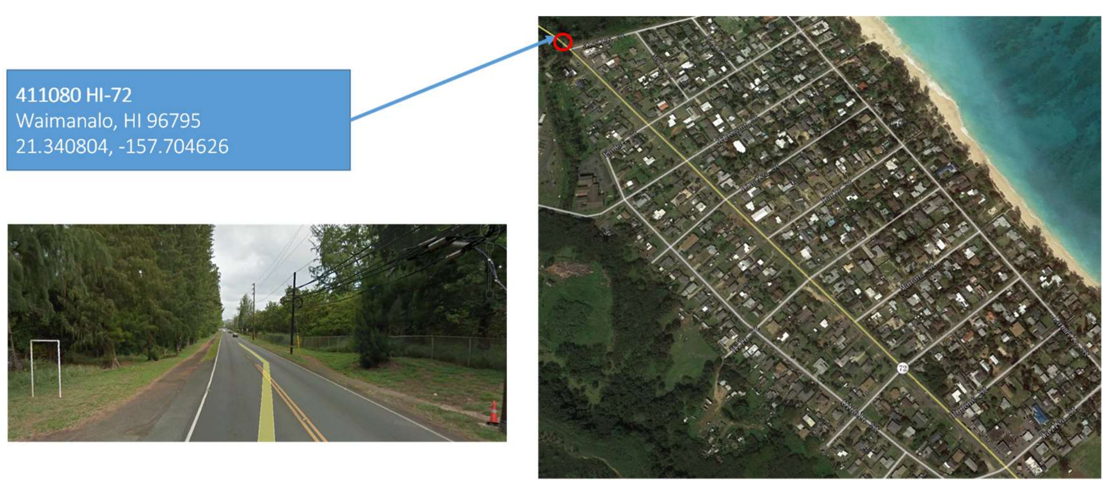


Figure 2.5. Data Collection Location and Its Scene from Google Earth at the First Site

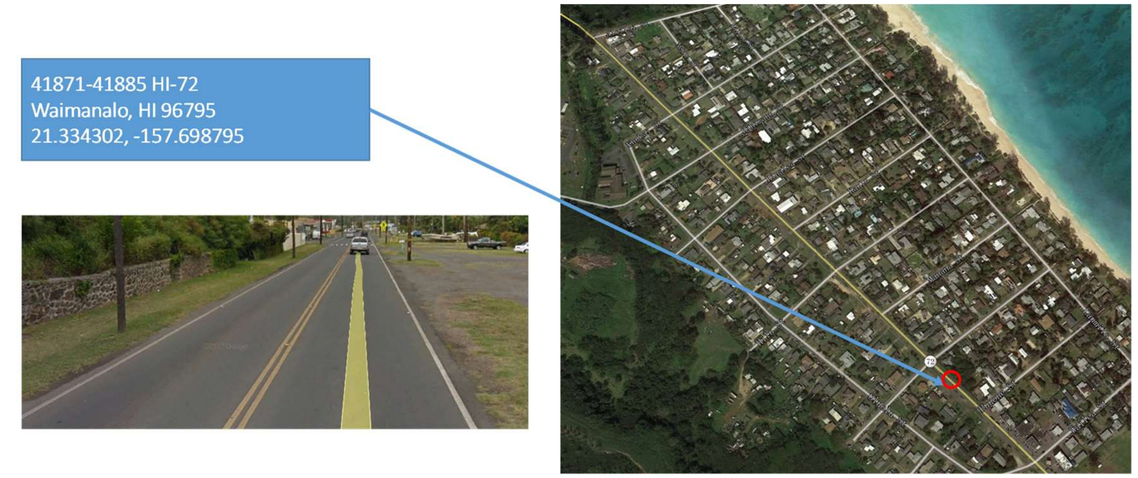


Figure 2.6. Data Collection Location and Its Scene from Google Earth at the Second Site

Figure 2.7. Data Collection Location and Its Scene from Google Earth at the Third Site

Figure 2.8. Data Collection Location and Its Scene from Google Earth at the Fourth Site

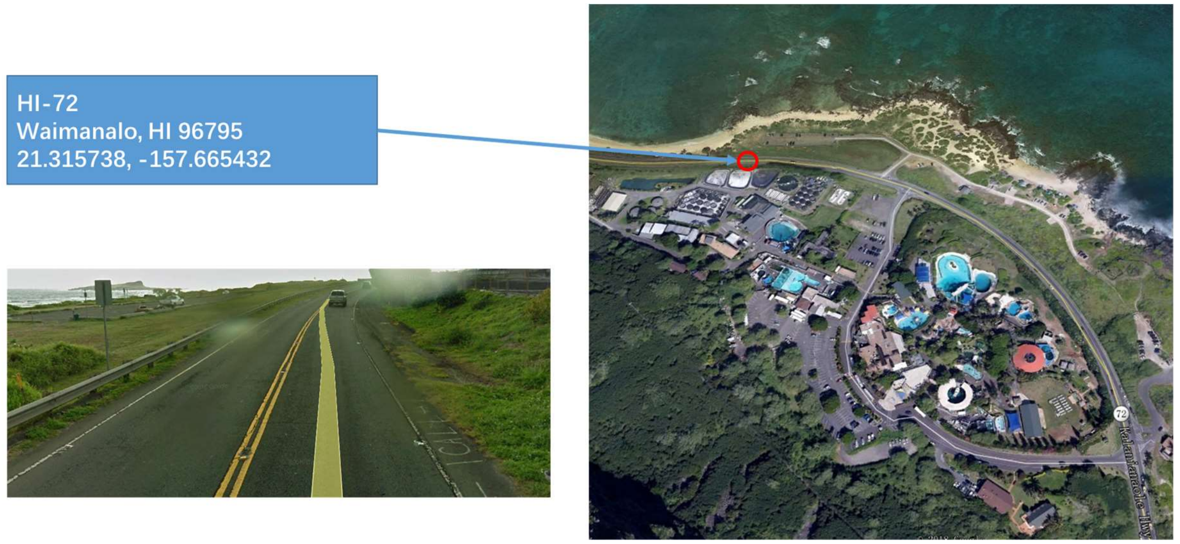


Figure 2.9. Data Collection Location and Its Scene from Google Earth at the Fifth Site

Figure 2.10 shows the sensor installation and deployment in the field. Our project team has worked intensively to collect sufficient data and conducted related surveys to obtain the necessary information to perform comprehensive assessments.

Figure 2.10. Overall Sensor Installation and Field Work

Based on the critical variables quantified in Table 2.1 as well as the data collected in the field and through the surveys, the variables are defined and calculated for Road Segment I illustrated in Figure 2.4. The detailed calculation process is shown in the follow steps in Figure 2.11 a) to i). The similar procedure will be conducted for the other roadway segments illustrated in Figure 2.4. The entire variable quantification is shown in Figure 2.12 for all the six road segments. Based on the values of these variables and the MNL model specified in Section 2.2.2, the level of significance and criticality of each road segment can be calculated. Figures 2.13 and 2.14 show the levels of significance and criticality for the six road segments and their color-coded map.

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic						
	Directional Non-peak Traffic						
	Traffic Composition						
Roadway Network Topology Structure	Network Redundancy						
	Connectivity						
	Accessibility						
	Capacity						
	Reliability						
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Annual Average Daily Traffic: **16,970 veh/day**

Figure 2.11a). Variable Quantification for Illustrative Roadway Segment One - AADT

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic						
	Traffic Composition						
Roadway Network Topology Structure	Network Redundancy						
	Connectivity						
	Accessibility						
	Capacity						
	Reliability						
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Directional Peak Traffic : **840 veh/hr**

Figure 2.11b). Variable Quantification for Illustrative Roadway Segment One - Directional Peak-Hour Traffic

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition						
Roadway Network Topology Structure	Network Redundancy						
	Connectivity						
	Accessibility						
	Capacity						
	Reliability						
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Directional Non-peak Traffic: **172 veh/hr**

Figure 2.11c). Variable Quantification for Illustrative Roadway Segment One - Directional Non-Peak-Hour Traffic

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition	2					
Roadway Network Topology Structure	Network Redundancy						
	Connectivity						
	Accessibility						
	Capacity						
	Reliability						
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Traffic Composition (Bus & Truck): **6.75%**

Figure 2.11d). Variable Quantification for Illustrative Roadway Segment One - Traffic Composition

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition	2					
Roadway Network Topology Structure	Network Redundancy	3					
	Connectivity						
	Accessibility						
	Capacity						
	Reliability						
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Alternative detour route

Figure 2.11e). Variable Quantification for Illustrative Roadway Segment One - Network Redundancy

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition	2					
Roadway Network Topology Structure	Network Redundancy	3					
	Connectivity	3					
	Accessibility	3					
	Capacity						
	Reliability	3					
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Connectivity & Accessibility & Reliability

Multiple Connections & Accesses

Figure 2.11f). Variable Quantification for Illustrative Roadway Segment One - Connectivity, Accessibility, and Reliability

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition	2					
Roadway Network Topology Structure	Network Redundancy	3					
	Connectivity	3					
	Accessibility	3					
	Capacity	1					
	Reliability	3					
	Alternative Travel Model						
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Figure 2.11g). Variable Quantification for Illustrative Roadway Segment One - Capacity

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition	2					
Roadway Network Topology Structure	Network Redundancy	3					
	Connectivity	3					
	Accessibility	3					
	Capacity	1					
	Reliability	3					
	Alternative Travel Mode	3					
Travel Characteristics	Trip Purposes						
	Travel Importance						
Land Use	Impacted Population groups						
	Trip Generation						
	Function and Social Impact						

Figure 2.11h). Variable Quantification for Illustrative Roadway Segment One - Alternative Travel Mode

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2					
	Directional Peak Traffic	1					
	Directional Non-peak Traffic	1					
	Traffic Composition	2					
Roadway Network Topology Structure	Network Redundancy	3					
	Connectivity	3					
	Accessibility	3					
	Capacity	1					
	Reliability	3					
	Alternative Travel Model	3					
Travel Characteristics	Trip Purposes	3					
	Travel Importance	1					
Land Use	Impacted Population groups	1					
	Trip Generation	3					
	Function and Social Impact	2					

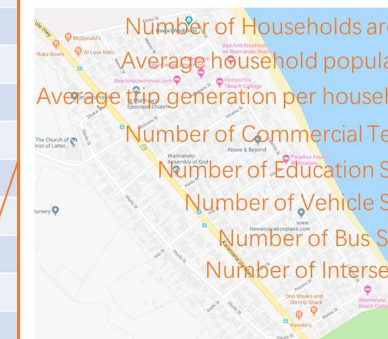


Figure 2.11i). Variable Quantification for Illustrative Roadway Segment One - Travel Characteristic and Land Function

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2	2	2	2	2	2
	Directional Peak Traffic	1	1	1	1	1	1
	Directional Non-peak Traffic	1	1	1	1	1	1
	Traffic Composition	2	2	2	1	1	1
Roadway Network Topology Structure	Network Redundancy	3	2	3	1	1	2
	Connectivity	3	2	2	1	1	2
	Accessibility	3	2	2	1	1	2
	Capacity	1	1	2	1	1	1
	Reliability	3	3	3	3	3	3
	Alternative Travel Model	3	2	1	1	1	2
Travel Characteristics	Trip Purposes	3	3	3	1	1	1
	Travel Importance	1	1	1	1	1	1
Land Use	Impacted Population groups	1	1	1	1	1	1
	Trip Generation	3	2	2	1	1	1
	Function and Social Impact	2	2	2	2	2	1

Figure 2.12. Variable Quantification for Illustrative Six Roadway Segments

Impact	Factor	I	II	III	IV	V	VI
Traffic Demand Dynamics	Annual Average Daily Traffic	2	2	2	2	2	2
	Directional Peak Traffic	1	1	1	1	1	1
	Directional Non-peak Traffic	1	1	1	1	1	1
	Traffic Composition	2	2	2	1	1	1
Roadway Network Topology Structure	Network Redundancy	3	2	3	1	1	2
	Connectivity	3	2	2	1	1	2
	Accessibility	3	2	2	1	1	2
	Capacity	[illegible]	1	[illegible]	[illegible]	[illegible]	1
	Reliability	3	3	3	3	3	3
	Alternative Travel Model	3	2	1	1	1	2
Travel Characteristics	Trip Purposes	3	3	3	1	1	1
	Travel Importance	1	1	1	1	1	1
Land Use	Impacted Population groups	1	1	1	1	1	1
	Trip Generation	3	2	2	1	1	1
	Function and Social Impact	2	2	2	2	2	1
		1	3	5	4	4	2

Figures 2.13. Levels of Significance and Criticality for Six Road Segments

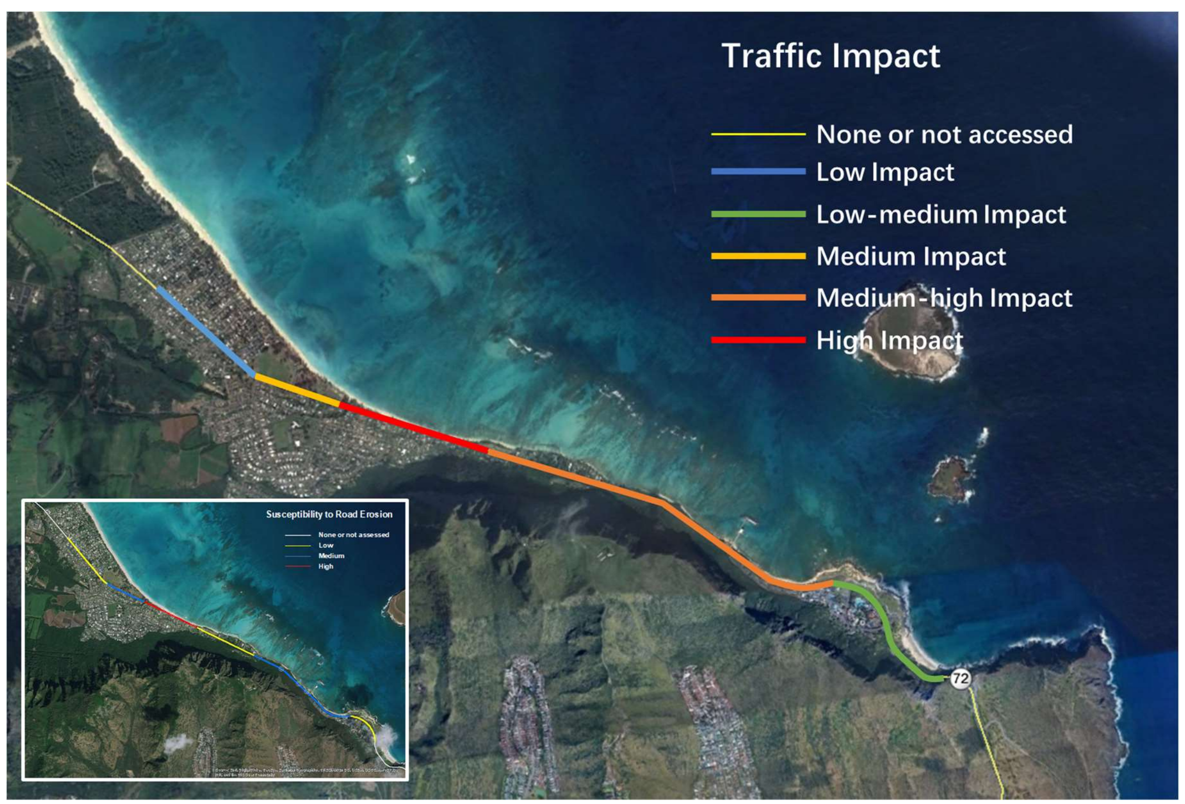


Figure 2.14. Color-Coded Map to Quantify Levels of Significance and Criticality for Roadway Sections

2.3. Traffic-Prioritized Significance Index Calculation

Applying the data collection and road significance level calculation procedure detailed in Section 2.2.3, the roadway network can be prioritized to quantify their levels of significance and criticality in Oahu Island. The proposed MLN model was applied to calculate the probabilities of the specific scale value assigned to each road segment. The probability values for each segment are shown in Figures 2.15 through 2.23. Based on these values, road segments were identified with one of five scale values, as shown in Figures 2.24 through 2.32.

The assessment presented in Figures 2.15 through 2.32 represents our best understanding of traffic-prioritized levels of significance and criticality of roadway segments based on our current scientific assessment and methodology. It is also need to mention that the results are obtained based on the data collected in a manner described above. Moreover, as mentioned before, for planning purpose, common years that might be of interest are 2050 and 2100. Challenges remain to assess how all the traffic-related characteristics change in the future. While carrying out future projections is difficult, it is recommended to take long-term state-wide planning efforts into consideration.

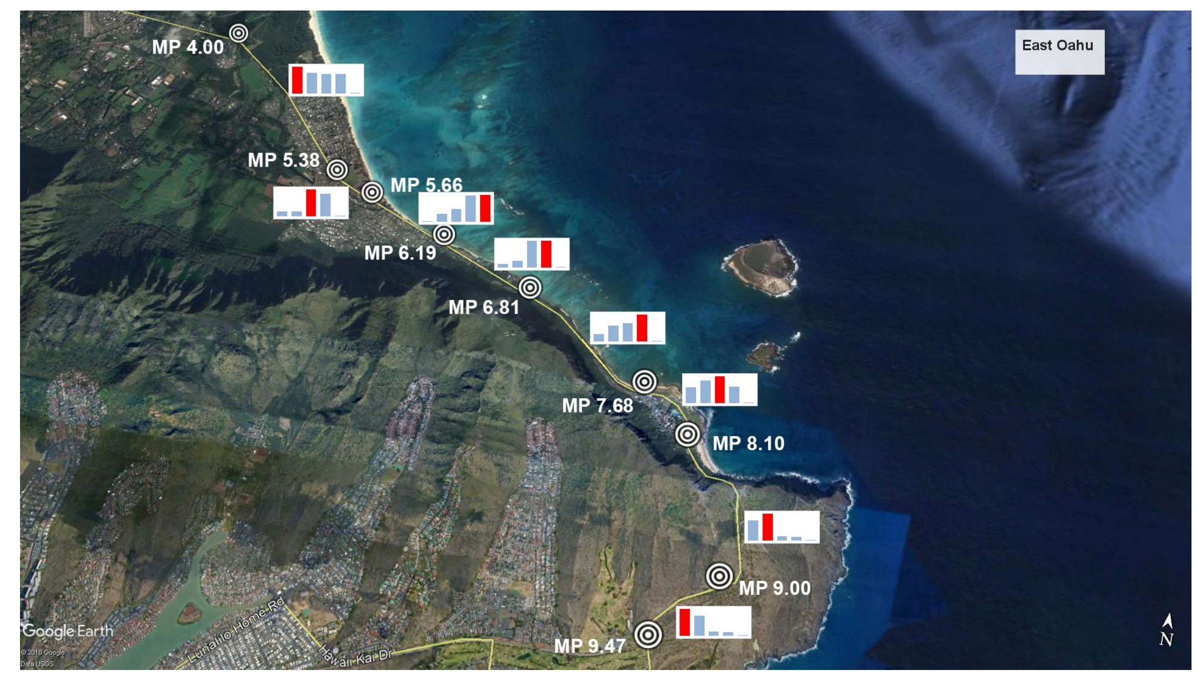


Figure 2.15. Probability distribution for traffic related priority index: Waimanalo to Makapuu

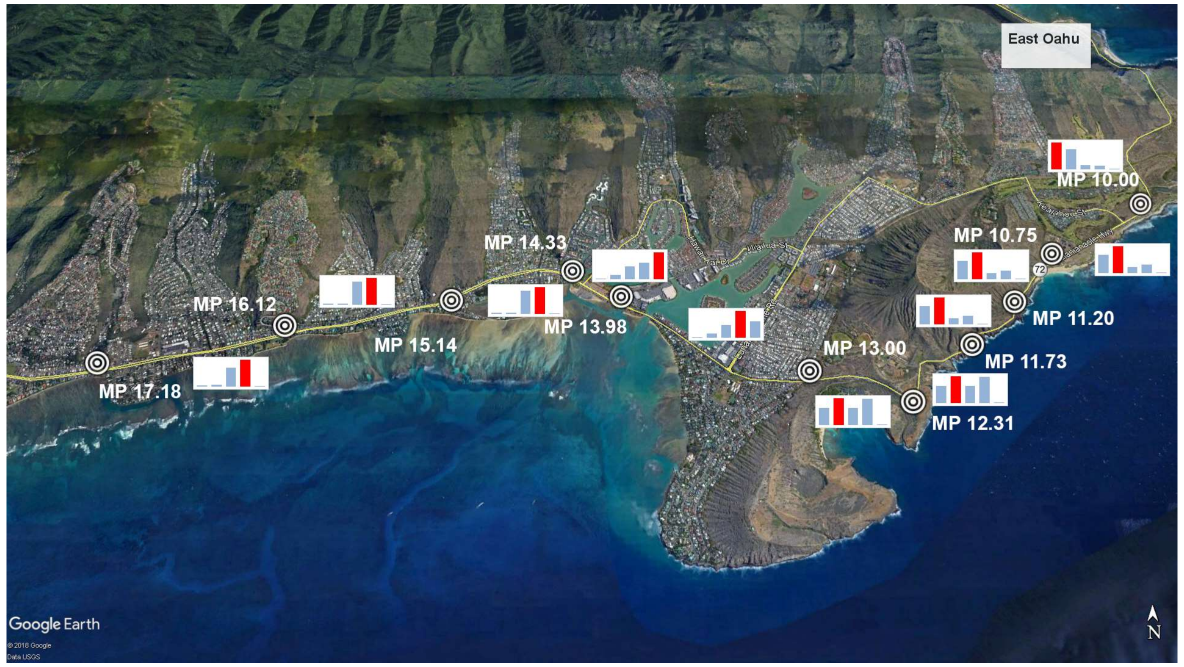


Figure 2.16. Probability distribution for traffic related priority index: Makapuu to Kahala

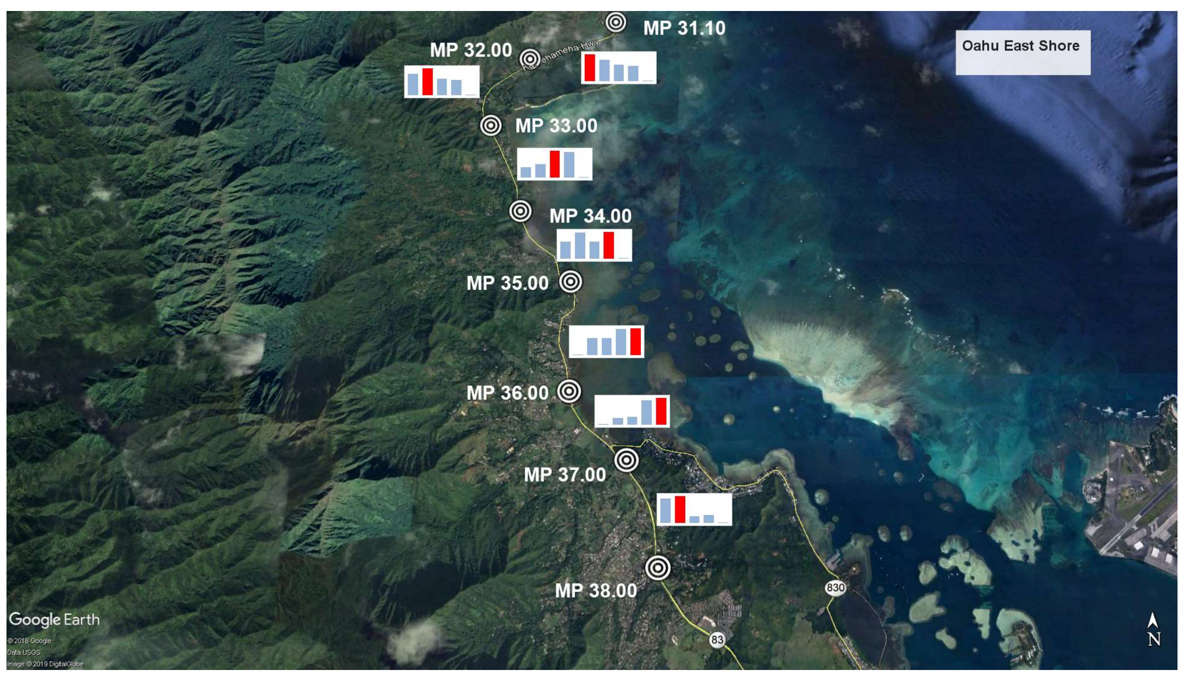


Figure 2.17. Probability distribution for traffic related priority index: Heeia to Kualoa

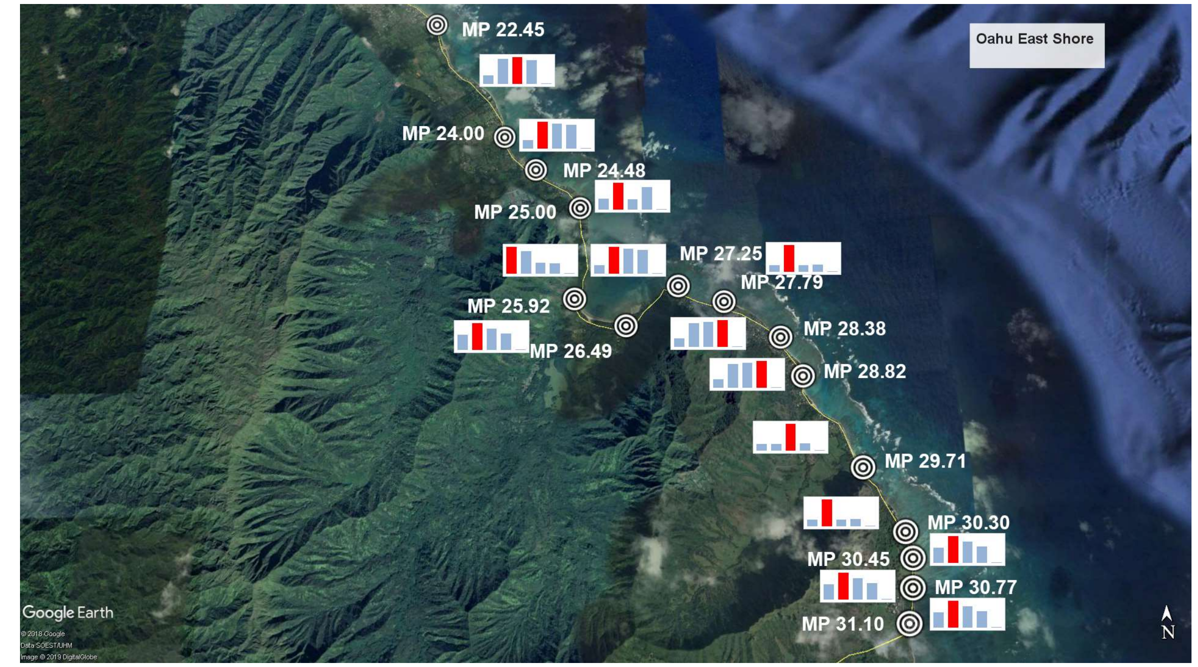


Figure 2.18. Probability distribution for traffic related priority index: Kualoa to Punaluu

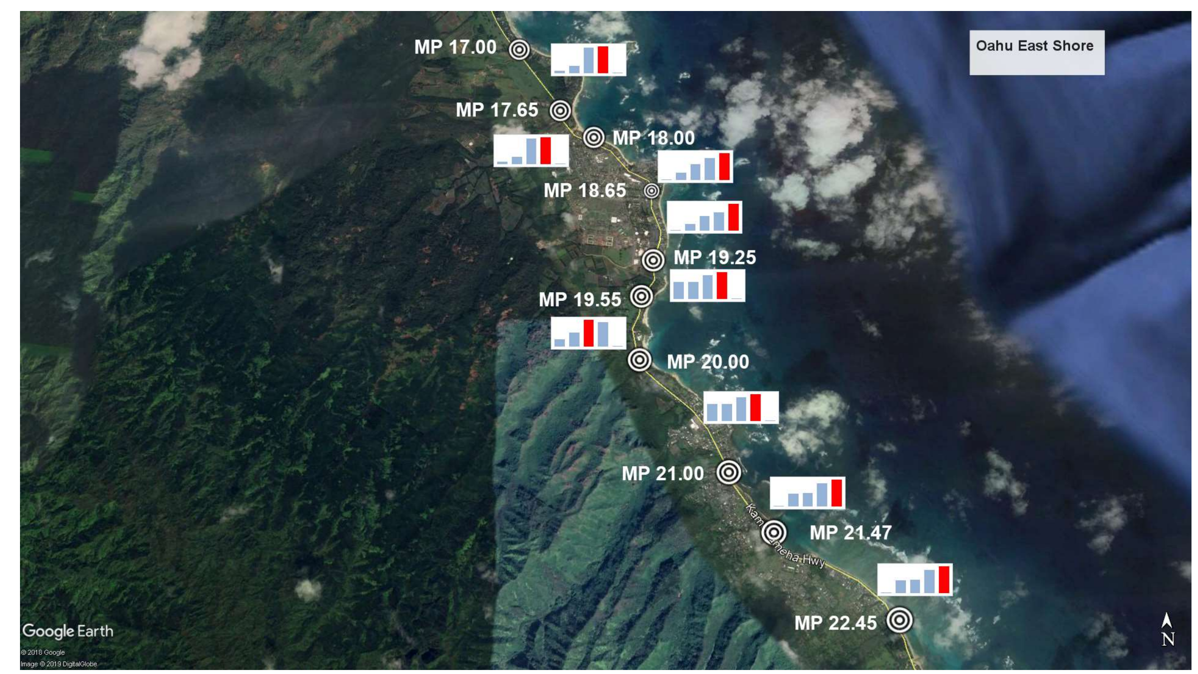


Figure 2.19. Probability distribution for traffic related priority index: Hauula to Laie

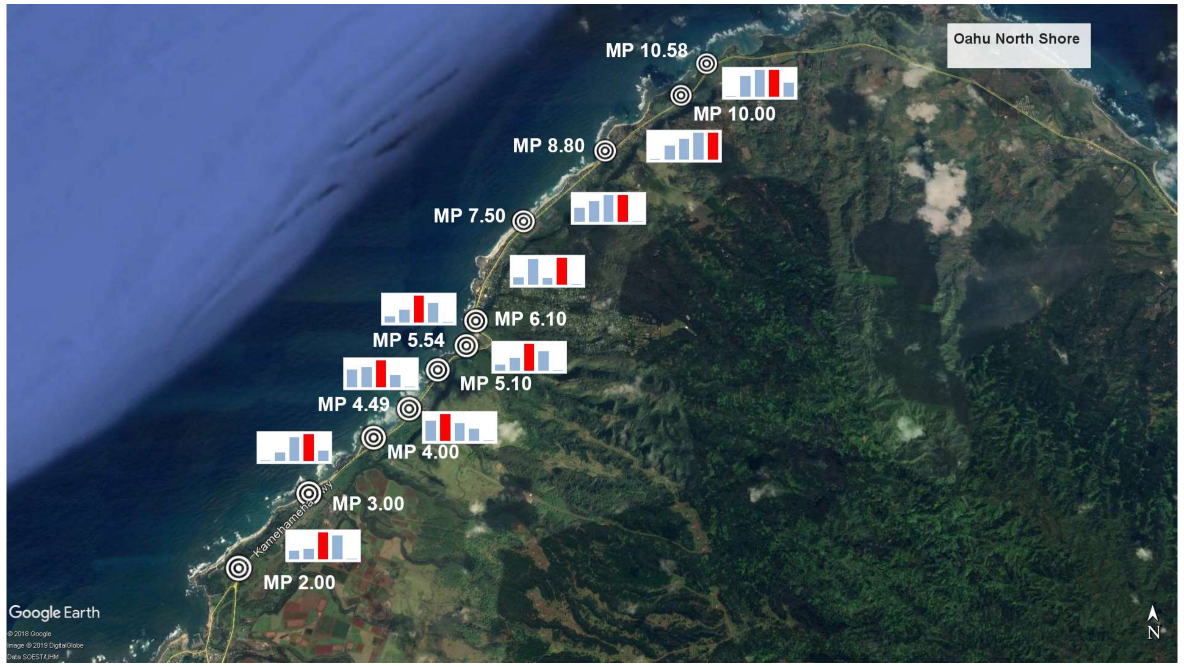


Figure 2.20. Probability distribution for traffic related priority index: Oahu North Shore

Figure 2.21. Probability distribution for traffic related priority index: HECO Plant to Nanakuli

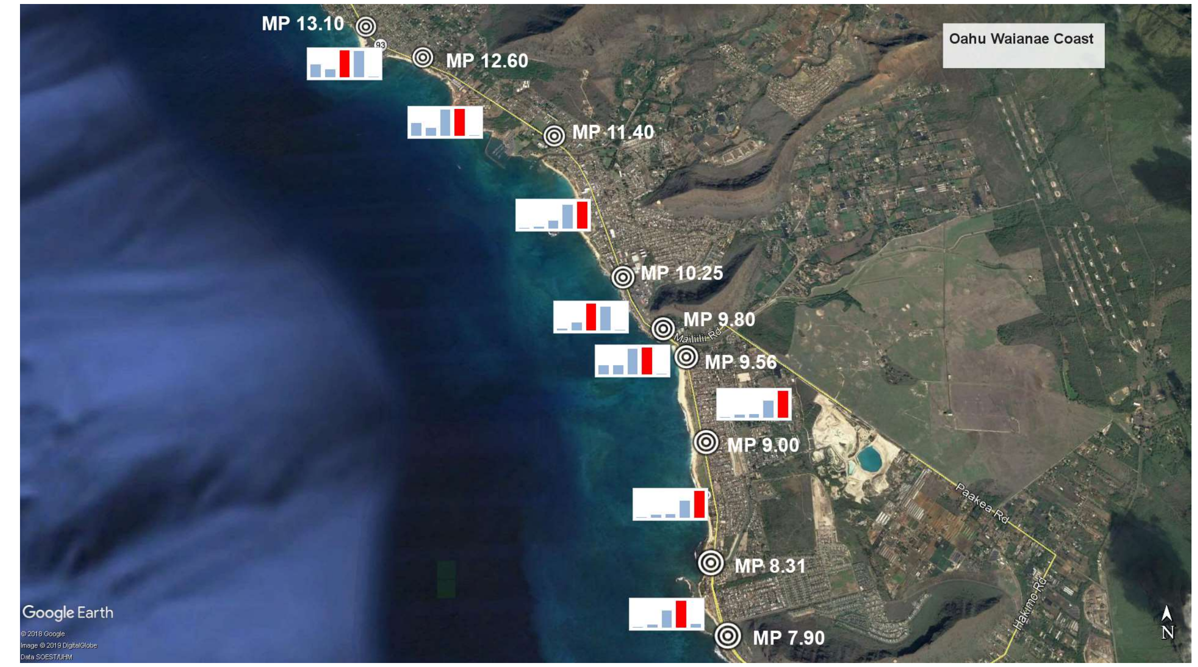


Figure 2.22. Probability distribution for traffic related priority index: Lualualei to Makaha

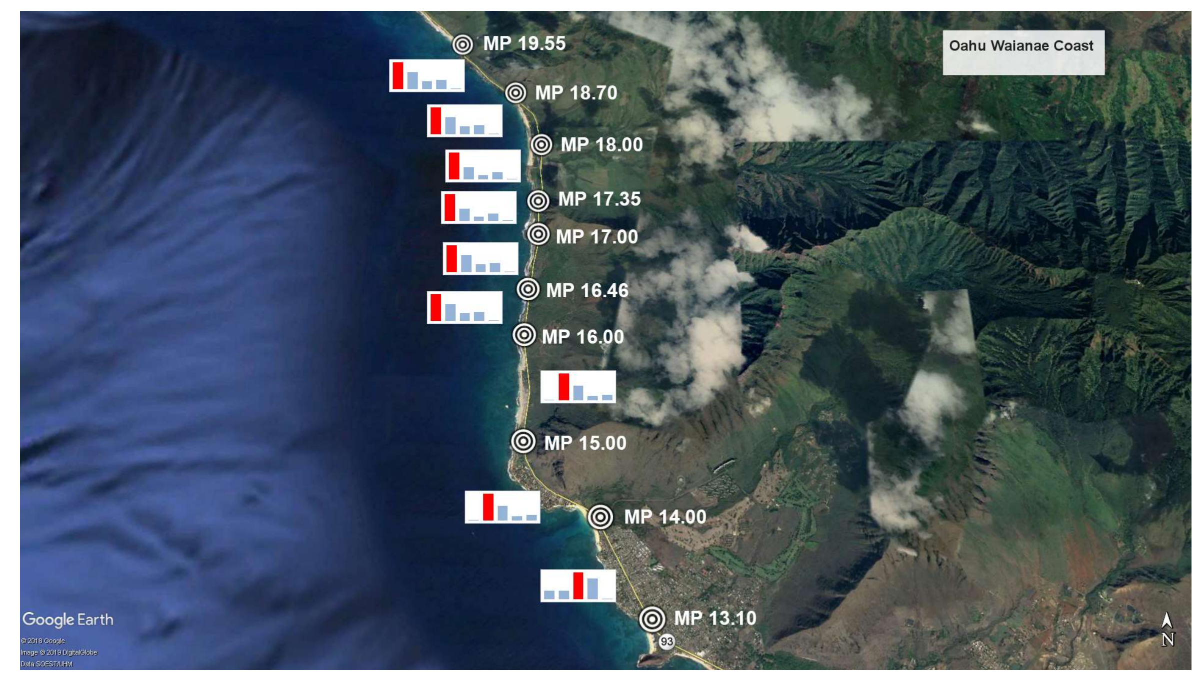


Figure 2.23. Probability distribution for traffic related priority index: Makaha to Makua

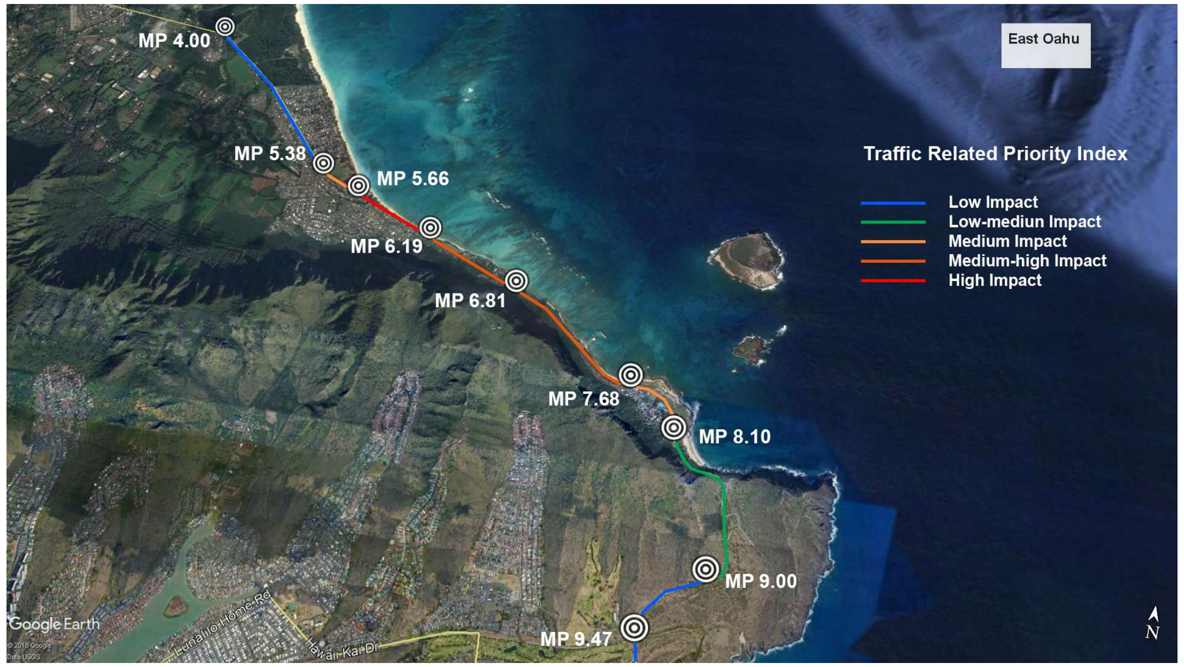


Figure 2.24. Segmentation map of traffic related priority index: Waimanalo to Makapuu

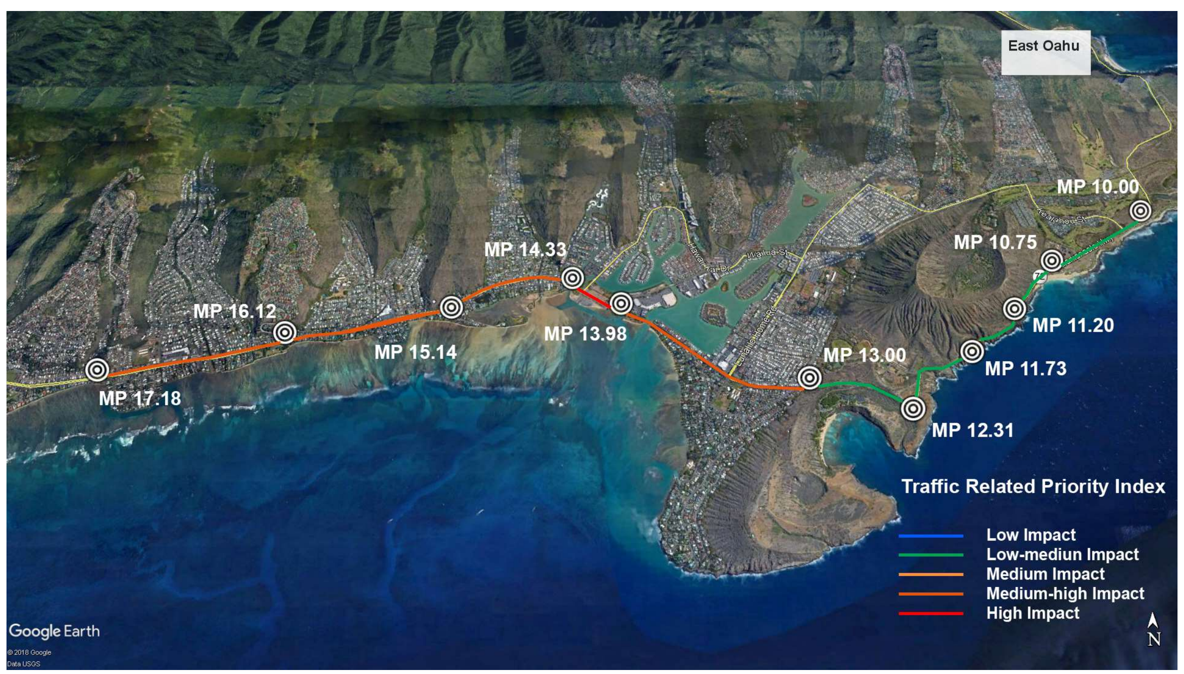


Figure 2.25. Segmentation map of traffic related priority index: Makapuu to Kahala

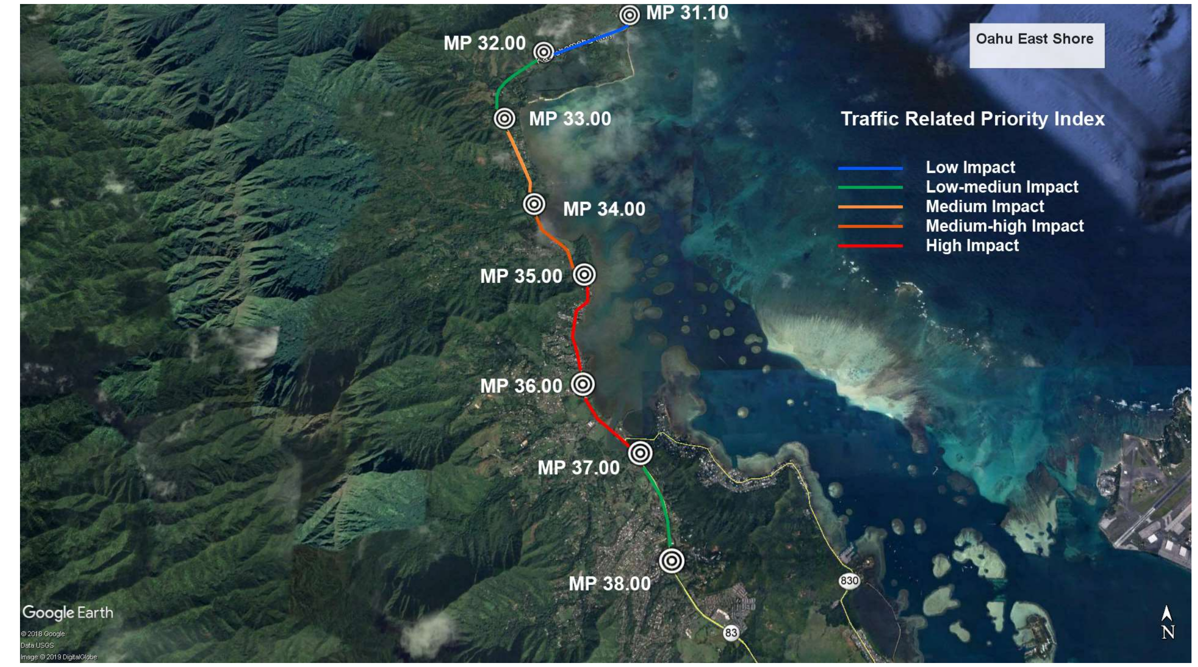


Figure 2.26. Segmentation map of traffic related priority index: Heeia to Kualoa

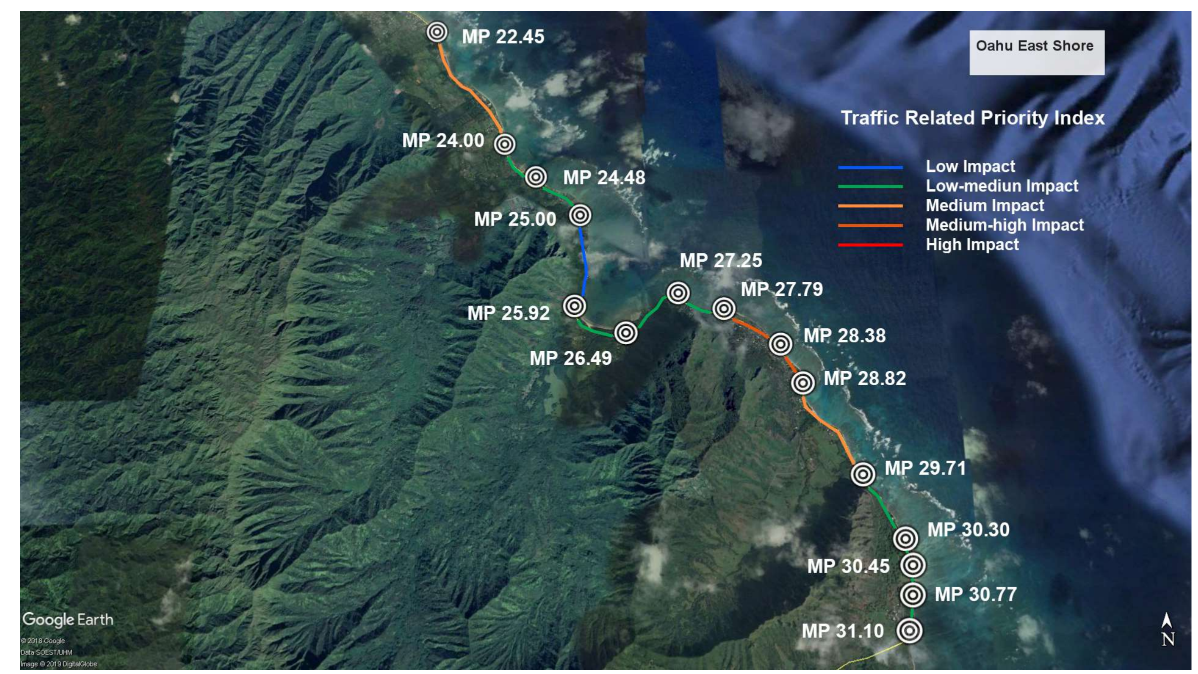


Figure 2.27. Segmentation map of traffic related priority index: Kualoa to Punaluu

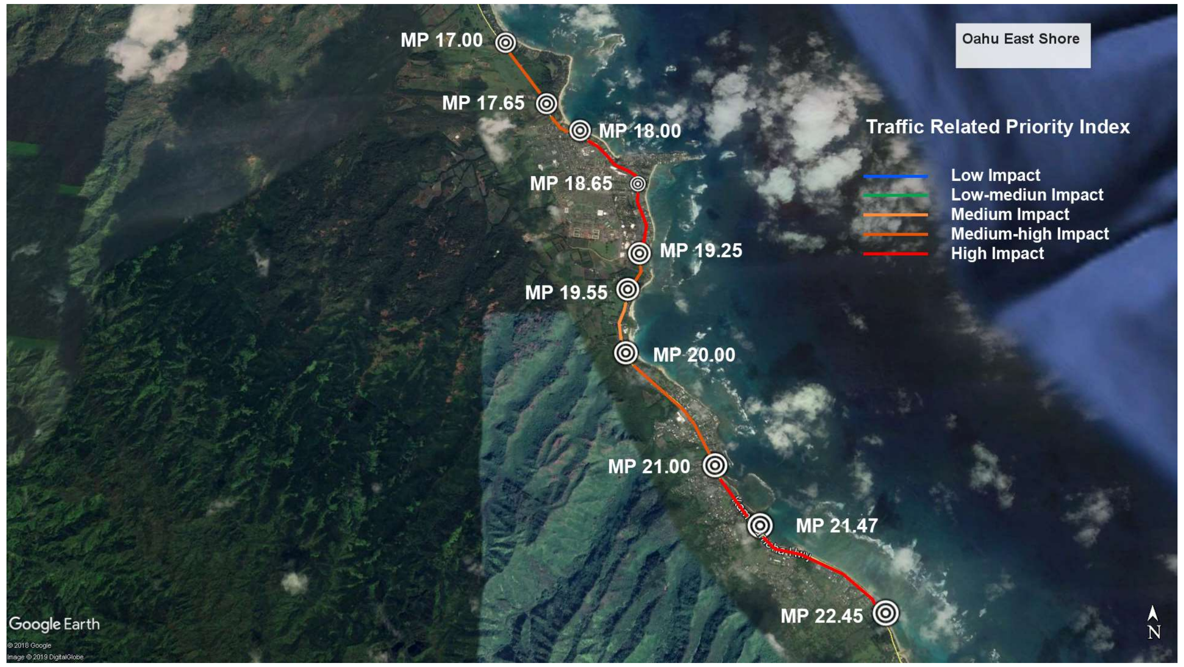


Figure 2.28. Segmentation map of traffic related priority index: Hauula to Laie

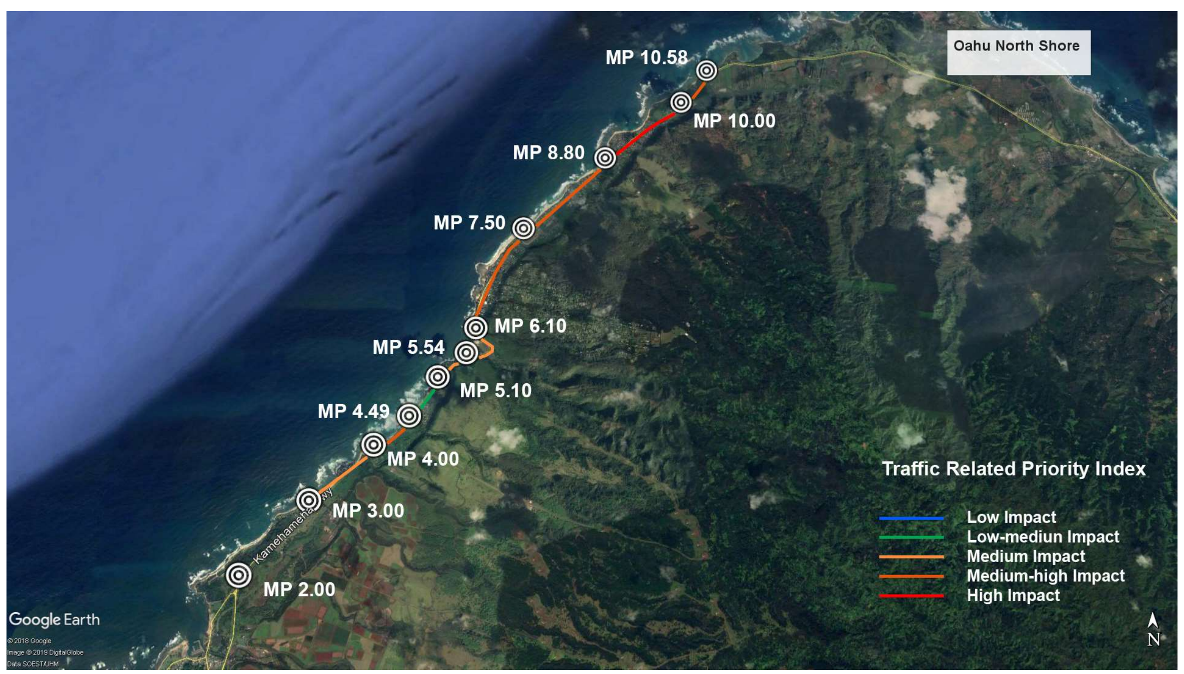


Figure 2.29. Segmentation map of traffic related priority index: Oahu North Shore

Figure 2.30. Segmentation map of traffic related priority index: HECO Plant to Nanakuli

Figure 2.31. Segmentation map of traffic related priority index: Lualualei to Makaha

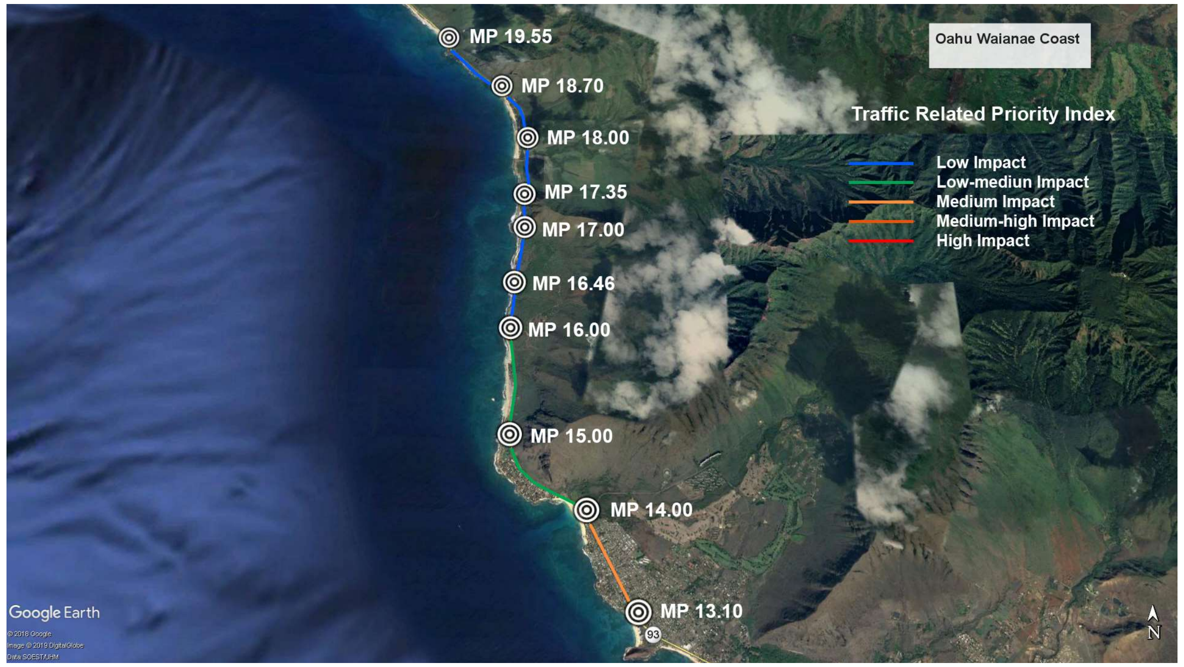


Figure 2.32. Segmentation map of traffic related priority index: Makaha to Makua

Table 2.4 illustrates the significance and priority level for each roadway segment visualized in Figures 2.24 to 2.32. For each roadway segment, its ID, area, and route attributes are provided. The mileposts are provided from starting points to ending points as well. These data are helpful to understand the priority level for each roadway segment.

Table 2.4. Traffic Significance of Priority Levels for Roadway Segment Each

Segment_ID	Area	Route/Area	Begin_Milepost	End_Milepost	Priority Level
1	East Oahu	Waimanalo	MP 4.00	MP 5.38	1
2	East Oahu	Waimanalo	MP 5.38	MP 5.66	3
3	East Oahu	Waimanalo	MP 5.66	MP 6.19	5
4	East Oahu	Waimanalo	MP 6.19	MP 6.81	4
5	East Oahu	Waimanalo	MP 6.81	MP 7.68	4
6	East Oahu	Waimanalo	MP 7.68	MP 8.10	3
7	East Oahu	Waimanalo	MP 8.10	MP 9.00	2
8	East Oahu	Waimanalo	MP 9.00	MP 9.47	1
9	East Oahu	Waimanalo	MP 9.47	MP 10.00	1
10	East Oahu	Waimanalo	MP 10.00	MP 10.75	2
11	East Oahu	Waimanalo	MP 10.75	MP 11.20	2
12	East Oahu	Waimanalo	MP 11.20	MP 11.73	2
13	East Oahu	Waimanalo	MP 11.73	MP 12.31	2
14	East Oahu	Waimanalo	MP 12.31	MP 13.00	2
15	East Oahu	Waimanalo	MP 13.00	MP 13.98	4
16	East Oahu	Waimanalo	MP 13.98	MP 14.33	5
17	East Oahu	Waimanalo	MP 14.33	MP 15.14	4
18	East Oahu	Waimanalo	MP 15.14	MP 16.12	4
19	East Oahu	Waimanalo	MP 16.12	MP 17.18	4
20	Oahu East Shore	Kahuku	MP 17.00	MP 17.65	4
21	Oahu East Shore	Kahuku	MP 17.65	MP 18.00	4
22	Oahu East Shore	Laie	MP 18.00	MP 18.65	5
23	Oahu East Shore	Laie	MP 18.65	MP 19.25	5
24	Oahu East Shore	Laie	MP 19.25	MP 19.55	4
25	Oahu East Shore	Laie	MP 19.55	MP 20.00	3
26	Oahu East Shore	Laie	MP 20.00	MP 21.00	4
27	Oahu East Shore	Laie	MP 21.00	MP 21.47	5
28	Oahu East Shore	Laie	MP 21.47	MP 22.45	5
29	Oahu East Shore	Punaluu	MP 22.45	MP 24.00	3
30	Oahu East Shore	Punaluu	MP 24.00	MP 24.48	2
31	Oahu East Shore	Punaluu	MP 24.48	MP 25.00	2
32	Oahu East Shore	Punaluu	MP 25.00	MP 25.92	1
33	Oahu East Shore	Punaluu	MP 25.92	MP 26.49	2
34	Oahu East Shore	Kaaawa	MP 26.49	MP 27.25	2
35	Oahu East Shore	Kaaawa	MP 27.25	MP 27.79	2
36	Oahu East Shore	Kaaawa	MP 27.79	MP 28.38	4

37	Oahu East Shore	Kaaawa	MP 28.38	MP 28.82	4
38	Oahu East Shore	Kaaawa	MP 28.82	MP 29.71	3
39	Oahu East Shore	Kaaawa	MP 29.71	MP 30.30	2
40	Oahu East Shore	Kaaawa	MP 30.30	MP 30.45	2
41	Oahu East Shore	Kaaawa	MP 30.45	MP 30.77	2
42	Oahu East Shore	Kaaawa	MP 30.77	MP 31.10	2
43	Oahu East Shore	Kaaawa	MP 31.10	MP 32.00	1
44	Oahu East Shore	Kaaawa	MP 32.00	MP 33.00	2
45	Oahu East Shore	Kaaawa	MP 33.00	MP 34.00	3
46	Oahu East Shore	Kaaawa	MP 34.00	MP 35.00	4
47	Oahu East Shore	Kaaawa	MP 35.00	MP 36.00	5
48	Oahu East Shore	Kaaawa	MP 36.00	MP 37.00	5
49	Oahu East Shore	Ahuimanu	MP 37.00	MP 38.00	2
50	Oahu North Shore	Sunset	MP 2.00	MP 3.00	3
51	Oahu North Shore	Sunset	MP 3.00	MP 4.00	4
52	Oahu North Shore	Sunset	MP 4.00	MP 4.49	2
53	Oahu North Shore	Sunset	MP 4.49	MP 5.10	3
54	Oahu North Shore	Sunset	MP 5.10	MP 5.54	3
55	Oahu North Shore	Sunset	MP 5.54	MP 6.10	3
56	Oahu North Shore	Sunset	MP 6.10	MP 7.50	4
57	Oahu North Shore	Sunset	MP 7.50	MP 8.80	4
58	Oahu North Shore	Sunset	MP 8.80	MP 10.00	5
59	Oahu North Shore	Sunset	MP 10.00	MP 10.58	4
60	Oahu Waianae Coast	Heco_plant	MP 3.00	MP 3.67	3
61	Oahu Waianae Coast	Heco_plant	MP 3.67	MP 4.35	2
62	Oahu Waianae Coast	Heco_plant	MP 4.35	MP 5.00	4
63	Oahu Waianae Coast	Heco_plant	MP 5.00	MP 5.46	5
64	Oahu Waianae Coast	Heco_plant	MP 5.46	MP 6.00	5
65	Oahu Waianae Coast	Heco_plant	MP 6.00	MP 6.62	5
66	Oahu Waianae Coast	Heco_plant	MP 6.62	MP 7.33	2
67	Oahu Waianae Coast	Heco_plant	MP 7.33	MP 7.90	3
68	Oahu Waianae Coast	Heco_plant	MP 7.90	MP 8.31	4
69	Oahu Waianae Coast	Waianae	MP 8.31	MP 9.00	5
70	Oahu Waianae Coast	Waianae	MP 9.00	MP 9.56	5
71	Oahu Waianae Coast	Waianae	MP 9.56	MP 9.80	4
72	Oahu Waianae Coast	Waianae	MP 9.80	MP 10.25	3
73	Oahu Waianae Coast	Waianae	MP 10.25	MP 11.40	5
74	Oahu Waianae Coast	Waianae	MP 11.40	MP 12.60	4
75	Oahu Waianae Coast	Waianae	MP 12.60	MP 13.10	3
76	Oahu Waianae Coast	Makaha	MP 13.10	MP 14.00	3
77	Oahu Waianae Coast	Makaha	MP 14.00	MP 15.00	2
78	Oahu Waianae Coast	Makaha	MP 15.00	MP 16.00	2
79	Oahu Waianae Coast	Makaha	MP 16.00	MP 16.46	1
80	Oahu Waianae Coast	Makaha	MP 16.46	MP 17.00	1
81	Oahu Waianae Coast	Makaha	MP 17.00	MP 17.35	1
82	Oahu Waianae Coast	Makaha	MP 17.35	MP 18.00	1
83	Oahu Waianae Coast	Makaha	MP 18.00	MP 18.70	1
84	Oahu Waianae Coast	Makaha	MP 18.70	MP 19.55	1

2.4. Model Parameter Calibration

The parameters shown in Table 2.2 are obtained from a model calibration process. This calibration process follow a standard multinomial logit model specification and calibration procedure. We identified a number of roadway segments whose priority levels are obviously known at different levels of significance, such as Manoa Rd., Kapiolani Blvd., S King St., Ala Moana Blvd, etc., crossing different locations. Then we collected all the related data along these roadway segments, such as AAD, directional peak traffic volume, directional non-peak traffic volume, truck percentage, network topological structure, connectivity, accessibility, capacity, impacted population groups, trip purposes, and social impacts. We used software package NLOGIT 10.0 to estimate the corresponding parameters based on the maximum likelihood methods to minimize the accumulated errors in the difference between these estimated data and known data. Eventually, all the parameters are calibrated and illustrated in Table 2.2

2.5. Integrating Traffic Index into CRESI Calculation

By applying the traffic-related priority index in the CRESI index, equation (7) in Chapter 1 is updated as follows.

$$\mathrm{CRESI}_t = \sqrt{\frac{\left(Variable1 * Variable2 * \mathrm{K} * Variable10 * Variable_{traffic}\right)^{0.6503}}{11}} \quad (5)$$

Based on equation (5), the traffic involved CRESI index, termed as CRESI_t, is thus calculated and the updated ranking locations are also shown in the respective segmentation maps (Figure 2.33 through 2.41).

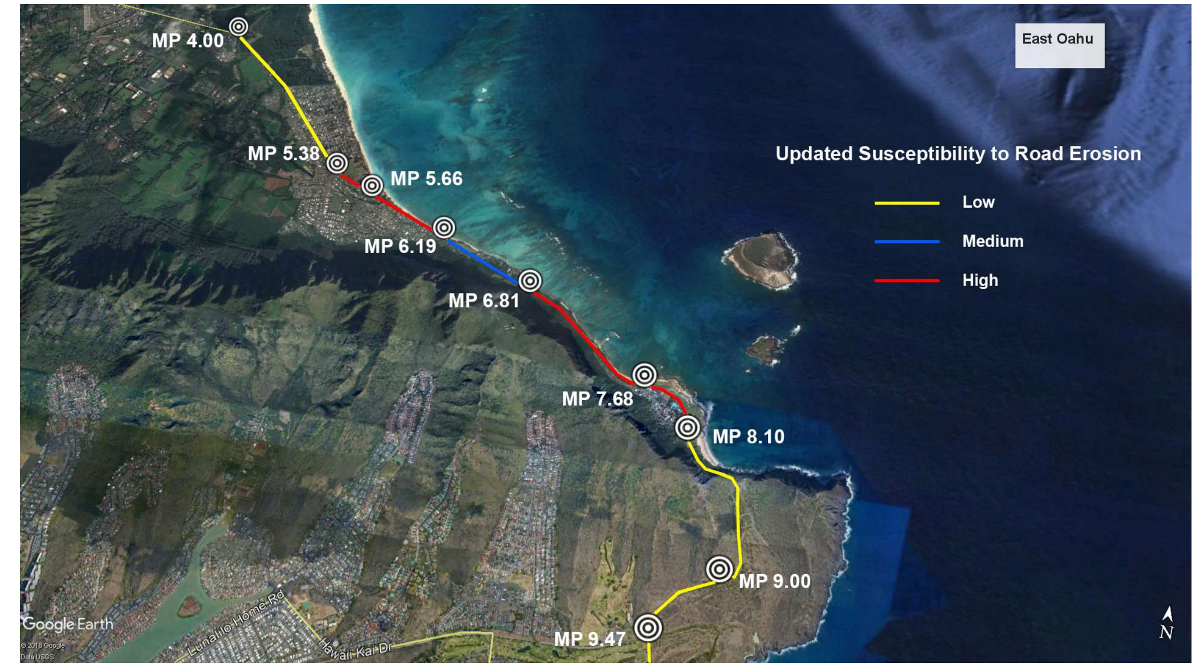


Figure 2.33. Traffic Index-Integrated CRESI Classification: Waimanalo to Makapuu

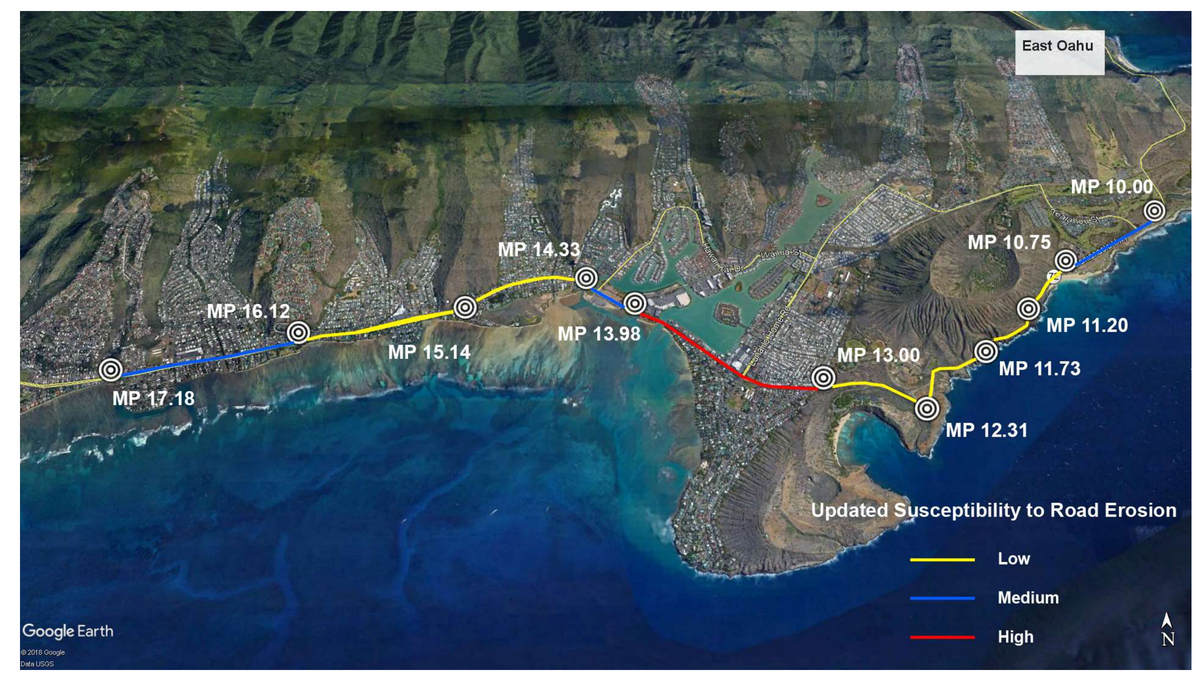


Figure 2.34. Traffic Index-Integrated CRESI Classification: Makapuu to Kahala

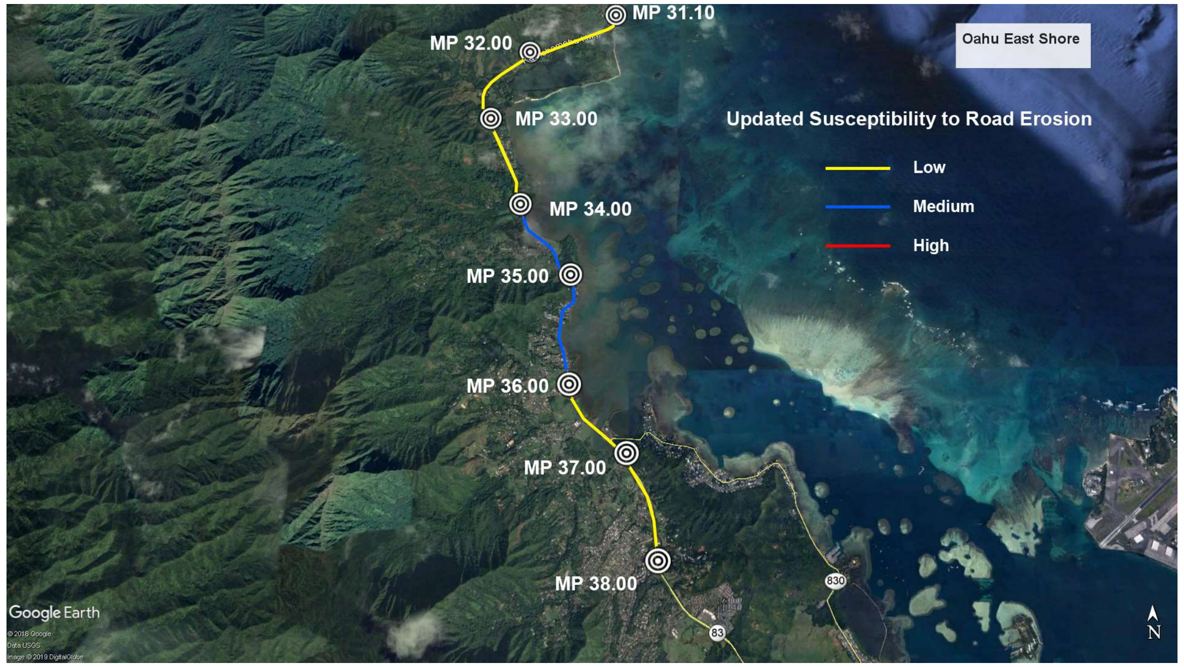


Figure 2.35. Traffic Index-Integrated CRESI Classification: Heeia to Kualoa

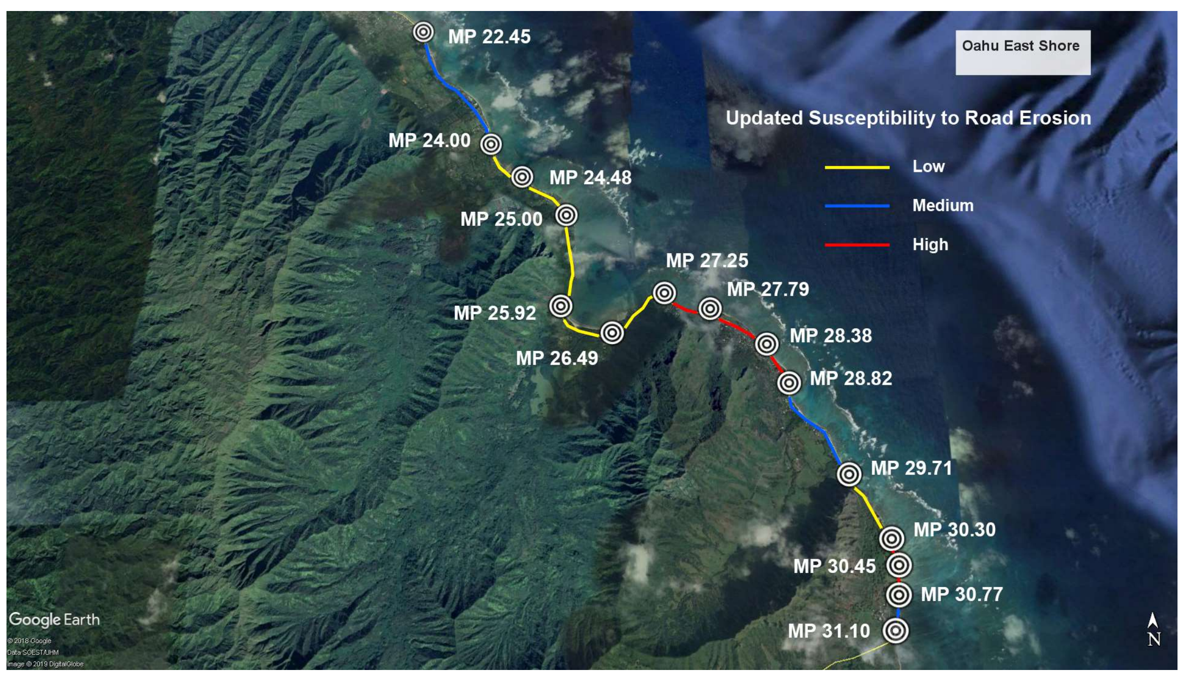


Figure 2.36. Traffic Index-Integrated CRESI Classification: Kualoa to Punalua

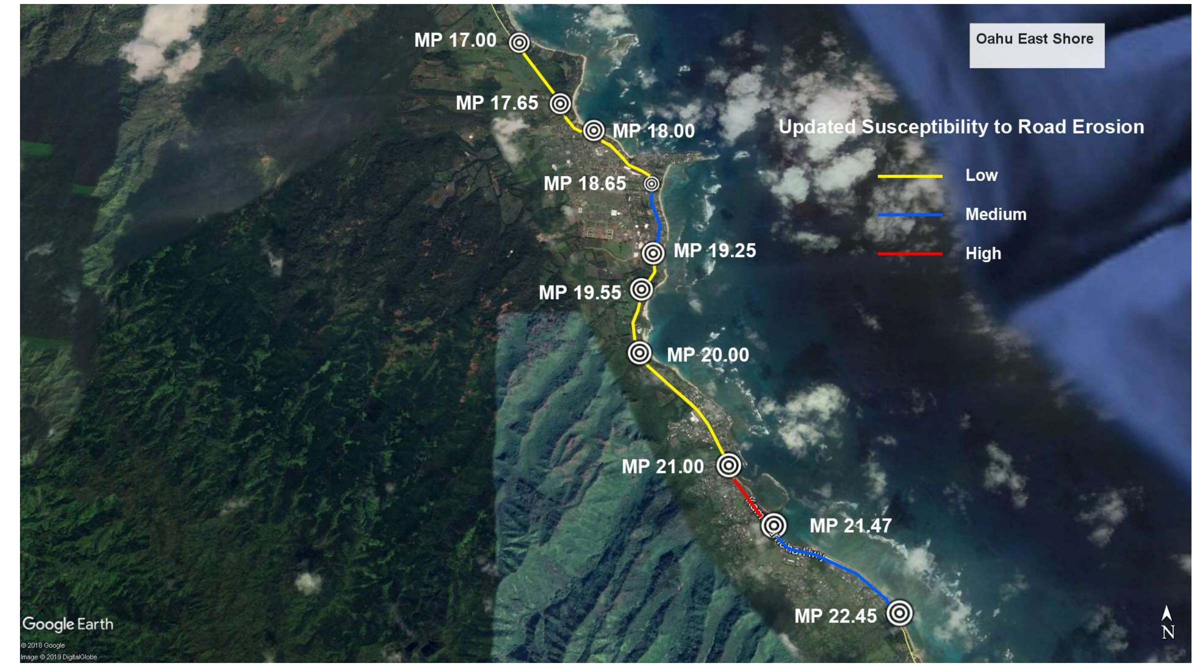


Figure 2.37. Traffic Index-Integrated CRESI Classification: Hauula to Laie

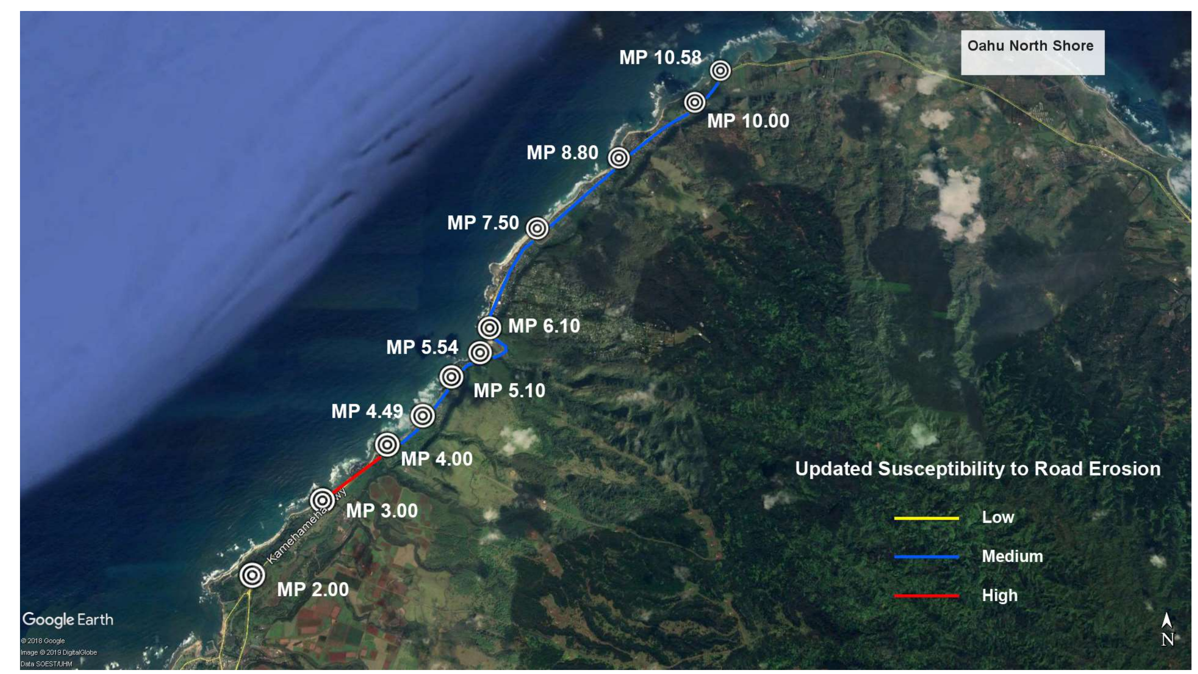


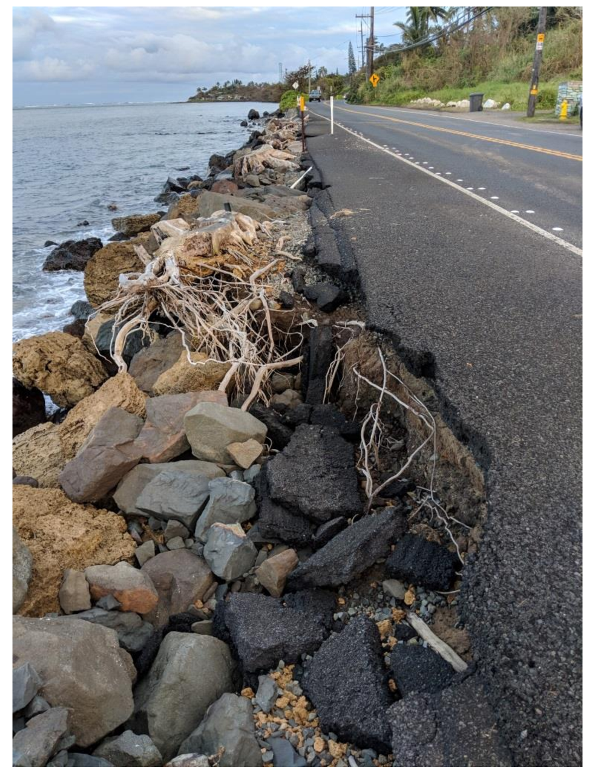
Figure 2.38. Traffic Index-Integrated CRESI Classification: Oahu North Shore

Figure 2.39. Traffic Index-Integrated CRESI Classification: HECO Plant to Nanakuli

Figure 2.40. Traffic Index-Integrated CRESI Classification: Lualualei to Makaha

Figure 2.41. Traffic Index-Integrated CRESI Classification: Makaha to Makua

Chapter 3 – Ocean Hazards



At Milepost 27 along the Kamehameha Highway, East Shore, Oahu.
Photo taken on June 6, 2019 by Francis, Togia and Yang.

3.1. Introduction: An Assessment of the Ocean Hazards Database (OHD) and Ocean Hazards Classification Scheme (OHCS) for State of Hawaii DOT coastal highways

Chapter 3 presents ocean hazards work requested by the State of Hawaii Department of Transportation (HDOT) and how it supports the Coastal Road Susceptibility Index (CRESI), Chapter 1, of this report. We develop two new contributions, an Ocean Hazards Database (OHD) (Francis et al., 2019), and a new scheme for classifying ocean hazards in the Hawaiian Islands, specifically, the Ocean Hazards Classification Scheme (OHCS).

The State of Hawaii Department of Transportation (HDOT) has tasked the team to research and develop the methodology and criteria used to identify and prioritize coastal road sites for mitigation. A major part of this task is providing criteria and the process for analyzing ocean hazards data which produces a statewide prioritized list of shoreline areas requiring future mitigation work. This includes developing an Ocean Hazards Database (OHD) (Francis et al., 2019) and an Ocean Hazards Classification Scheme (OHCS) (Table 3.2) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.

Previous work relating directly to this study is a 2003 HDOT study developed and prepared by Noda and Associates, Inc., Honolulu, Hawaii (Noda and Associates, Inc., 2003) which developed a long-range master plan for protection and mitigation of wave and erosion damage to the statewide highway system. Major work activities included an inventory to identify the problem areas on each island, analysis of shoreline changes and development of recommendations for dealing with the erosion/wave problem at each priority site (Noda and Associates, Inc., 2003).

Our study area specifically focuses on HDOT coastal roads, specifically at 302 mileposts scattered throughout the State of Hawaii, which were identified as "susceptible" in Chapter 1, due to the condition of or proximity of the road to the ocean. Here, we develop an Ocean Hazards Database (OHD) comprising of ocean data influencing HDOT coastal roads, at each of the 302 mileposts, as well as the design and construction of offshore structures (e.g. breakwater, groin, etc.) (Francis et al., 2019).

A list of the seven OHD variables are given in Table 3.1, which include: 1a,b,c) sea level rise 2050, 2100, by Feet, respectively; 2) tides; 3a,b) wave period and height, respectively; 4a,b) shoreline change rate and armoring, respectively; 5a,b) tsunami historical and hypothetical flow depths, respectively; 6a,b,c,d) storm surge Category 1, 2, 3, 4, respectively and; 7a,b,c,d) nearshore benthic habitat zone, major structure, detailed structure, and coverage, respectively.

In the OHD we also present statewide maps of different hazard scenarios and their influence on HDOT coastal roads at the 302 mileposts for the State of Hawaii Statewide Coastal Highway Program Report (Francis et al., 2019). There are ten different types of maps, and we include an example of each in this report as follows:

1. Topographic and nearshore bathymetric transects (Figure 3.2)
2. Offshore bathymetric transects along the peak wave direction (Figure 3.3)
3. Sea level rise inundation for 1-foot, 2-feet and 3-feet (Figure 3.4)
4. Sea level rise inundation by 2050 (Figure 3.5)
5. Sea level rise inundation by 2100 (Figure 3.6)
6. Maximum annually recurring significant wave height, period, and direction (Figure 3.7)
7. Projected shoreline change with sea level rise (Figure 3.8)
8. Tsunami inundation (Figure 3.9)
9. Storm surge inundation for Category 1-2 storms (Figures 3.10)
10. Storm surge inundation for Category 3-4 storms (Figure 3.11)

The remaining scenario maps of the 302 mileposts are found in the OHD (Francis et al., 2019), except for tsunami inundation which is not publicly available but provided to HDOT.

Summary tables of the OHD for 302 mileposts are included at the end of this chapter, and are meant to serve as a quick reference for engineers and planners in the field or for those who need to understand general conditions in the area. Nine summary tables are included in this report, and are as follows:

1. Sea level rise inundation for 1-foot, 2-feet and 3-feet (Table 3.4)
2. Sea level rise inundation by 2050 (Table 3.5)
3. Sea level rise inundation by 2100 (Table 3.6)
4. Maximum annually recurring significant wave height and period (Table 3.7)
5. Bathymetric description along the peak wave direction (i.e. open, sheltered, interisland) (Table 3.8)
6. Mean shoreline change rate (Table 3.9)

7. Tsunami inundation (Table 3.10)
8. Storm surge inundation for Category 1-4 storms (Table 3.10)
9. Land use (i.e. public, business/industrial, residential) (Table 3.11)

We also develop an Ocean Hazards Classification Scheme (OHCS) based on the data from the OHD (Francis et al., 2019) which presents six main ocean hazard variables in Table 3.2: 1a,b,c) sea level rise 2050, 2100, by Feet, respectively, 2) tides, 3a,b) wave period and height, respectively, 4) shoreline change (i.e. Variable 4 is summarized using 4a and 4b), 5) tsunami (i.e. Variable 5 is summarized using 5a and 5b), and 6) storm surge (i.e. Variable 6 is summarized using 6a, 6b, 6c, and 6d). Of these, six variables are to be used in CRESI for the State of Hawaii Statewide Coastal Highway Program Report, Version 2 (Final): Variables 1a, 2, 3b, 4, 5, and 6. As of this report, only four variables are used in CRESI for the State of Hawaii Statewide Coastal Highway Program Report, Version 1: Variables 1c, 2, 3, and 4.

In the subsequent sections, we present the following. In Section 3.2 we introduce the methodology for the development and ranking of the OHD (Francis et al., 2019) and OHCS) for State of Hawaii coastal highways. In Section 3.3, we present and discuss the results. In the following four sections, Sections 3.4, 3.5, 3.6, and 3.7, we present the future work, references, figures, and tables, respectively.

3.2. Methodology: Development and ranking for Ocean Hazards Database (OHD) and Ocean Hazards Classification Scheme (OHCS) for State of Hawaii DOT coastal highways

There are seven types of ocean hazards data in the OHD we use for the State of Hawaii Statewide Coastal Highway Program Report, the OHCS, and CRESI, which we present (Table 3.1). These seven ocean hazards variables are: 1) sea level rise, 2) tides, 3) waves, 4) shoreline change, 5) tsunami flow depth, 6) storm surge, and 7) nearshore benthic habitat.

Variable 1, sea level rise, is the sea level rise rate sub-classified into 1a.) sea level rise rate (1905-2050, extreme scenario) (in/yr); 1b.) sea level rise rate (1905-2050, extreme scenario) (in/yr); and 1c.) historical sea level rise rate (1905-2016) (in/yr). Local sea level rise is the result of both global sea level rise and local factors. Global sea level rise is due to warmer ocean temperatures and melting land ice, both caused by climate change. Local factors include land motions and tides, currents, and winds. Local sea levels can rise faster than the average global rate.

Variable 2, tides, is the mean tidal range (1983-2001) (ft). Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun, and the rotation of the Earth.

Variable 3, maximum annually recurring waves, is sub-classified into 3a.) peak wave period (2010-2018) (sec); and 3b.) significant wave height (2010-2018) (ft). This includes all forecasted wind-waves from 2010-2018, which was modeled in the wind-driven Simulating WAves Nearshore (SWAN) wave model. We use maximum annually recurring waves to understand what the design wave should be.

Variable 4, shoreline change, is sub-classified into 4a.) mean projected shoreline change rate (2008–2100) (ft/yr); and 4b.) CRESI – armoring ranking (1-5) (Brandes et al., 2019). Variable 4, shoreline change, determines the seaward encroachment of the beach towards the road and how protected the road is, whether there is existing armoring or not. Shoreline change is seasonal, where erosion and accretion are present during different times of the year. The most significant shoreline change is influenced by wave action, particularly storm surge events, which occur almost annually, transporting much of the coastline away during one event.

Variable 5, tsunamis, is sub-classified into 5a.) historical flow depth (ft); and 5b.) hypothetical flow depth (ft). Variable 5, tsunamis, are seismic ocean waves causing coastal inundation caused by earthquakes, underwater landslides, volcanic eruptions, or meteorites.

Variable 6, storm surge, is sub-classified into 6a.) Category 1 storm inundation height (ft); 6b.) Category 2 storm inundation height (ft); 6c.) Category 3 storm inundation height (ft); 6d.) Category 4 storm inundation height (ft). Variable 6, storm surge, is a rapid rise in sea level causing coastal inundation due to low pressure, high winds, and high waves associated with hurricanes.

Variable 7, nearshore benthic habitat, is sub-classified into 7a.) zone; 7b.) major structure; 7c.) detailed structure; and 7d.) coverage. We use Variable 7, nearshore benthic habitat, to understand the wave transformation occurring in the nearshore zone. We also use Variable 7 to understand whether an offshore structure, such as an artificial reef or breakwater, may be feasibly constructed offshore.

In the following Sections 3.2.1 to 3.2.8, we present the following: the development of the seven ocean hazard variables (sea level rise, tides, waves, shoreline change, tsunamis, storm surge, and nearshore benthic habitat); the development of the elevation and bathymetric transects; and the development and ranking scheme of the six ocean hazard variables used in OHCS (i.e. sea level rise, tides, waves, shoreline change, tsunamis, and storm surge).

3.2.1. Elevation and Bathymetric Transects

Because the distances and elevation changes between the coastal roads and ocean are essential to the assessment of the State of Hawaii Statewide Coastal Highway Program Report, we create a combined topographic and nearshore bathymetric elevation transect and an offshore bathymetry transect along the peak wave direction at each milepost. Transects start from the milepost and extend to the ocean or water bodies connected to the ocean (e.g., the transect at milepost 38 (MP 38) ends in the stream connected to the ocean) along either a direction perpendicular to the road for nearshore elevations, or the peak wave direction for offshore elevations. In this project, we use Light Detection and Ranging (LiDAR) data to create a nearshore Digital Elevation Model (DEM) to obtain topography and shallow bathymetry information. Offshore information is collected from a bathymetric DEM synthesized of both multibeam echosounder tracks and satellite altimetry created by the Hawaii Mapping Research Group (HMRG, 2016). LiDAR data can be downloaded through the Data Access Viewer of NOAA (https://coast.noaa.gov/dataviewer/#/lidar/ search/). For each island, the majority of DEMs is created using the data from the 2013 U.S. Army Corps of Engineers (USACE) National Coastal Mapping Program (NCMP) Topobathy LiDAR – Local Mean Sea Level (LMSL) (OCM Partners, 2018c, 2018d, 2018e, 2018f, and 2018g). Included LiDAR data is classified into three categories: 1 (valid non-ground topographic data), 2 (valid ground topographic data), and 29 (valid bathymetric data). Classes 1 and 2 are defined following the classification codes defined by the American Society of Photogrammetry and Remote Sensing (ASPRS). In this project, we use classes 2 and 29 to create the bare earth DEM at a resolution of 3.28 ft. LiDAR data is referenced to the North American Datum of 1983 Pacific Adjustment of 2011 (NAD83 PA11) in the horizontal and adjusted to LMSL in the vertical. In the horizontal, the topographic LiDAR data have an accuracy of 3.28 ft with a 95% confidence interval, and the bathymetric LiDAR data have an accuracy of $11.48 + 0.05 * depth$ (ft) with a 95% confidence interval. In vertical, the topographic LiDAR data have an accuracy of 7.72 inches with a 95% confidence interval, the shallow bathymetric LiDAR data have an accuracy of $\sqrt{0.67+(0.025*depth)^2}$ (ft) with a 95% confidence interval, and the deep bathymetric data have an accuracy of $\sqrt{0.97+(0.043*depth)^2}$ (ft) with a 95% confidence interval. However, this data set do not cover all the study areas in this project. To fill gaps in the DEM, we use the LiDAR data from 2006 FEMA LiDAR: Hawaiian Islands (OCM Partners, 2018a) and 2007 JALBTCX Hawaii LiDAR: North Coasts of Hawaii (Big Island), Kauai, Maui, Molokai, Oahu (OCM Partners, 2018b), which are accessed in the Data Access Viewer of NOAA. For the LiDAR data of OCM Partners (2018a), it is referenced to the North American Datum of 1983 (NAD83) in the horizontal and it provides the orthometric height which is referenced to the GEOID12B model in the vertical. To keep the projection consistence of the data, we use ArcGIS software to re-project the data to NAD83 PA11 in horizontal and adjust the height to make LMSL as the vertical reference. The vertical adjustment value from the GEOID12B to LMSL for each island can be obtained from the metadata of 2013 USACE NCMP Topobathy LiDAR – LMSL (OCM Partners, 2018c, 2018d, 2018e, 2018f, and 2018g) (Kauai: -2.71 ft, Oahu: -2.08 ft, Maui: -1.97 ft, Molokai: -1.97 ft, and Big Island: -1.56 ft). The LiDAR data of OCM Partners (2018a) have an accuracy of 1 ft in the horizontal, but the accuracy in the vertical varies among different islands: Kauai has an accuracy of 0.88 ft, Oahu has an accuracy of 0.73 ft, and Hawaii has an accuracy of 0.69 ft, each at the 95% confidence interval limit. For the LiDAR data of OCM Partners (2018b), it is referenced to the North American Datum of 1983 (NAD83) in horizontal and adjusted to LMSL in vertical. We use ArcGIS software to re-project the data to NAD83 PA11 in the horizontal before creating the DEM. OCM Partners (2018b) LiDAR data have an accuracy of 2.46 ft in the horizontal and 0.66 ft in the vertical.

After deriving the DEM, we use the tool Stack Profile in ArcGIS software to sample and extract the elevations along the transect for each milepost. The elevations are sampled at an interval of 3.28 ft.

3.2.2. Sea Level Rise

Sea level rise poses a significant threat to the Hawaiian Islands because it is one of the main drivers for coastal hazards. Therefore, we take into account sea level rise when assessing for the State of Hawaii Statewide Coastal Highway Program Report. In this project, we not only calculate historical and future sea level rise rates but also create sea level rise inundation maps for each milepost to help understand the impacts of sea level rise to the coastal roads in the Hawaiian Islands.

Historical rates of sea level rise are estimated from observed data, and future sea level rise rates are estimated from projected data. For both historical and future scenarios, it is essential to take the spatial variation into consideration when determining the rate of sea level rise. For this reason, we divide each island into a certain number of segments and derive the historical and future sea level rise rates for each segment, respectively. Figure 3.1 shows the segmentation of sea level rise for each island based on the sea level rise index introduced in Onat et al. (2018). For Hawaii Island, only Segment 2 is considered because all the mileposts are located in this segment. For Maui, Segment 2 is not considered because there are no mileposts located at this area in this project. Currently, there are two types of data used to estimate the historical sea level rise rate: tide gauge and satellite altimetry data. Tide gauges are usually placed on piers and measure the sea level relative to a nearby geodetic benchmark, known as relative sea level (RSL). Satellite altimetry measures the sea level relative to a reference ellipsoid, known as absolute sea level (ASL). This project is intended to study how the sea level rise affects the coastal roads in the Hawaiian Islands. Therefore, we focus on the trend estimates of RSL. There are six tide gauge stations in operation in the Hawaiian Islands, as shown in Figure 3.1; NAWI is located in Nawiliwili Bay, Kauai Island with data spanning 1955–2016; MOKU is located in Mokuoloe Island, Oahu Island with data spanning 1957–2016; HONO is located in Honolulu, Oahu Island with data spanning 1905–2016; KAHA is located in Kahului Harbor, Maui Island with data spanning 1947–2016; KAWA is located in Kawaihae, Hawaii Island with data spanning 1988–2016; and HIHA is located in Hilo, Hawaii Island with data spanning 1927–2016. Because considerable seasonal, interannual and decadal variability exists in sea level records, long records are required to get accurate estimates of sea level trends based on monthly mean sea level (Church and White, 2011). In this project, the RSL data of the six available stations in the Hawaiian Islands are downloaded from the Permanent Service for Mean Sea Level (PSMSL) (Holgate et al., 2013; PSMSL, 2018). We make use of all available RSL data from the six tide gauge stations to estimate the RSL trends, respectively. Before estimating the RSL trends, the following process is applied. First, the seasonal signal is removed from the RSL time series using the Seasonal Trend Decomposition using Loess (STL) procedure (Cleveland et al., 1990). Second, we remove the common-mode-oceanographic signals from each RSL time series. The common-mode-oceanographic signals can be derived by averaging the monthly detrended and de-seasoned RSL time series of the all six available tide-gauge stations in the Hawaiian Islands. Finally, the linear trends of the RSL are estimated. However, tide gauge stations are sparsely distributed and not all the segments are covered as shown in Figure 3.1. For those segments not covered by the tide gauge stations, an indirect way is applied to derive the relative sea level rise trend (RSLT). The RSL variation is comprised of two components: ASL variation and vertical land motion (VLM). Eq. (1) indicates the relationship of the three components:

$$ASLT = RSLT + VLMR \tag{1}$$

where *ASLT* represents ASL trend, *RSLT* represents RSL trend, and *VLMR* represents VLM rate. Therefore, the RSLT of the segments without tide gauge stations can be estimated by combining the ASLT and VLMR. In this project, we use the reprocessed and merged-gridded sea-level-anomaly heights for global areas processed by Ssalto/Duacs (Mertz et al., 2018) to derive the ASLT. The satellite altimetry data spans 1993–2017 and has a resolution of 0.25 arc degrees. If there is more than one satellite altimetry grid point near the study segment, the time series are averaged to derive the ASLT. Before estimating the ASLT, the Dynamic Atmospheric Correction (DAC) is downloaded and added back to the satellite altimetry data to keep in accordance with the tide gauge data which do not use the barometric pressure correction. The DAC data are produced by Collecte Localisation Satellites (CLS) using the Mog2D model from Legos and distributed by Aviso+, with support from CNES (https://www.aviso.altimetry.fr/). The satellite altimetry data is accessible at the Copernicus Marine Environment Monitoring Service (CMEMS) (http://marine.copernicus.eu/). The data of Global Navigation Satellite System (GNSS) which has proven to be a robust tool to monitor VLM (Wöppelmann and Marcos, 2016; Yang et al., 2016a; Yang et al., 2016b) is used to derive the VLMR. The GNSS data is available at the Nevada Geodetic Laboratory (NGL) (http://geodesy.unr.edu/NGLStationPages/GlobalStationList) (Blewitt et al., 2018). Detailed information for the selected tide gauge, satellite altimetry, and GNSS data of each segment is available in Yang and Francis (2019).

Several future sea level rise scenario products have been developed to help planning and decision-making stakeholders analyze and understand vulnerabilities and future risks under scientific uncertainty (Parris et al., 2012; Hall et al., 2016; Sweet et al., 2017). Parris et al. (2012) provides a set of four global mean sea level (GMSL) rise scenarios for 2100 (0.66 ft, 1.64 ft, 3.94 ft, and 6.56 ft). Hall et al. (2016) provides a set of five GMSL rise scenarios for 2100 (0.66 ft, 1.64 ft, 3.28 ft, 4.92 ft, and 6.56 ft). Sweet et al. (2017) provides a set of six GMSL rise scenarios for 2100 (0.98 ft, 1.64 ft, 3.28 ft, 4.92 ft, 6.56 ft, and 8.2 ft). Since the scenarios Sweet et al. (2017) provides represent the most up-to-date science and methodologies for regionally adjusting a given GMSL rise scenario when this project began, we use the results of Sweet et al. (2017) to estimate the future sea level rise rate for each segment. Sea levels under different scenarios of Sweet et al. (2017) are projected to tide gauge stations and grid points, which have a resolution of 1 arc degree. If a tide gauge station exists in the segment, we use the data projected to the tide gauge station. If no tide gauge station exists in the segment, the projected grid points nearby the segment will be used. If there is more than one grid point nearby a segment, the mean value is derived and used to represent the projected sea level rise of the segment. Detailed information on the projected sea level rise data for each segment is available in Yang and Francis (2019). In this project, we consider the projected sea level rise under extreme scenario for 2050 and 2100. For segments with tide gauge stations, the tide gauge data are integrated with the projected sea level rise data to obtain the future sea level rise rate. For segments without tide gauge stations, the combined satellite altimetry and GNSS data are integrated with the projected sea level rise data to obtain the future sea level rise rate.

After deriving the historical and future sea level rise rates, we rank them according to the percentile of the observed maximum rates, respectively. If a value falls within the highest 80 to 100th percentile, it is ranked 5 (very high). Similarly, values falling within the 60 to 80th percentile are ranked 4 (high), 40 to 60th percentile are ranked 3 (moderate), 20 to 40th percentile are ranked 2 (low), and 0 to 20th percentile are ranked 1 (very low).

For the inundation maps, we consider two types of scenarios: one shows the inundation due to sea level rise by a specific height (i.e., 1 ft, 2 ft, and 3 ft), and the other shows the inundation due to sea level rise by a certain time (i.e., 2050 and 2100). The process of creating maps of sea level rise inundation is as follows. Three components are required for the process. First, is the DEM. Detailed information on and the process of creating the DEM are introduced in Section 3.2.1. The second component is the tidal surface of mean higher high water (MHHW). We use the software Pydro to obtain the MHHW surface for the Hawaiian Islands region as introduced in Section 3.2.3. The determined MHHW surface is referenced to the NAD83 PA11 horizontally and referenced to LMSL vertically. The MHHW surface has a resolution of 3.28 ft, which is the same as that of the DEM. The third component is the height of sea level rise. For this component the two scenarios, sea level rise by a specific height and sea level rise by a certain time, are processed slightly differently. When mapping the inundation due to sea level rise by a specific height, the desired amount of sea level rise (i.e., 1 ft, 2 ft, and 3 ft) is directly added to the determined present MHHW surface to obtain the future MHHW surfaces. When mapping the inundation due to sea level rise by a certain time, the desired amount of sea level rise provided by Sweet et al. (2017) is added to the present MHHW surface of each segment, respectively. New MHHW surfaces of segments in each island are then mosaiced together, respectively, to get the future MHHW surface for that island. When adding the desired amount of sea level rise, which is provided by Sweet et al. (2017), to the present MHHW surface a sea level adjustment is applied. The vertical adjustment corrects base differences between the present MHHW surface which uses the National Tidal Datum Epoch (NTDE) dated 1983-2001, and the data of Sweet et al. (2017) which sets the year 2000 as the base for zero sea level rise. Therefore, the projected data of Sweet et al. (2017) is adjusted to 1992 (the midpoint of the current NTDE) from 2000 before adding to the present MHHW surface. After obtaining the future MHHW surface, a conditional evaluation is applied between the DEM and future MHHW raster surfaces using the ArcGIS software. If the cell value of the future MHHW surface is greater than that of the DEM, the cell is assigned an integer value ‘1’. Otherwise, the cell is assigned a ‘NaN’ value. Then, the integer raster is converted to polygon features. Finally, the polygon features which are connected to the ocean are selected as the sea level rise inundation areas. We repeat this process to obtain inundation maps for all scenarios, both sea level rise inundation by a specific height and sea level rise inundation by a certain time.

3.2.3. Tides

In order to incorporate the tidal variability within Hawaiian Islands region, we use a method called Tidal Constituent and Residual Interpolation (TCARI) which is presented in Hess et al. (1999) to determine the tidal datums. TCARI spatially interpolates the harmonic constituents, tidal datums and residuals (i.e., the non-tidal component) using the values at a combination of operational and historical tide gauge stations. The TCARI grid file for Hawaiian Islands region, which includes the tidal datum information, is created and provided by NOAA. We apply the publicly distributed software named Pydro, which is a suite of software tools used to support hydrography and cartography developed by NOAA and Center for Coastal and Ocean Mapping at University of New Hampshire (https://svn.pydro.noaa.gov/Docs/html/Pydro /universe_overview.html), to extract the tidal datums. In this project, we use the difference between MHHW and Mean Lower Low Water (MLLW) surfaces as the tidal range. The MHHW and MLLW surfaces are extracted using Pydro and each has a resolution of 0.01 degrees. Both the two tidal datums, MHHW and MLLW, are referred to the present National Tidal Datum Epoch (NTDE), which is 1983 through 2001. We use ArcGIS software to reduce the MLLW surface from the MHHW surface to get the tidal range surface for the Hawaiian Islands region.

Tidal range at individual mileposts are sampled from the tidal range data, using the generate near table tool in ArcGIS. Reported tidal range values are sampled and attributed to the nearest milepost through the generate near table tool.

3.2.4. Maximum Annually Recurring Waves

Due to the sparse distribution of buoy stations in the Hawaiian Islands region, there is not enough coverage to provide wave information at a local level, i.e., for each milepost. Therefore, we use modeled wave output downloaded from Pacific Islands Ocean Observing System (PacIOOS) (PacIOOS, 2018) to understand the wave conditions at each milepost. PacIOOS provides 5-day hourly wave forecasts that are calibrated using local wave buoys for the Hawaiian Islands region. Wave forecasts are simulated using WaveWatch III (WW3), surrounding the main Hawaiian Islands at an approximate resolution of 0.05 degrees, and the SWAN model, surrounding each main island at an approximate resolution of 0.31 mile (500 m) (PacIOOS, 2018). In this study, we use the wave forecasts simulated by the SWAN model, which has a finer resolution. The time span of wave data for each island varies, i.e., Oahu: 2010-2019, Maui: 2016-2019, Molokai: 2016-2019, Kauai: 2010-2019, Hawaii: 2016-2019. For each milepost, a ‘virtual buoy’, that is, the closest point offshore and perpendicular to the road at each milepost, is selected to obtain wave data. In this study, three types of wave data are analyzed, which are significant wave height, peak wave direction, and peak period. The significant wave height available from PacIOOS is estimated as four times the square root to the zeroth order moment of the wave spectrum, the peak wave direction indicates the direction that the peak surface waves are traveling from, e.g., North as zero degrees and East as ninety degrees, and the peak period is the duration between two continuous peak surface waves (PacIOOS, 2018).

We extract the maximum annually recurring wave information using the method presented in Vitousek and Fletcher (2008) and Anderson et al. (2018). The process of deriving maximum annually recurring wave information is as follows. First, we identify the local peaks from the time series of significant wave heights with a time interval greater than 24 hours. Second, the peaks are divided into different bins according to incoming directions. Here, we select a 30-degree bin window, which shifts by 15-degree increments. Therefore, a maximum of 24 bins can be obtained, and there are overlaps between bins. Third, we select the three highest significant wave heights from each year and perform the generalized extreme value (GEV) fit for each bin. Then, the maximum annually recurring significant wave height (MARSWH) and corresponding peak direction and peak period for each bin are derived. Finally, the wave information triplet with maximum MARSWH among all bins is selected as the annually recurring maximum wave information. We repeat this process to obtain wave information at each milepost, except for milepost 37 (MP 37) on Route 83, East Shore, Oahu which has no maximum annually recurring wave information since peak wave directions have changed significantly since 2016.

After deriving the wave information triplet for each milepost, we rank the two index variables, MARSWH and corresponding peak period, according to the percentile of the observed maximum value, respectively. If a value falls within the highest 80 to 100th percentile, it is ranked 5 (very high). Similarly, values falling within the 60 to 80th percentile is ranked 4 (high), 40 to 60th percentile is ranked 3 (moderate), 20 to 40th percentile is ranked 2 (low), and 0 to 20th percentile is ranked 1 (very low).

3.2.5. Shoreline Change (influenced by sea level rise)

Erosion and weakening shorelines are a direct threat to coastal roads and infrastructure. Through the course of this project, we have observed both damages and an increased failure potential of nearshore HDOT roads induced by ocean erosion. The 2019 Annual Sustainability Report by the City and County of Honolulu reported that “25% of Oahu’s sandy beach has narrowed and or been completely lost” (C&CH: OCCSR, 2019).

Seasonal and storm-driven shifts in the directional transportation of sand, as well as the projected effects of sea level rise (SLR), limit the long-term numerical modeling of Hawaiian shoreline evolution. To assess the potential impact of an acceleration of shoreline change in response to rising sea levels, we interpret relative rates of shoreline change from erosion exposure forecasts developed in the Hawaii Coastal Geology Group (HCGG) by Anderson et al. (2018). Anderson et al. (2015) describes the probabilistic method by which erosion exposure areas are determined. Anderson et al. (2015) uses an equation for shoreline change similar to that of Yates et al. (2011), while substituting in the geometric sediment transport model for shoreline equilibrium proposed by Davidson-Arnott (2005), to forecast the evolution of sandy shores on the islands of Oahu, Maui, and Kauai. Hindcast and study area limits for the Anderson et al. (2018) model are identified from historical shorelines produced through the United States Geological Survey (USGS) National Assessment of Shoreline Change: Historical Shoreline Change in the Hawaiian Islands by Fletcher et al. (2012). Hindcast timespans vary between islands and study areas. Complete hindcast timespans for each island are: 1910–2007 on Oahu, 1899–2007 on Maui, and 1926–2008 on Kauai (Fletcher et al., 2012). Acceleration of SLR used by Anderson et al. (2015) are taken from the Intergovernmental Panel on Climate Change (IPCC) 2013 report, AR5 high-end representative concentration pathway (RCP) 8.5 scenario – the “business as usual” scenario (Church et al., 2013).

Shoreline change is shown in ArcGIS by digitizing the nearshore vegetation line over different periods (Anderson et al., 2018). Digitized vegetation lines (polylines), which we refer to as “Shoreline Vegetation Lines (SVLs)”, are determined in Anderson et al. (2018) as the 80th percentile of the probability density function for change due to SLR of the present SVL defined during a 2006–2008 study. Projected shoreline change rates (ft/yr) are determined by dividing the length between the SVLs at the milepost, from the present vegetation line to future projected vegetation lines for SLR of 0.5, 1.1, 2.0, and 3.2 feet, by the number of years within the respective period. We assess the shoreline change at each milepost along a new polyline perpendicular to the road and extending through the SVLs, which we identify as the “measurement axis”. Projected occurrence for SLR of 0.5, 1.1, 2.0, and 3.2 feet is identified by Anderson et al. (2018) using the IPCC 2013 report AR5 RCP 8.5 scenario, for the years 2030, 2050, 2075, and 2100, respectively (Church et al., 2013). We average the rates of shoreline erosion (+) and accretion (−) at each milepost over the four time periods (i.e. 2030, 2050, 2075, 2100).

Rates of interpreted averaged shoreline change are ranked into five classes according to their percentile ranges, from no change and accretion to the maximum observed averaged rate. Erosion values roughly within the highest 80 to100th percentile, are ranked 5 (very high). Similarly, erosion rates falling near the 60 to 80th percentile are ranked 4 (high), the 40 to 60th percentile is ranked 3 (moderate), and the 20 to 40th percentile is ranked 2 (low). Shoreline change values representing accretion or no change, fall roughly within the 0 to 20th percentile of maximum observed values are ranked 1 (very low). Mileposts outside of the Anderson et al. (2018) study are assigned a change rate value of ‘Not Assessed‘ (N/A) and are ranked based on armoring observations made in CRESI (Brandes et al., 2019). Mileposts with shoreline change values of N/A and hard armoring, where the CRESI armor ranking is greater than 3, are ranked 2 (low). Mileposts with shoreline change values of N/A and no armoring, where CRESI armor ranking (Brandes et al., 2019) is less than or equal to 3, are ranked 3 (moderate).

3.2.6. Tsunamis

Tsunami, which is commonly caused by an earthquake in subduction zones, is one of the most devastating coastal hazards. The Hawaiian Islands region, located in the center of the Pacific Ocean, is circled by the ‘Ring of Fire’, a region of subduction zone volcanism. Therefore, the Hawaiian Islands region is significantly threatened by tsunamis, which result from earthquakes along the ‘Ring of Fire’ (Butler et al., 2017). For this reason, we take into account tsunami hazard when assessing for the State of Hawaii Statewide Coastal Highway Program Report. We use modeled tsunami flow depth data, provided by Professor Kwok Fai Cheung at the Department of Ocean and Resources Engineering at the University of Hawaii at Manoa (personal communication), to create inundation maps and ranks for each milepost which in turn helps us understand how tsunami hazards affect the coastal roads in the Hawaiian Islands. The term tsunami flow depth refers to the height of tsunami water surface above ground, which can be derived by subtracting ground elevation from tsunami water level. In this project, we use two types of tsunami flow depth data: one is modeled according to historical earthquake events, and the other is based on hypothetical earthquake events. Both types of data were simulated using the model Non-hydrostatic Evolution of Ocean Wave (NEOWAVE), which is a community model developed and maintained at the University of Hawaii (Yamazaki et al., 2011; Yamazaki et al., 2009). Historical tsunami scenarios are based on the five most destructive far-field or trans-Pacific tsunamis, which were generated by the 1946 Aleutian, the 1952 Kamchatkan, the 1957 Aleutian, the 1960 Chilean, and the 1964 Alaskan earthquakes. NEOWAVE model parameters are calibrated by comparing results with well-documented runup records for those tsunamis on Hawaii shores (Cheung, 2009, 2011, 2012, and 2013). The NEOWAVE model applied nested grids with increasing resolution, from 2 arcminutes (~2.3 miles) for open ocean to 0.3 arcseconds (~29.53 ft) for coastlines (Cheung, 2009, 2011, 2012, and 2013). Hypothetical tsunami scenarios are based on two extreme tsunamis which apply the seismic source parameters of two hypothetical great Aleutian earthquakes. Tectonic parameters of the two great Aleutian earthquakes, with moment magnitudes of (Mw) 9.3 and 9.6, were compiled by NOAA Pacific Marine Environmental Laboratory (PMEL) and both hypothetical earthquakes are identified by a seismological study as potential sources of devastating tsunamis to Hawaii (Bulter, 2012; Cheung, 2015). The model also applies nested grids with increasing resolution from 2 arcminutes (~2.3 miles) for open ocean to 0.3 arcseconds (~29.53 ft) for coastlines (Cheung, 2015).

We use the Geographical Information System (GIS) software ArcGIS to create tsunami inundation maps and extract tsunami flow depth values for each milepost. Tsunami flow depths are ranked for each milepost as follows. First, mileposts are classified into three categories: Category 1 has values in the historical scenario, Category 2 has no values in the historical scenario, but has values in the hypothetical scenario, and Category 3 has no values in both historical and hypothetical scenarios. For Category 1, if a value falls within the highest 67 to 100th percentile of the observed maximum value in the historical scenario, it is ranked 5 (very high). Similarly, if a value falls within the 33 to 67th percentile, it is ranked 4 (high), and within the 0 to 33rd percentile, it is ranked 3 (moderate). For Category 2, because the tsunami flow depth in the hypothetical scenario for milepost 6 (MP 6) on Route 83, North Shore, Oahu exceeds three standard deviations of the mean, we rank it 2 and remove it from the list when searching the maximum value of Category 2. Therefore, if a value falls within the highest 50 to100th percentile of the observed maximum value in the hypothetical scenario, it is ranked 2 (low), within the 0 to 50th percentile, it is ranked 1 (very low). All mileposts in Category 3 are ranked 1 (very low).

3.2.7. Storm Surge

Predicting and preparing for hurricanes is a top priority for the residents and city managers of Hawaii. City and County of Honolulu suggests in their 2019 Annual Sustainability Report, that an "estimated ... 64% of all single-family homes on Oahu lack sufficient hurricane wind resistance" (C&CH: OCCSR, 2019). To assess the "worst case scenario" of inundation from storm surge, we utilize the most recent national storm surge hazard maps produced by the Storm Surge Unit (SSU) of the National Hurricane Center (NHC), National Oceanic and Atmospheric Administration (NOAA) (Zachry et al., 2015).

Version 1 of the national storm surge hazard maps are published by Zachry et al. (2015) and include inundation model results for flooding caused by storm surge along the East and Gulf Coasts of the United States. Version 2, also by Zachry et al. (2015), became available in November 2018 and include storm surge inundation estimates for the U.S. Virgin Islands, Hawaii, and Hispaniola. Measures of storm surge inundation height reflect the extents of flooding caused by storm driven uplift of the ocean surface. Estimates of storm surge inundation in this assessment are based on GIS datasets obtained through personal communication with members of the SSU and NOAA affiliates. Internal SSU issues, beyond the control of our team, have prevented a complete handover and description of the Hawaii storm surge data. As a result of the incomplete handover, there are minor errors in the projection of the data, as well as a limited understanding of the model hindcast. Storm surge hazard maps present hypothetical inundations found using a composite deterministic and probabilistic approach with the Sea, Lake and Overland Surges from Hurricanes (SLOSH) numerical model, developed by the National Weather Service (NWS). In the Hawaiian Islands, where steep offshore bathymetry can produce an increase in mean water level due to wave dissipation, or wave setup, the SLOSH model is loosely coupled to the third generation of the SWAN model to account for storm-related increases in mean water levels. SLOSH model forecasts consider historical atmospheric and hurricane track data, to produce a model of the wind field which drives hypothetical storm surge. However, as we mention, internal SSU issues prevents us from describing the time period for the historical atmospheric data, as well as the number and distribution of historical storm tracks.

Hawaii SLOSH model estimates include inundation scenarios for category 1 through 4 hurricanes and a broad range of storm tracks and landfall locations, consisting of hundreds of thousands of hypothetical hurricanes. Assessed storm surge inundation heights are determined as the maximum of the maximum envelops of water (MOMs), relative to a DEM of Hawaii from NOAA Office for Coastal Management (OCM) high-resolution raster elevation datasets. DEMs for each island are reoriented and divided to optimize SLOSH operation, resulting in polar oriented cells of various sizes, as small as roughly 24 ft (9 m), on each side. Within each cell, MOM values are determined in feet as a combination of all simulated inundation scenarios, with the MOM identifying the greatest observed inundation height from all simulations. Milepost assessments of storm surge inundation are sampled from the individual category of storm surge datasets, within a circular buffer centered on the milepost with a radius of 82 ft (25 m). Ranked values of storm surge inundation are determined as the percent coverage-area-weighted mean of the MOM values within the milepost buffer area. Percent coverage for each milepost buffer area is determined by first using the ArcGIS zonal statistics tool to find the buffer area overlapping with the storm surge dataset. Then, the inundation, or overlapping of the buffer area, is divided by the known total buffer area of roughly 21,000 square ft, to determine the percentage of the buffer inundated. Mean inundation height within the milepost buffer areas is also determined using the ArcGIS zonal statistics tool. Ranked values of storm surge inundation are finally calculated as the mean inundation height multiplied by the percent coverage.

Percent coverage-area-weighted mean storm surge inundation heights are ranked based on their observed distribution within the maximum observed value of each category of storm, respectively. Mileposts with inundation heights within the 50 to 100th percentile of Category 1 storm surge are ranked 5 (very high). Inundation heights greater than zero and within the 0 to 50th percentile of Category 1 storm surge, as well as the 50 to 100th percentile of Category 2 storm surge, are ranked 4 (high). If milepost inundation heights for Category 2 storm surge are greater than zero and within the 0 to 50th percentile, or within the 50 to 100th percentile for Category 3 storm surge, they are ranked 3 (moderate). Storm surge inundation heights within the 50 to 100th percentile for Category 4 storm surge, or within the 0 to 50th percentile for Category 3 storm surge are ranked 2 (low). Milepost assessments with no inundation, or with inundation heights in the 0 to 50th percentile for Category 4 storm surge are ranked 1 (very low).

3.2.8. Nearshore Benthic Habitat

Nearshore benthic habitats represent both the structural and biological diversity of the shallow ocean. In Hawaii, certain benthic habitats can influence shallow wave dynamics, as well as the type and implementation of shoreline adaptations. In this study, Hawaiian benthic habitat information is sampled from GIS datasets of geomorphological structure and biological cover submitted by BAE Systems with their "Mapping of Benthic Habitats for The Main Eight Hawaiian Islands" report to NOAA in 2007(BAE Systems, 2007). Habitat and structural extents are interpreted and digitized from multispectral satellite imagery of Hawaiian shores using both computational and manual methods (BAE Systems, 2007). Interpretation and results are based on a two-tiered classification system that integrates geomorphologic reef structure and biological cover into a single scheme, with subsets for each detail. Fourteen combined reef zone classifications are subdivided into two morphological structure classifications, major and detailed, as well as biological coverage classifications, which includes both the type and percent extent of coverage for a zone (BAE Systems, 2007).

Assessment of the benthic habitat data is accomplished in ArcGIS using the generate near table tool. Along polylines perpendicular to the road at each milepost, near tables are produced from reduced habitat polygons excluding unidentified or land classified zones. At each milepost and polyline pair, the nearest reef zone (Zone), major and detailed morphological structure (Major Structure/Detailed Structure), and biological cover are sampled and reported.

3.3. Results and Discussion: Ocean Hazards Database (OHD) and Ocean Hazards Classification Scheme (OHCS) for State of Hawaii DOT coastal highways

The Ocean Hazards Classification Scheme (OHCS) for the State of Hawaii DOT coastal highways, based on the OHD, is shown in Table 3.2. The star (*) represents those variables to be used in CRESI (see Chapter 1) for this study. We take the greatest value in each dataset for N = 302 and divide by 5 to get the percent range, and rank the percent ranges as 1 (very low or 0-20%), 2 (low or 21-40%), 3 (medium or 41-60%), 4 (high or 60-80%) and 5 (very high or 81-100%). All values were round to the nearest significant figure.

3.3.1. Elevation and Bathymetric Transects

Elevation and bathymetric transects are useful for obtaining the road position relative to the shoreline. We extend transects beyond the waterline to obtain the nearshore and offshore bathymetric elevations for each milepost. The results are used in CRESI which are discussed in Chapter 1. A mapping and plot example of a combined topographic and nearshore bathymetric transect is given in Figure 3.2, and an offshore bathymetric transect is given in Figure 3.3.

3.3.2. Sea Level Rise

For Variable 1, sea level rise (SLR), which include Variables 1a, 1b, 1c (i.e. 2050, 2100, historical), we estimate and rank SLR rate (Table 3.2). Variable 1c, SLR historical rate, is used in CRESI for this report (Version 1). Variables 1a, 1b, 1c (i.e. 2050, 2100, historical) have a maximum of 0.52, 1.09, and 0.10 in/yr, respectively, for N = 302 (Francis et al., 2019). For 2050, this puts the majority of mileposts at rank 2 (0.1 to 0.2 in/yr) and rank 3 (0.4 to 0.7 in/yr) for 2100. Although for 2050 and 2100, 21% of N = 302 fall within rank 5 (≥0.4 in/yr and ≥0.9 in/yr, respectively) (Tables 3.2 and 3.3). For historical sea level rise rate (in/yr), the majority of mileposts fall within the highest ranges, rank 4 and 5 (i.e. ≥0.06 in/yr) (Tables 3.2 and 3.3).

For Variable 1, SLR, we also estimate inundation (Tables 3.4, 3.5 and 3.6). Table 3.4 shows the SLR inundation by 1, 2, 3 feet. Tables 3.5 and 3.6 show the SLR inundation by 2050 and 2100 for six different scenarios (i.e. lowest, low, intermediate, high, highest, extreme) based on historical and projected data. The "X" indicates inundation between mileposts, rather than at the milepost (filled circles). From the results, we see that the SLR inundation, for all mileposts, both by feet and by year 2050, fall within the extreme and highest scenarios (Rank 1-2). For 2100, most mileposts fall within the extreme, highest, high scenarios (Rank 1-3). Mapping examples of Variable 1, SLR, for 1, 2, 3 feet, 2050, and 2100 are given in Figures 3.4, 3.5, and 3.6, respectively.

Although we develop the SLR inundation for roads using Hall et al. (2016) and Sweet et al. (2017) predictions, after personal communication with experts (Charles Fletcher, Ph.D. and Philip Thompson, Ph.D.), we choose the Sweet et al. (2017) prediction for our study. From the Sweet et al. (2017) prediction, we chose the 2050 SLR rate and inundation to use in both CRESI and the engineering adaptation assessment, since it correlates well to the SLR 1, 2, 3 ft version, which is currently being used by the State of Hawaii DOT and most agencies.

Upon closer examination of the inundation for Variable 1a, 2050 SLR, there is no inundation at 1 ft (Rank 4 & 5), while only one milepost, Molokai MP 9, is cutoff at 2 ft (Rank 2 & 3). For the 2050 SLR inundation, high scenario (Rank 2 & 3) and the highest scenario (Rank 1 & 2) include: MP 9 Molokai, Molokai; and 0+0.53 Molokai, Molokai; and MP 1, 1+0.05 on East Maui, Maui. For SLR at 3ft (Rank 1) or SLR extreme scenario (Rank 1) by 2050, there are 15 mileposts which include: MP 36, East Shore, Oahu; MPs 1, 1+0.50 at East Maui, Maui; and MPs 0+0.53, 3, 3+0.75, 5+0.38, 8+0.21, 8+0.63, 0; 9+0.41, 10, 10+0.06, 14+0.70, 16 at Molokai, Molokai (Tables 3.4 and 3.5). For SLR 2100, there is inundation almost everywhere due to the steep projections provided in Sweet et al. (2017).

For road relocation in Chapter 4, Adaptation Recommendations, we only consider SLR at 3ft (Rank 5) or SLR extreme scenario (Rank 5) by 2050.

3.3.3. Tides

For Variable 2, tides, we estimate the tidal range (ft), rather than the rate or inundation. Variable 2, tides, is used in CRESI for this report (Version 1). The high tide height is 2.398 ft and the low tide height is 1.930 ft (Francis et al., 2019). This is considered a small tidal range compared to some areas, such as the U.S. East Coast tidal range (Gornitz et al., 1994). For N = 302, the majority of mileposts (129) fall within rank 2 (2.0-2.1 ft) for a tidal range (Tables 3.2 and 3.3).

3.3.4. Maximum Annually Recurring Waves

Variable 3, maximum annually recurring waves, include Variable 3a, peak wave period (sec); and Variable 3b, significant wave height (ft). Variable 3b, maximum annually recurring significant wave height (ft), is used in CRESI for this report (Version 1). Tables 3.2 3.3 and 3.7 show that the majority (113) of N = 302 mileposts have a wave period of rank 5 (≥14 sec), while the majority (234) have a significant wave height of rank 1 (<7 ft). A wave period of ≥14 sec is of no surprise given Hawaii's location to the open ocean, and although <7 ft is a low wave height for Hawaii, the same value would be considered a high wave event in other areas, such as Northwestern Alaska (Francis et al., 2011; Francis and Atkinson 2012a; 2012b). A mapping example of Variable 3, maximum annually occurring waves, which includes wave period, significant wave height, and wave direction, is given in Figure 3.7.

When we look at the bathymetry along the peak wave direction for Variables 3a and 3b, we see that the majority of mileposts are "open to the ocean", instead of "sheltered to open ocean" meaning the nearshore is sheltered then opens to the ocean to the island shelf, or "interisland channel" meaning there is another island which creates a channel, so the bathymetry never opens to the ocean and to the island shelf (Table 3.8).

3.3.5. Shoreline Change

For Variable 4, shoreline change rate, i.e. the linear amount that the shoreline moves per year, we estimate the shoreline change rate using Variable 4a, mean shoreline change rate, and Variable 4b, resistance to erosion. Variable 4a, shoreline change rate, is used in CRESI for this report (Version 1). Variable 4b, armoring ranking (Brandes et al., 2019), a variable in CRESI, fills in the gaps where the mean shoreline change rate (Anderson et al., 2018) did not provide values. We combine Variables 4a and 4b to get a mean shoreline change rate (ft/yr) (Tables 3.1 and 3.2).

From Tables 3.3 and 3.9, we see that an overwhelming majority of N = 302 mileposts fall within rank 2-3 (0 ft to 5 ft/yr). For extreme erosion >5 ft/yr, there are 6 mileposts in this category, which include MPs 0+0.05 and 6 at Central Maui, Maui; MP 2+0.50 at North Shore Kauai, Kauai; and MPs 26+0.16, 26+0.66, and 28 at West Kauai, Kauai. Besides seasonal influences, the shoreline change rate could be higher or lower for a number of reasons such as surrounding groins, boat harbors, dredging, etc. and whether the site is armored or not. A mapping example of Variable 4, shoreline change, is given in Figure 3.8.

3.3.6. Tsunamis

For Variable 5, tsunami flow depth (ft), the distribution is more even for ranks 1-5. The majority of N = 302 mileposts fall within rank 3–4, with a historical inundation of 0-12 ft (Tables 3.2 and 3.3, and 3.10). A mapping example of Variable 5, tsunami inundation, is given in Figure 3.9.

3.3.7. Storm Surge

For Variable 6, storm surge height (ft), a majority of mileposts fall within rank 1, no inundation or Category 4 inundation <4 ft (Tables 3.2, 3.3, and 3.10). A mapping example of Variable 6, storm surge Category 1 & 2, is given in Figure 3.10, and storm surge Category 3 & 4, is given in Figure 3.11.

3.3.8. Nearshore Benthic Habitat

For Variable 7, nearshore benthic habitat, although it is not ranked for this report (Version 1), it is still considered an important variable for wave transformation, and design/build in the nearshore/offshore region. We provide habitat data in the OHD (Francis et al, 2019) at each of the 302 mileposts.

3.5. Future Work for Chapter 3, Ocean Hazards

(UPDATE: For Chapter 3, DOT requested no changes be made from Version 1. Complete maps and tables for Chapter 3 can be found on Francis et al., 2019).

We plan to further analyze the OHD and OHCS, and provide more results and discussion. From these results, we will provide conclusions for Chapter 3, Ocean Hazards. We have not provided conclusions yet, based on the need for further analysis.

We also plan to update Chapter 1, CRESI, in the State of Hawaii Statewide Coastal Highway Program Report, Version 2 (Final), to include Variables 1a, 2, 3b, 4, 5, and 6 (Version 2). As of this report, only four variables are used in CRESI for the State of Hawaii Statewide Coastal Highway Program Report, Version 1: Variables 1c, 2, 3, and 4.

We also plan to include MP 3 + 0.30, North Shore, Oahu, which was not provided in the original version in the new Chapter 3. This will then bring the total mileposts from 302 to 303.

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See additional Reference list on footnote on Tables 3.1 to 3.11

3.7. Table of Figures (Figure 3.1 -3.11)

Figure 3.1. Map of sea level rise segmentation in the Hawaiian Islands. Map showing the segmentation of sea level rise in the Hawaiian Islands based on the sea level rise index presented in Onat et al. (2018b). The sea level rise index data are available in Onat et al. (2018a). "S" represents segment.

Figure 3.2. Sample map and plot of combined topographic and nearshore bathymetric transect at MP 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). (a) Map and (b) plot of combined topographic and nearshore bathymetric transect perpendicular to the State of Hawaii Department of Transportation (HDOT) route 83 at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). HDOT state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Elevations along the transect are referenced to local mean sea level (LMSL) and are sampled from a merged digital elevation model (DEM) of Oahu prepared by Francis et al. (2019).

Figure 3.3. Sample map and plot of offshore bathymetric transect along the peak wave direction at MP 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). (a) Map and (b) plot of the offshore bathymetric transect taken along the peak wave direction at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Elevations along the transect are referenced to local mean sea level (LMSL) and are sampled from a Hawaiian bathymetric digital elevation model (DEM) created by the Hawaii Mapping Research Group (2016).

Figure 3.4. Sample map of sea level rise inundation for +1, 2, 3 ft along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of sea level rise (SLR) inundation for +1, 2, 3 ft along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Future SLR for +1 ft, +2 ft, and +3 ft are shown with respect to mean higher high water (MHHW).

Figure 3.5. Sample map of sea level rise inundation by 2050 along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of sea level rise (SLR) inundation by 2050 along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Future SLR projections by 2050 are based on the report of Sweet et al. (2017) with respect to mean higher high water (MHHW).

Figure 3.6. Sample map of sea level rise inundation by 2100 along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of sea level rise (SLR) inundation by 2100 along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Future SLR projections by 2100 are based on the report of Sweet et al. (2017) with respect to mean higher high water (MHHW).

Figure 3.7. Sample map of maximum annually recurring wave information at Virtual Buoy (VB) 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). Map of maximum annually recurring wave information at Virtual Buoy (VB) 28+0.38, SR 83, perpendicular to the State of Hawaii Department of Transportation (HDOT) route 83 at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. PWD represents Peak Wave Direction, from which the wave is coming, SWH represents Significant Wave Height, and PWP represents Peak Wave Period. Virtual Buoys (VB) are identified by Francis et al. (2019), and Mileposts (MP) are identified by Brandes et al. (2019). HDOT state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). The maximum annually recurring wave information is available at Francis et al. (2019), which is derived according to the method presented in Anderson et al. (2018) and Vitousek & Fletcher (2008).

Figure 3.8. Sample map of projected shoreline change with sea level rise at MP 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). Map of projected vegetation lines for various sea level rise (SLR) heights at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Projected vegetation lines are determined and reported by the Hawaii Coastal Geology Group (HCGG) in Anderson et al. (2018). Rate of projected erosion is determined as a mean value of rates along the measurement axis (magenta line) from the 2008 vegetation line (blue) to subsequent SLR vegetation lines (red, orange, yellow, and green). Dates for SLR elevations are reported by Anderson et al. (2018) using the IPCC AR5 high-end representative concentration pathway (RCP) 8.5 scenario as 2030 for 0.5 ft of SLR, 2050 for 1.1 ft of SLR, 2075 for 2.0 ft of SLR, and 2100 for 3.2 ft of SLR.

Figure 3.9. Sample map of tsunami inundation along Mile 28, SR 83, East Shore, Oahu. Map of tsunami inundation based on historical events (1946 Aleutian, 1952 Kamchatka, 1957 Aleutian, 1960 Chile, and 1964 Alaska tsunamis) and hypothetical events (two great Aleutian earthquakes with moment magnitude (Mw) 9.3 and 9.6 as potential sources) along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Potential inundation areas are determined by the tsunami flow depth datasets reported in Cheung (2009, 2011, 2012, 2013, and 2015) with respect to mean higher high water (MHHW).

Figure 3.10. Sample map of Category 1 & 2 storm surge inundation along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of modeled storm inundation from Category 1 & 2 storms along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Storm surge maximum of maximum (MOM) inundation extents are determined by the NOAA National Hurricane Center Storm Surge Unit using the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model, and are reported in Zachry et al. (2015).

Figure 3.11. Sample map of Category 3 & 4 storm surge inundation along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of modeled storm inundation from Category 3 & 4 storms along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets were acquired from HDOT (2017) and HOLIS, C&CH (2017). Storm surge maximum of maximum (MOM) inundation extents were determined by the NOAA National Hurricane Center Storm Surge Unit using the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model, and are reported in Zachry et al. (2015).

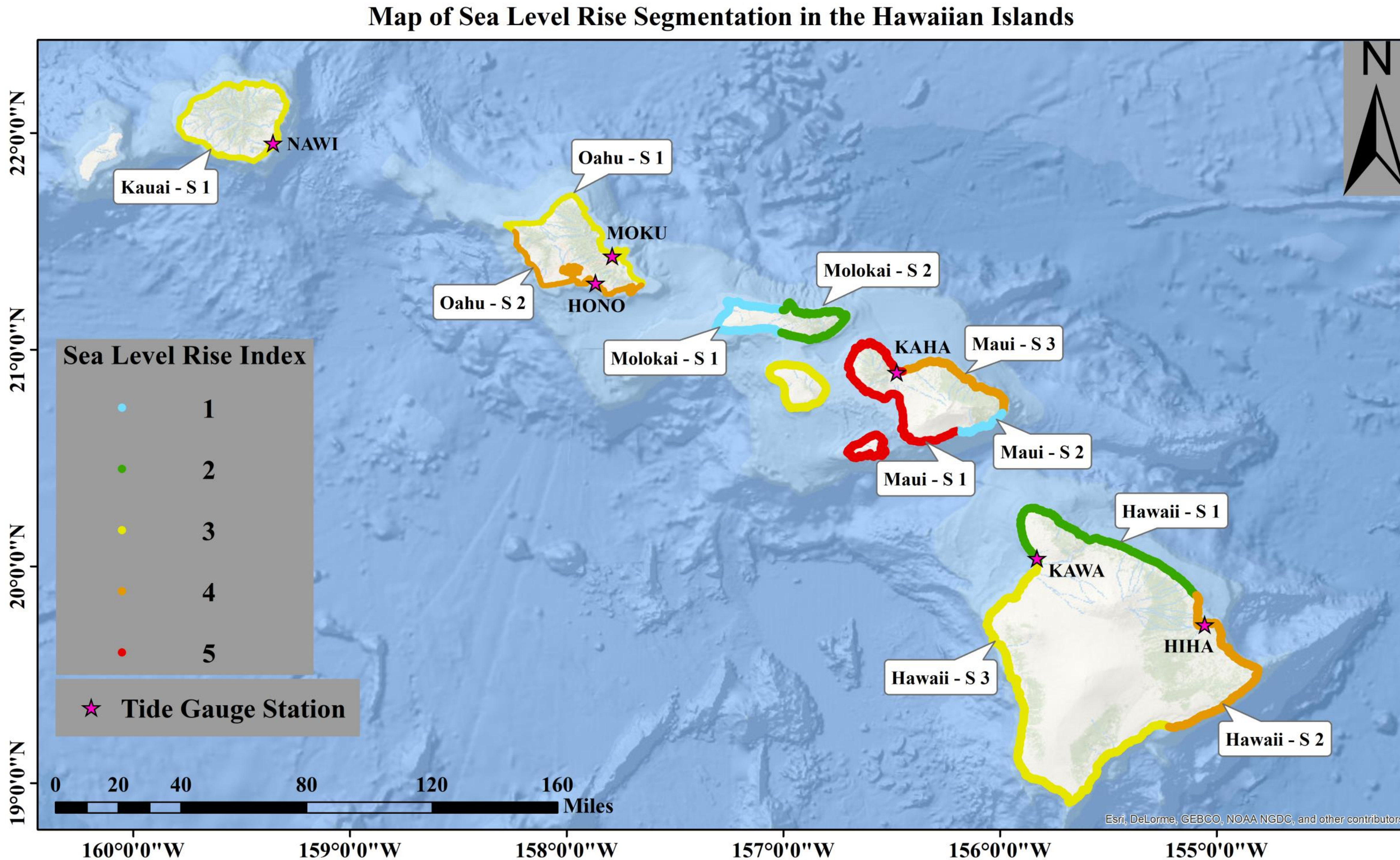

Figure 3.1. Map of sea level rise segmentation in the Hawaiian Islands. Map showing the segmentation of sea level rise in the Hawaiian Islands based on the sea level rise index presented in Onat et al. (2018b). The sea level rise index data are available in Onat et al. (2018a). “S” represents segment.

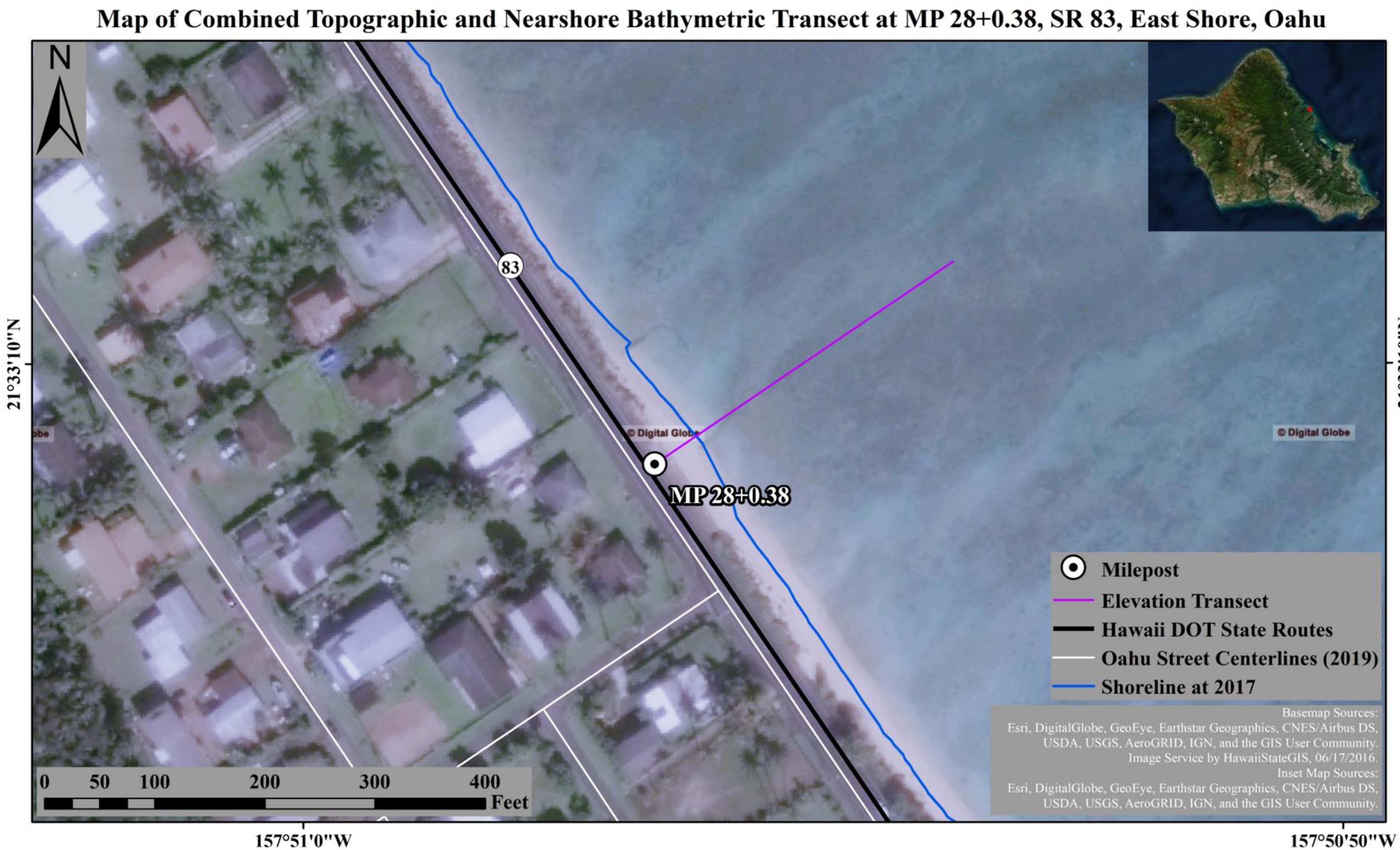

Figure 3.2. Sample map and plot of combined topographic and nearshore bathymetric transect at MP 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). (a) Map and (b) plot of combined topographic and nearshore bathymetric transect perpendicular to the State of Hawaii Department of Transportation (HDOT) route 83 at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). HDOT state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Elevations along the transect are referenced to local mean sea level (LMSL) and are sampled from a merged digital elevation model (DEM) of Oahu prepared by Francis et al. (2019).

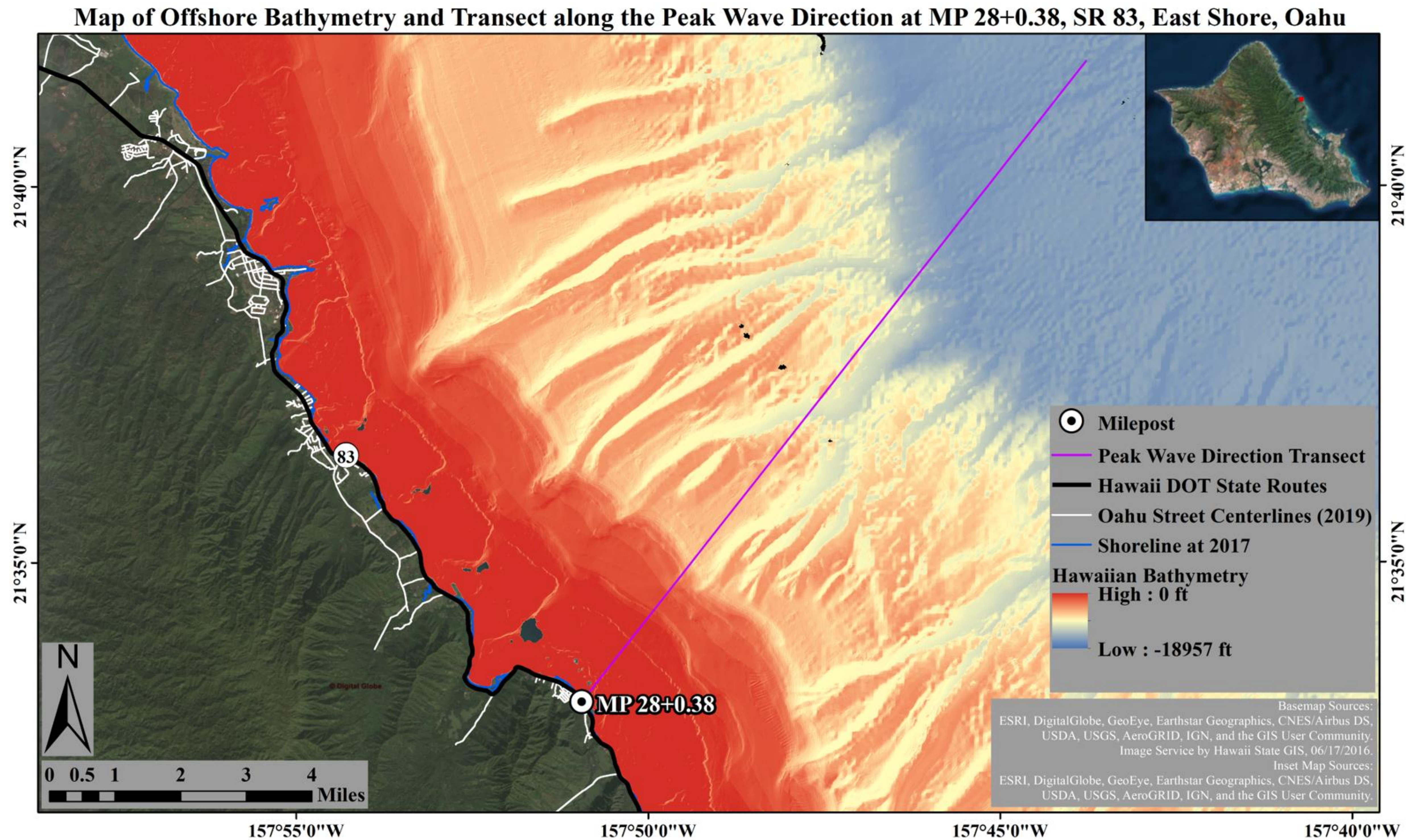

Figure 3.3. Sample map and plot of offshore bathymetric transect along the peak wave direction at MP 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). (a) Map and (b) plot of the offshore bathymetric transect taken along the peak wave direction at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Elevations along the transect are referenced to local mean sea level (LMSL) and are sampled from a Hawaiian bathymetric digital elevation model (DEM) created by the Hawaii Mapping Research Group (2016).

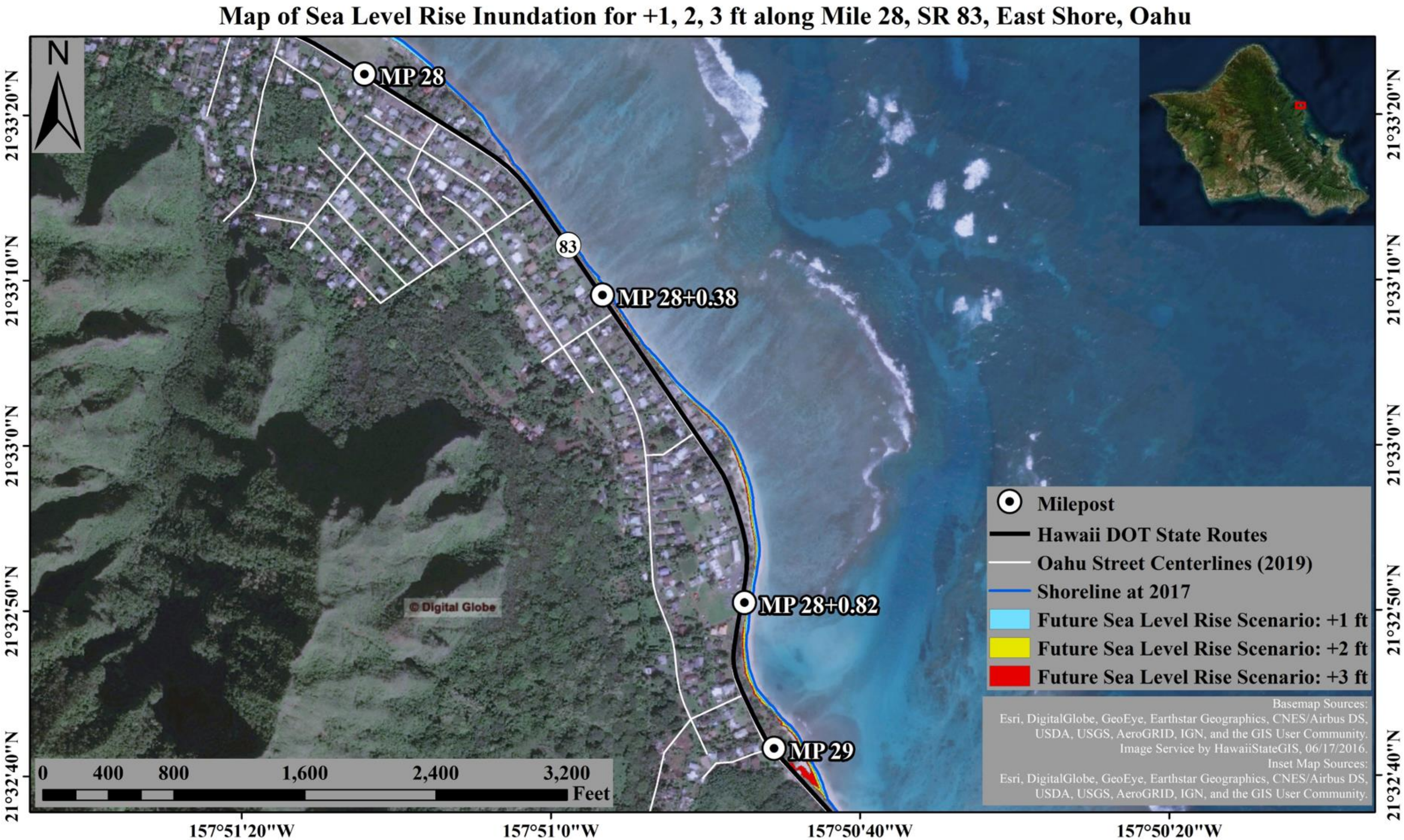

Figure 3.4. Sample map of sea level rise inundation for +1, 2, 3 ft along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of sea level rise (SLR) inundation for +1, 2, 3 ft along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Future SLR for +1 ft, +2 ft, and +3 ft are shown with respect to mean higher high water (MHHW).

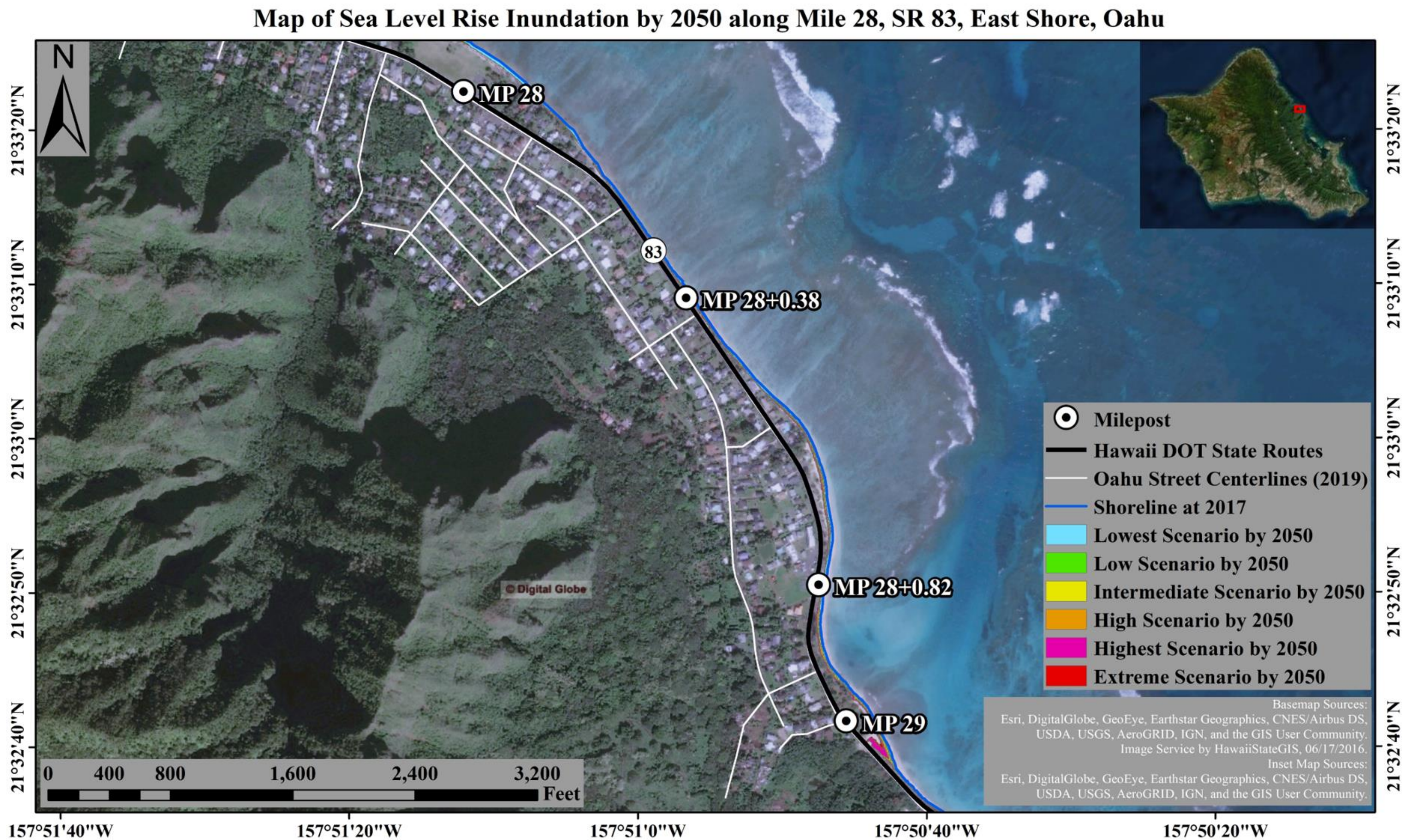

Figure 3.5. Sample map of sea level rise inundation by 2050 along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of sea level rise (SLR) inundation by 2050 along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Future SLR projections by 2050 are based on the report of Sweet et al. (2017) with respect to mean higher high water (MHHW).

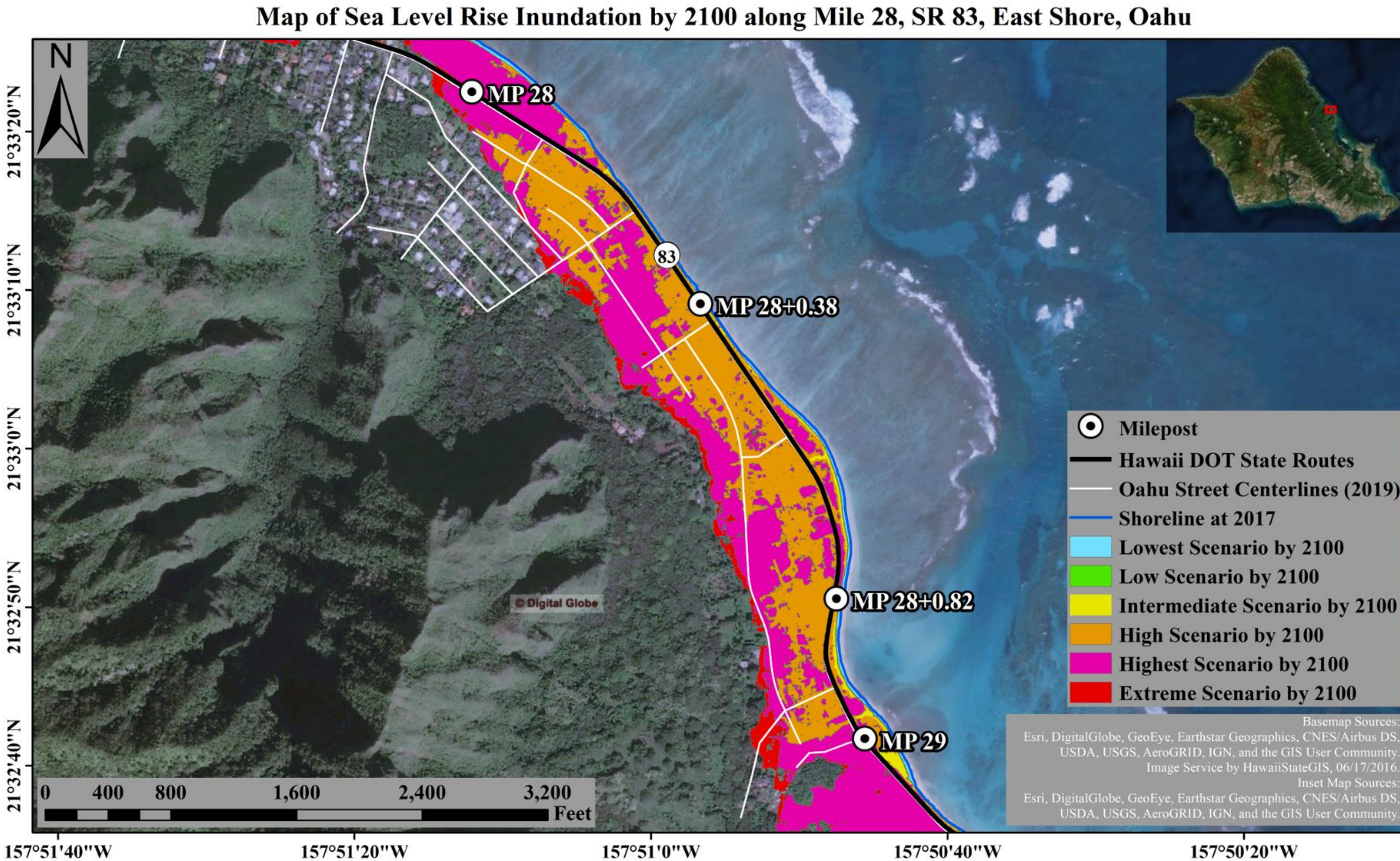

Figure 3.6. Sample map of sea level rise inundation by 2100 along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of sea level rise (SLR) inundation by 2100 along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Future SLR projections by 2100 are based on the report of Sweet et al. (2017) with respect to mean higher high water (MHHW).

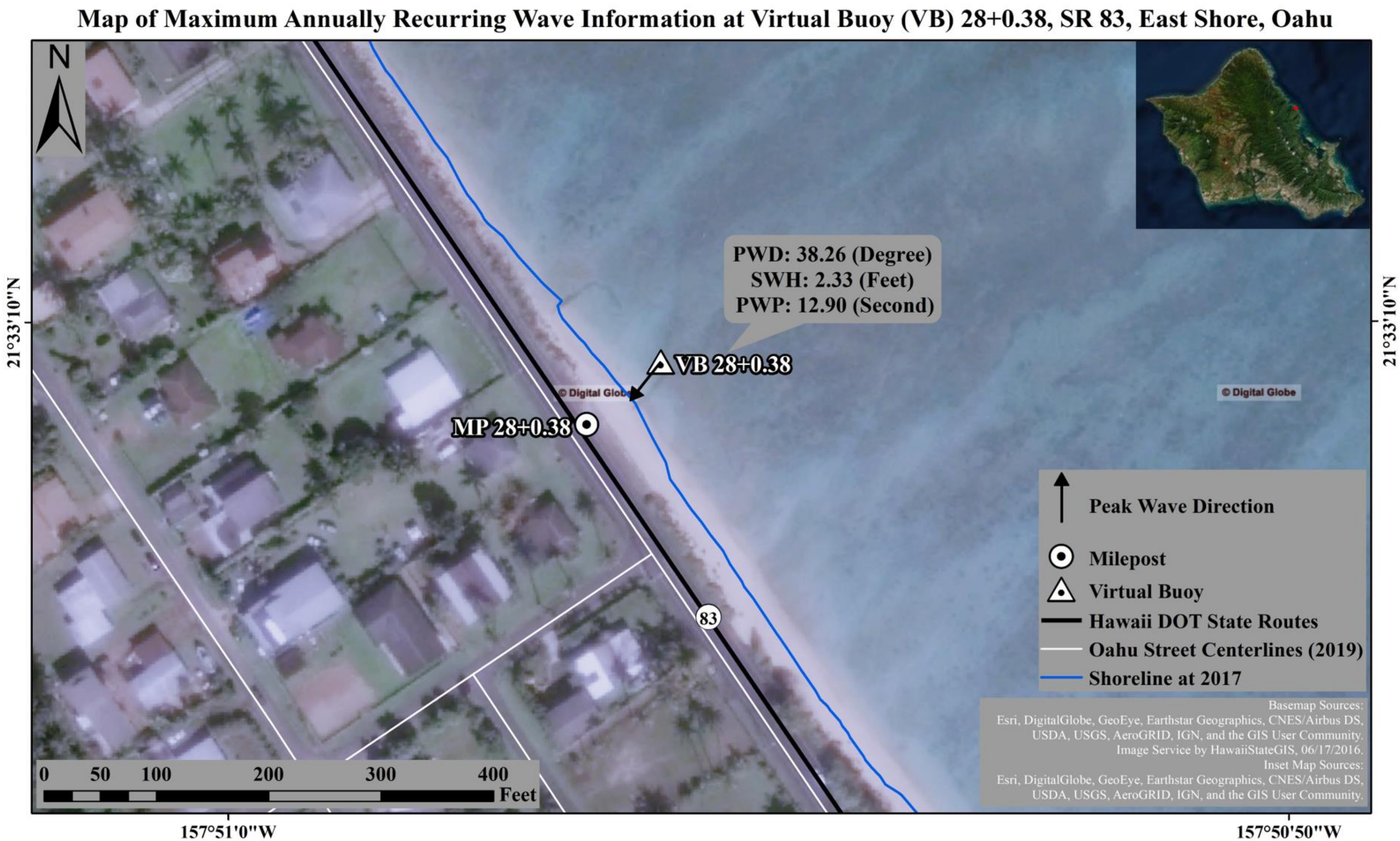

Figure 3.7. Sample map of maximum annually recurring wave information at Virtual Buoy (VB) 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). Map of maximum annually recurring wave information at Virtual Buoy (VB) 28+0.38, SR 83, perpendicular to the State of Hawaii Department of Transportation (HDOT) route 83 at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. PWD represents Peak Wave Direction, from which the wave is coming, SWH represents Significant Wave Height, and PWP represents Peak Wave Period. Virtual Buoys (VB) are identified by Francis et al. (2019), and Mileposts (MP) are identified by Brandes et al. (2019). HDOT state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). The maximum annually recurring wave information is available at Francis et al. (2019), which is derived according to the method presented in Anderson et al. (2018) and Vitousek & Fletcher (2008).

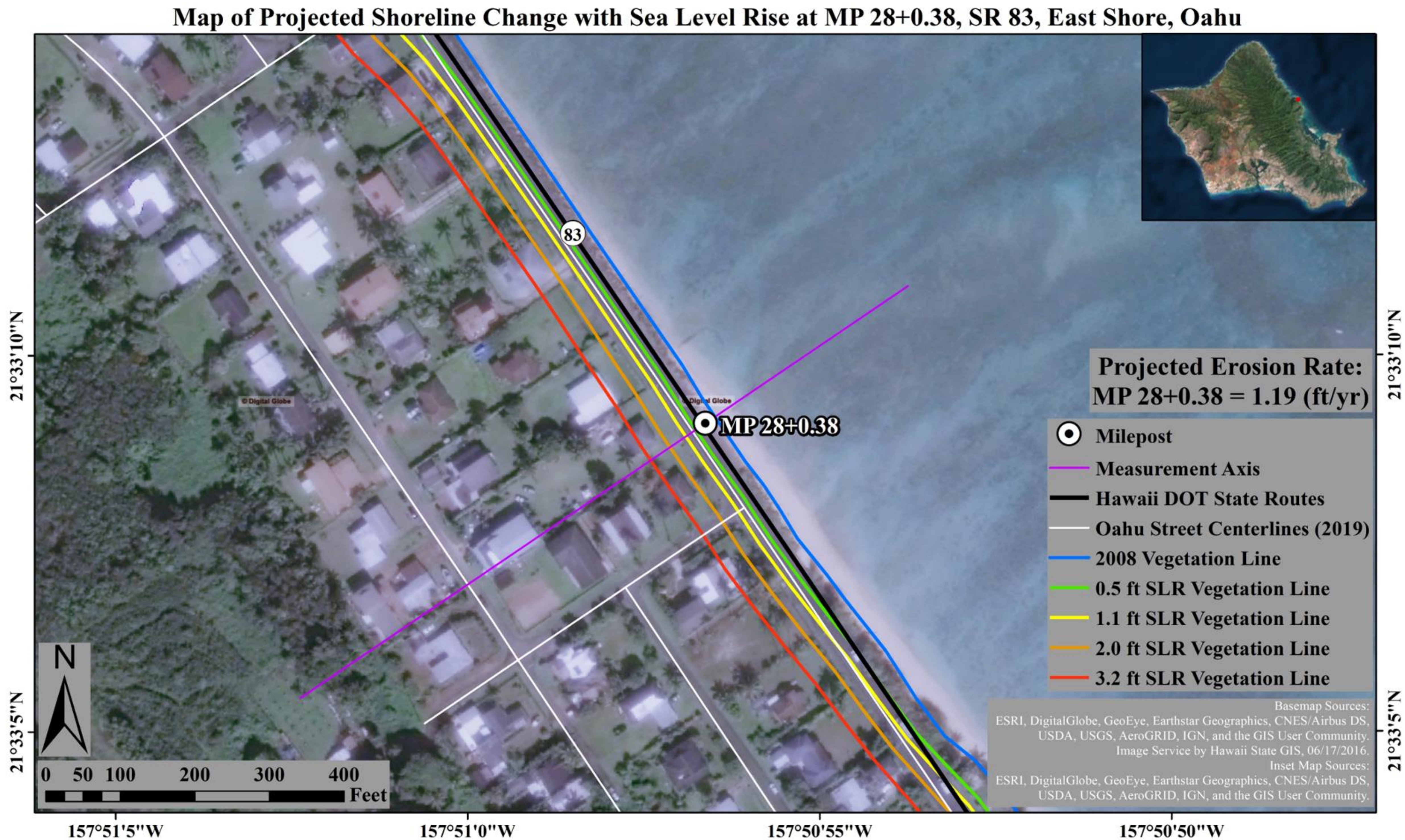

Figure 3.8. Sample map of projected shoreline change with sea level rise at MP 28+0.38, SR 83, East Shore, Oahu (Francis et al., 2019). Map of projected vegetation lines for various sea level rise (SLR) heights at Milepost (MP) 28+0.38, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Projected vegetation lines are determined and reported by the Hawaii Coastal Geology Group (HCGG) in Anderson et al. (2018). Rate of projected erosion is determined as a mean value of rates along the measurement axis (magenta line) from the 2008 vegetation line (blue) to subsequent SLR vegetation lines (red, orange, yellow, and green). Dates for SLR elevations are reported by Anderson et al. (2018) using the IPCC AR5 high-end representative concentration pathway (RCP) 8.5 scenario as 2030 for 0.5 ft of SLR, 2050 for 1.1 ft of SLR, 2075 for 2.0 ft of SLR, and 2100 for 3.2 ft of SLR.

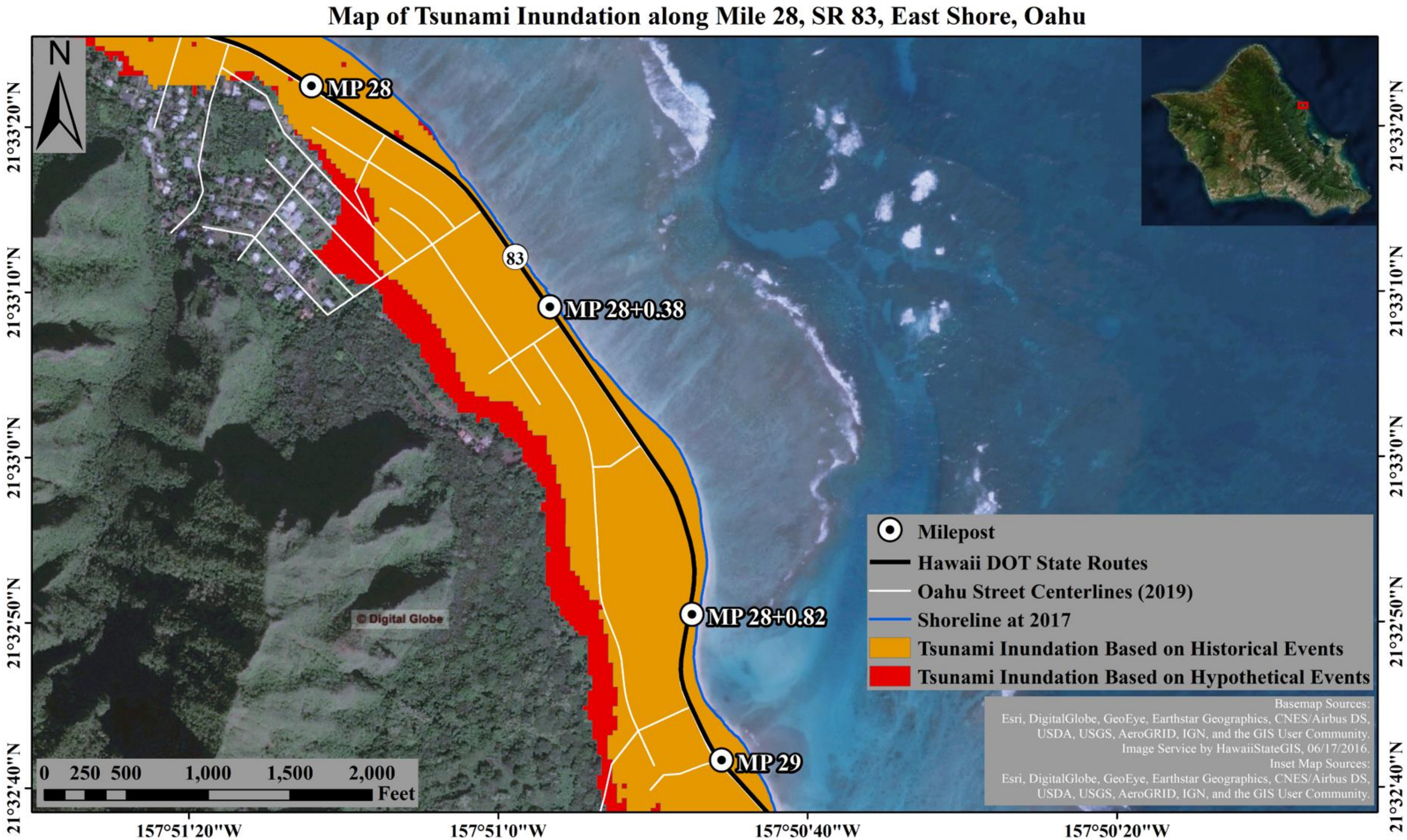

Figure 3.9. Sample map of tsunami inundation along Mile 28, SR 83, East Shore, Oahu. Map of tsunami inundation based on historical events (1946 Aleutian, 1952 Kamchatka, 1957 Aleutian, 1960 Chile, and 1964 Alaska tsunamis) and hypothetical events (two great Aleutian earthquakes with moment magnitude (Mw) 9.3 and 9.6 as potential sources) along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Shoreline datasets are provided by NGS (2017). Potential inundation areas are determined by the tsunami flow depth datasets reported in Cheung (2009, 2011, 2012, 2013, and 2015) with respect to mean higher high water (MHHW).

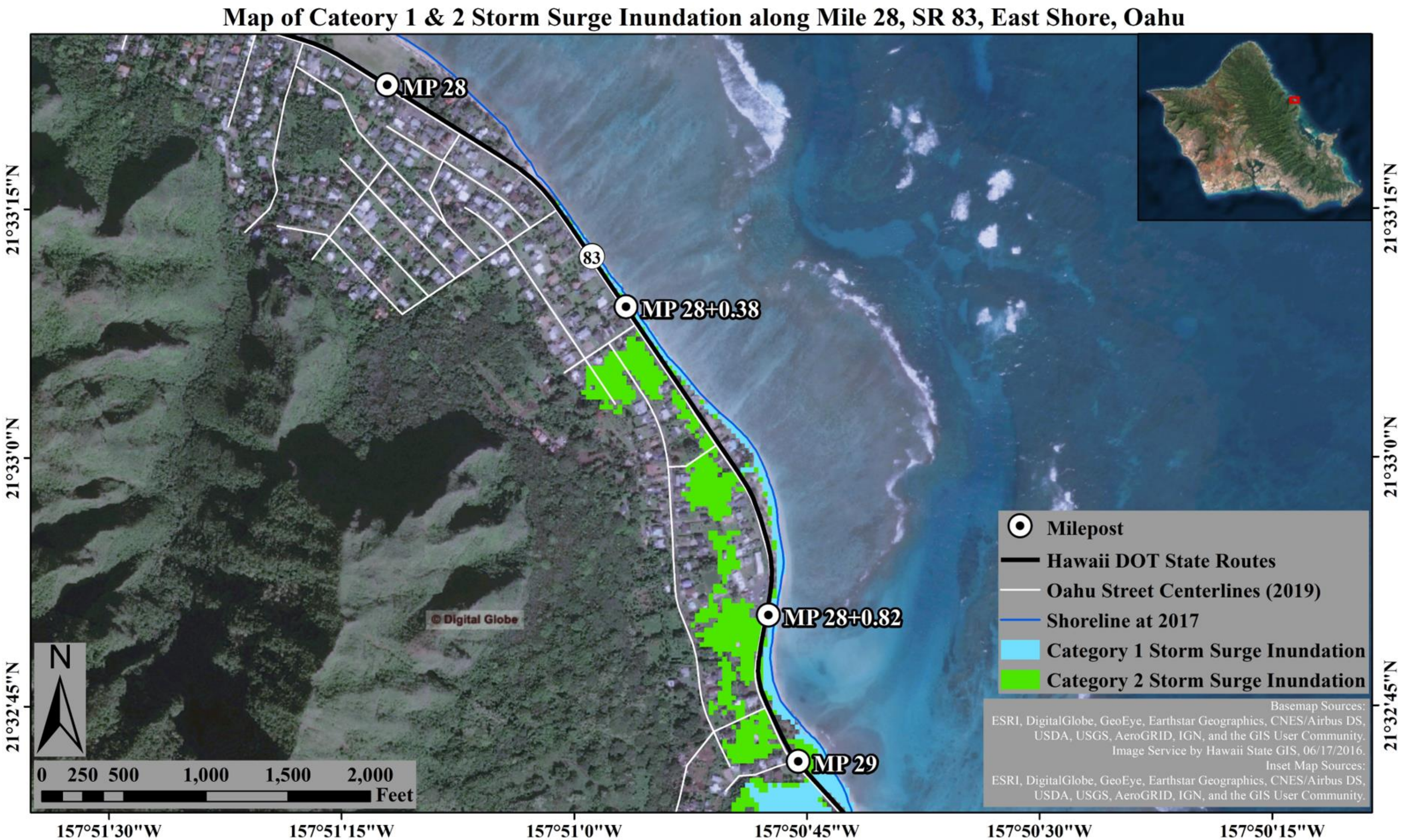

Figure 3.10. Sample map of Category 1 & 2 storm surge inundation along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of modeled storm inundation from Category 1 & 2 storms along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets are acquired from HDOT (2017) and HOLIS, C&CH (2017). Storm surge maximum of maximum (MOM) inundation extents are determined by the NOAA National Hurricane Center Storm Surge Unit using the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model, and are reported in Zachry et al. (2015).

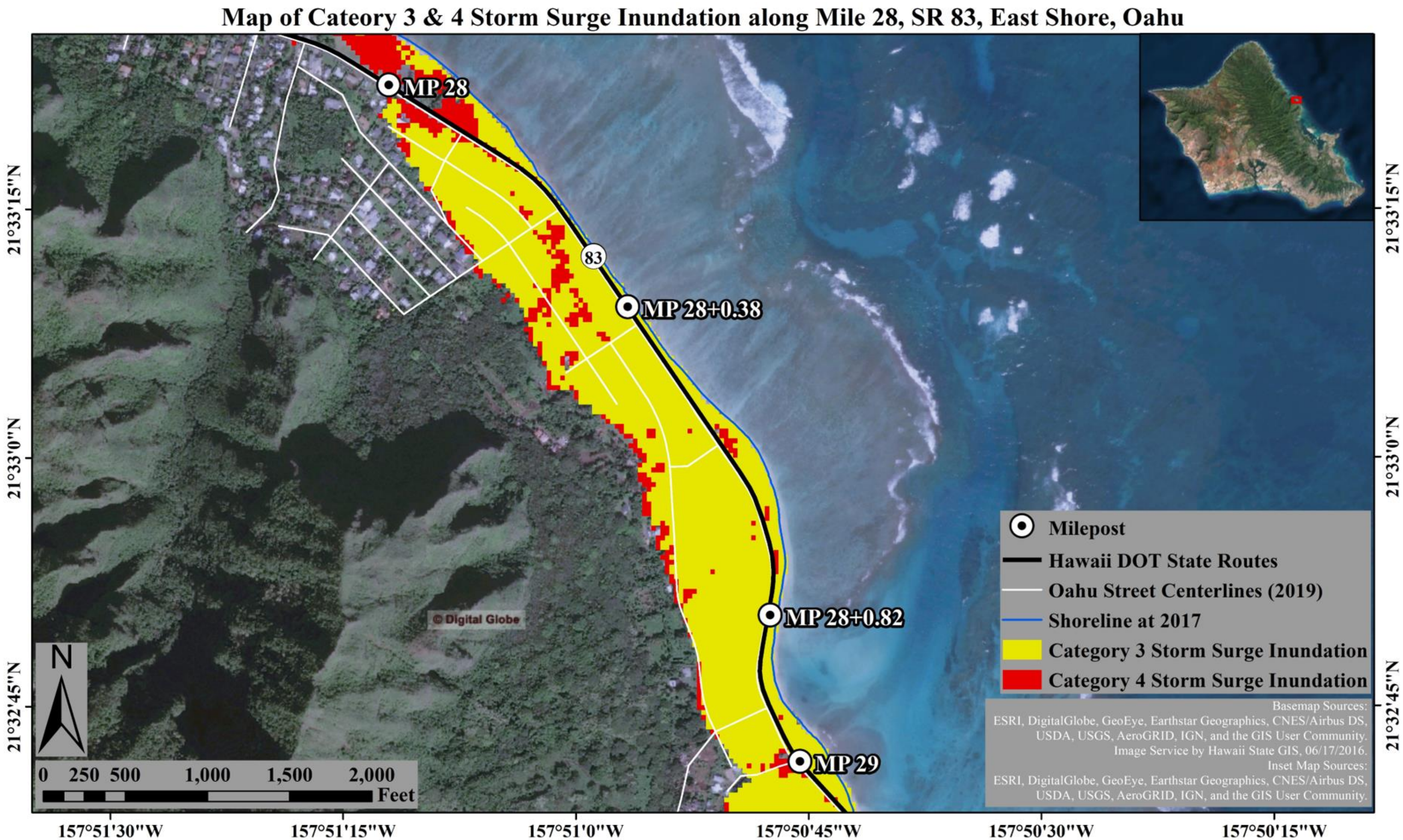

Figure 3.11. Sample map of Category 3 & 4 storm surge inundation along Mile 28, SR 83, East Shore, Oahu (Francis et al., 2019). Map of modeled storm inundation from Category 3 & 4 storms along Mile 28, SR 83, East Shore, Oahu. Mileposts are identified by Brandes et al. (2019). State of Hawaii Department of Transportation (HDOT) state routes and Oahu street centerline datasets were acquired from HDOT (2017) and HOLIS, C&CH (2017). Storm surge maximum of maximum (MOM) inundation extents were determined by the NOAA National Hurricane Center Storm Surge Unit using the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model, and are reported in Zachry et al. (2015).

3.8. Table of Tables (Tables 3.1 – 3.11)

Table 3.1. List of ocean hazards data collected for the Ocean Hazards Classification Scheme (OHCS) from the Ocean Hazards Database[11] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report.

Variable	Sub-Variable	Classification	Sub-classification
1	1a	Sea Level Rise	2050 Sea Level Rise Rate[1,2] (1905-2050, extreme scenario) [in/yr]
	1b	Sea Level Rise	2100 Sea Level Rise Rate[1,2] (1905-2100, extreme scenario) [in/yr]
	1c	Sea Level Rise	Historical Sea Level Rise Rate[3,2] (1905-2016) [in/yr]
2	---	Tides	Mean Tidal Range[4] (1983-2001) [ft]
3	3a	Maximum Annually Recurring Waves	Peak Wave Period[5] (2010-2018) [sec]
	3b	Maximum Annually Recurring Waves	Significant Wave Height[5] (2010-2018) [ft]
4	4a	Shoreline Change	Mean Shoreline Change Rate[6] (2008 - 2100) [ft/yr]
	4b	Shoreline Change	CRESI - Armoring Ranking[7] [1 - 5]
5	5a	Tsunami	Historical Flow Depth[8] [ft]
	5b	Tsunami	Hypothetical Flow Depth[8] [ft]
6	6a	Storm Surge	Category 1 Storm Inundation Height[9] (Hypothetical) [ft]
	6b	Storm Surge	Category 2 Storm Inundation Height[9] (Hypothetical) [ft]
	6c	Storm Surge	Category 3 Storm Inundation Height[9] (Hypothetical) [ft]
	6d	Storm Surge	Category 4 Storm Inundation Height[9] (Hypothetical) [ft]
7	7a	Nearshore Benthic Habitat	Zone[10]
	7b	Nearshore Benthic Habitat	Major Structure[10]
	7c	Nearshore Benthic Habitat	Detailed Structure[10]
	7d	Nearshore Benthic Habitat	Coverage[10]

Table 3.1. (Continued)

[1] Sweet, W.V., Kopp, R.E., Weaver, C.P., Obeysekera, J., Horton, R.M., Thieler, E.R., & Chris, Z. (2017). Global and Regional Sea Level Rise Scenarios for the United States (Tech. Rep. NOS CO-OPS 083), Silver Spring, MD: National Oceanic and Atmospheric Administration.

[2] Yang, Linqiang; Francis, Oceana. (2019). Historical and future sea level rise rates derived by combining observed and modeled data in the Hawaiian Islands. Coastal Hydraulics Engineering Resilience (CHER) Lab, Department of Civil and Environmental Engineering, University of Hawai'i at Manoa. Mendeley Data, v1 http://dx.doi.org/10.17632/3ks4dtk29v.1

[3] Holgate, S.J., Matthews, A., Woodworth, P.L., Rickards, L.J., Tamisiea, M.E., Bradshaw, E., et al. (2013). New Data Systems and Products at the Permanent Service for Mean Sea Level. *Journal of Coastal Research* , 29(3), 493–504. https://doi.org/10.2112/JCOASTRES-D-12-00175.1 ; PSMSL. (2018). Tide Gauge Data. Retrieved from https://www.psmsl.org/data/obtaining/ ; Mertz, F., Pujol, M.-I., and Faugère, Y. (2018). Product user manual (Version 4.0). Copernicus Marine Environment Monitoring Service. Retrieved from http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf

[4] Hess, K., Schmalz, R., Zervas, C., & Collier, W. (1999). Tidal constituents and residual interpolation (TCARI): A new method for the tidal correction of bathymetric data. NOAA Technical Report, NOS CS 4, 99.

[5] Anderson, T.R., Fletcher, C.H., Barbee, M.M., Romine, B. M., Lemmo, S., & Delevaux, J.M.S. (2018). Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports* , 8(1), 1–14. https://doi.org/10.1038/s41598-018-32658-x. ; PacIOOS (Pacific Islands Ocean Observing System). (2018). Wave Forecast. Retrieved from http://www.pacioos.hawaii.edu/waves-category/model/ (November 2018)

[6] Anderson, T.R., Fletcher, C.H., Barbee, M.M., Romine, B.M., Lemmo, S., & Delevaux, J.M.S. (2018). Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports* , 8(1), 1–14. https://doi.org/10.1038/s41598-018-32658-x.

[7] Brandes, H., Doygun, O., Rossi, C., Francis, O., Yang, L., Togia, H., (2019) Coastal Road Exposure Susceptibility Index (CRESI) for the State of Hawaii Statewide Coastal Highway Program Report. Department of Civil and Environmental Engineering, University of Hawai'i at Manoa, doi: 10.17632/frr3fsx3j6.2.

[8] Cheung, K.F. (2009). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for Oahu. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2011). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Hawaii. Honolulu, HI: University of Hawaii ; Cheung, K.F. (2012). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Maui. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2013). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Kauai. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2015). Hawaii Tsunami Mapping Project : Data Sources, Procedures, and Products for Extreme Aleutian Events. Final Report Prepared for the Hawaii Emergency Management Agency. Honolulu, HI: University of Hawaii (Personal Communication).

[9] Zachry, B.C., Booth, W.J., Rhome, J.R., and Sharon, T.M. (2015). A National View of Storm Surge Risk and Inundation. *Weather, Climate, and Society* , 7(2), 109–117. DOI: http://dx.doi.org/10.1175/WCAS–D–14–00049.1. (Personal Communication)

[10] BAE Systems, Sensor Solutions Identification & Surveillance. (2007). Mapping of Benthic Habitats for The Main Eight Hawaiian Islands (NOAA Contract NO.: DG133C-02CN-007). Honolulu, HI

[11] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). “Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report”. Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.2. Ocean Hazards Classification Scheme (OHCS) developed from the Ocean Hazards Database[9] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report.

Vunerability Rank	Percent	Variable 1 Sea Level Rise			Variable 2 Tides	Variable 3 Maximum Annually Recurring Waves		Variable 4 Shoreline Change	Variable 5 Tsunami	Variable 6 Storm Surge
		2050 Sea Level Rise Rate[1,2]* (1905-2050, extreme scenario) **[1a]**	**2100 Sea Level Rise Rate[1,2]** (1905-2100, extreme scenario) **[1b]**	**Historical Sea Level Rise Rate[3,2]** (1905-2016) **[1c]**	**Mean Tidal Range[4]** (1983-2001) **[2]**	**Peak Wave Period[5]** (2010-2018) **[3a]**	**Significant Wave Height[5]*** (2010-2018) **[3b]**	**Mean Shoreline Change Rate[6]*** (2008-2100) **[4a]**	**Tsunami Flow Depth[7]*** (Historical and Hypothetical) **[5]**	**Weighted Mean Storm Surge Inundation Height[8]*** (Hypothetical) **[6]**
1	**0-20%**	< 0.1 in/yr	< 0.2 in/yr	< 0.02 in/yr	< 2.0 ft	< 4 sec	< 7 ft	< 0 ft/yr	No inundation or Hypothetical inundation < 16 ft with no Historical Inundation	No Inundation or Category 4 Inundation < 4 ft
2	**21-40%**	0.1 to 0.2 in/yr	0.2 to 0.4 in/yr	0.02 to 0.04 in/yr	2.0 to 2.1 ft	4 to 7 sec	7 to 14 ft	0 to 2 ft/yr & "N/A" with > 3 Armoring Ranking	Hypothetical inundation ≥ 16 ft with no Historical Inundation	Category 3 Inundation < 4 ft or Category 4 Inundation of 4 to 8 ft
3	**41-60%**	0.2 to 0.3 in/yr	0.4 to 0.7 in/yr	0.04 to 0.06 in/yr	2.1 to 2.2ft	7 to 11 sec	14 to 21 ft	2 to 5 ft/yr & "N/A" with ≤ 3 Armoring Ranking	Historical inundation < 6 ft	Category 3 Inundation of 4 to 7 ft or Category 2 Inundation < 1 ft
4	**61-80%**	0.3 to 0.4 in/yr	0.7 to 0.9 in/yr	0.06 to 0.08 in/yr	2.2 to 2.3 ft	11 to 14 sec	21 to 29 ft	5 to 7 ft/yr	Historical inundation of 6 to 12 ft	Category 2 Inundation of 1 to 6 ft or Category 1 Inundation < 1 ft
5	**81% or greater**	≥ 0.4 in/yr	≥ 0.9 in/yr	≥ 0.08 in/yr	≥ 2.3 ft	≥ 14 sec	≥ 29 ft	> 7 ft/yr	Historical inundation ≥ 12 ft	Category 1 Inundation of 1 to 4 ft

Table 3.2. (Continued)

[*] Variables to be used in the Ocean Hazards Classification Scheme (OHCS) rankings.

[1] Sweet, W.V., Kopp, R.E., Weaver, C.P., Obeysekera, J., Horton, R.M., Thieler, E.R., & Chris, Z. (2017). Global and Regional Sea Level Rise Scenarios for the United States (Tech. Rep. NOS CO-OPS 083), Silver Spring, MD: National Oceanic and Atmospheric Administration.

[2] Yang, Linqiang; Francis, Oceana. (2019). Historical and future sea level rise rates derived by combining observed and modeled data in the Hawaiian Islands. Coastal Hydraulics Engineering Resilience (CHER) Lab, Department of Civil and Environmental Engineering, University of Hawai'i at Manoa. Mendeley Data, v1 http://dx.doi.org/10.17632/3ks4dtk29v.1

[3] Holgate, S.J., Matthews, A., Woodworth, P.L., Rickards, L.J., Tamisiea, M.E., Bradshaw, E., et al. (2013). New Data Systems and Products at the Permanent Service for Mean Sea Level. Journal of Coastal Research, 29(3), 493–504. https://doi.org/10.2112/JCOASTRES-D-12-00175.1 ; PSMSL. (2018). Tide Gauge Data. Retrieved from https://www.psmsl.org/data/obtaining/ ; Mertz, F., Pujol, M.-I., and Faugère, Y. (2018). Product user manual (Version 4.0). Copernicus Marine Environment Monitoring Service. Retrieved from http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf

[4] Hess, K., Schmalz, R., Zervas, C., & Collier, W. (1999). Tidal constituents and residual interpolation (TCARI): A new method for the tidal correction of bathymetric data. NOAA Technical Report, NOS CS 4, 99.

[5] Anderson, T.R., Fletcher, C.H., Barbee, M.M., Romine, B.M., Lemmo, S., & Delevaux, J.M.S. (2018). Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports* , 8(1), 1–14. https://doi.org/10.1038/s41598-018-32658-x. ; PacIOOS (Pacific Islands Ocean Observing System). (2018). Wave Forecast. Retrieved from http://www.pacioos.hawaii.edu/waves-category/model/ (November 2018)

[6] Anderson, T. R., Fletcher, C. H., Barbee, M. M., Romine, B. M., Lemmo, S., & Delevaux, J. M. S. (2018). Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports* , 8(1), 1–14. https://doi.org/10.1038/s41598-018-32658-x.

[7] Cheung, K.F. (2009). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for Oahu. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2011). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Hawaii. Honolulu, HI: University of Hawaii ; Cheung, K.F. (2012). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Maui. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2013). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Kauai. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2015). Hawaii Tsunami Mapping Project : Data Sources, Procedures, and Products for Extreme Aleutian Events. Final Report Prepared for the Hawaii Emergency Management Agency. Honolulu, HI: University of Hawaii (Personal Communication).

[8] Zachry, B.C., Booth, W.J., Rhome, J.R., and Sharon, T.M. (2015). A National View of Storm Surge Risk and Inundation. *Weather, Climate, and Society* , 7(2), 109–117. DOI: http://dx.doi.org/10.1175/WCAS–D–14–00049.1. (Personal Communication)

[9] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). “Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report”. Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.3. Number of ranked mileposts (n) using the Ocean Hazards Classification Scheme (OHCS) from the Ocean Hazards Database[9] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts (N).

Vunerability Rank	Percent	Variable 1			Variable 2	Variable 3		Variable 4	Variable 5	Variable 6
		Sea Level Rise			Tides	Maximum Annually Recurring Waves		Shoreline Change	Tsunami	Storm Surge
		2050 Sea Level Rise Rate[1,2]* (1905-2050, extreme scenario) **[1a]**	**2100 Sea Level Rise Rate[1,2]** (1905-2100, extreme scenario) **[1b]**	**Historical Sea Level Rise Rate[3,2]** (1905-2016) **[1c]**	**Mean Tidal Range[4]*** (1983-2001) **[2]**	**Peak Wave Period[5]** (2010-2018) **[3a]**	**Significant Wave Height[5]*** (2010-2018) **[3b]**	**Mean Shoreline Change Rate[6]*** (2008-2100) **[4a]**	**Tsunami Flow Depth[7]*** (Historical and Hypothetical) **[5]**	**Weighted Mean Storm Surge Inundation Height[8]*** (Hypothetical) **[6]**
1	**0-20%**	46	1	1	76	68	234	7	58	141
2	**21-40%**	179	46	0	129	6	60	129	28	24
3	**41-60%**	0	178	77	79	69	5	160	86	22
4	**61-80%**	13	13	94	5	45	0	4	95	65
5	**81-100%**	64	64	130	13	113	2	2	35	50

[*] Variables to be used in the Ocean Hazards Classification Scheme (OHCS) rankings.

[1] Sweet, W.V., Kopp, R.E., Weaver, C.P., Obeysekera, J., Horton, R.M., Thieler, E.R., & Chris, Z. (2017). Global and Regional Sea Level Rise Scenarios for the United States (Tech. Rep. NOS CO-OPS 083), Silver Spring, MD: National Oceanic and Atmospheric Administration.

[2] Yang, Linqiang; Francis, Oceana. (2019). Historical and future sea level rise rates derived by combining observed and modeled data in the Hawaiian Islands. Coastal Hydraulics Engineering Resilience (CHER) Lab, Department of Civil and Environmental Engineering, University of Hawai'i at Manoa. Mendeley Data, v1 http://dx.doi.org/10.17632/3ks4dtk29v.1

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Table 3.4. Sea level rise inundation by 1, 2, and 3 ft from the Ocean Hazards Database[1] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.
The "**X**" indicates inundation between mileposts, rather than at the milepost (filled circles).

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W			
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W			
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W			
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W			
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W			
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W			
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W			
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W			
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W			
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W			
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W			
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W			
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W			
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W			
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W			
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W			
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W			
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W			
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W			
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W			
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W			
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W			
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W			
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W			
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W			
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W			
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W			
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W			
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W			
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W			
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W			
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W			
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W			
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W			
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W			
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W			
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W			
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W			
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W			
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W			X
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W			
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W			
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W			
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W			
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W			
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W			
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W			
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W			
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W			
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W			
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W			
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W			
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W			
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W			
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W			
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W			
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W			
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W			
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W			
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W			
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W			
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W			
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W			
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W			
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W			
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W			
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W			
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W			
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W			
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W			
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W			
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W			
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W			
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W			
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W			
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W			
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W			
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W			
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W			
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W			
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W			
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W			
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W			
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W			
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W			
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W			
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W			
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W			
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W			
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W			
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W			
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W			
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W			
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W			
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W			
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W			
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W			
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W			
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W			
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W			
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W			
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W			
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W			
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W			
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W			
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W			
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W			
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W			
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W			
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W			
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W			
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W			
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W			
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W			
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W			
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W			
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W			
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W			
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W			
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W			
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W			
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W			
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W			
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W			
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W			
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W			
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W			
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W			
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W			
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W			X
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W			●
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W			
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W			
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W			
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W			
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W			
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W			
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W			
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W			
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W			
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W			
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W			
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W			
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W			
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W			
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W			
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W			
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W			
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W			
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W			
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W			
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W			
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W			
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W			
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W			
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W			
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W			
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W			
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W			
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W			
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W			
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W			
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W			
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W			
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W			
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W			
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W			
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W			
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W			
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W			
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W			
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W			
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W			
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W			
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W			
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W			
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W			
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W			
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W			
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W			
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W			
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W			
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W			
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W			
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W			
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W			
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W			
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W			
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W			
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W			
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W			
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W			
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W			
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W			
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W			
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W			
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W			
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W			
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W			
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W			
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W			
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W			
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W			
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W			
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W			
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W			
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W			
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W			
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W			
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W			
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W			
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W			
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W			
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W			
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W			
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W			
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W			
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W			
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W			
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W			
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W			
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W			
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W			
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W			
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W			
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W			
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W			
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W			
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W			
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W			
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W			
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W			X
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W			
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W			
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W			
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W			
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W			
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W			
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W			
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W			
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W			
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W			X
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W			●
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W			
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W			
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W			
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W			X
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W			
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W			
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W			
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W			
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W			X

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W			X
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W		X	●
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W			●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W			●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W			X
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W			
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W			
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W			
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W			
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W			
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W			
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W			X
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W			
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W			X
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1] 1 ft	2 ft	3 ft
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W			
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W			
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W			
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W			
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W			
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W			
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W			
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W			
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W			
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W			
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W			
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W			
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W			
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W			
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W			

Table 3.4. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by Feet[1]		
					1 ft	2 ft	3 ft
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W			
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W			
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W			

[1] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.5. Sea level rise inundation by 2050 for six different scenarios (i.e. lowest, low, intermediate, high, highest, extreme) based on historical[2] and projected[3] data (1905-2050) from the Ocean Hazards Database[1] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.
The "**X**" indicates inundation between mileposts, rather than at the milepost (filled circles).

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W						
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W						
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W						
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W						
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W						
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W						
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W						
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W						
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W						
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W						
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W						
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W						
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W						
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W						
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W						
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W						
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W						
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W						
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W						
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W						
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W						
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W						
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W						
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W						
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W						
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W						
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W						
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W						
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W						
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W						
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W						
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W						
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W						
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W						
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W						
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W						
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W						
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W						
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W						
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W						X
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W						
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W						
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W						
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W						
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W						
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W						
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W						
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W						
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W						
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W						
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W						
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W						
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W						
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W						
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W						
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W						
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W						
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W						
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W						
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W						
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W						
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W						
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W						
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W						
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W						
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W						
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W						
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W						
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W						
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W						
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W						
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W						
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W						
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W						
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W						
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W						
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W						
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W						
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W						
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W						
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W						
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W						
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W						
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W						
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W						
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W						
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W						
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W						
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W						
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W						
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W						
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W						
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W						
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W						
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W						
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W						
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W						
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	**Low Scenario**	**Intermediate Scenario**	**High Scenario**	**Highest Scenario**	**Extreme Scenario**
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W						
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W						
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W						
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W						
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W						
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W						
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W						
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W						
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W						
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W						
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W						
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W						
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W						
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W						
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W						
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W						
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W						
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W						
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W						
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W						
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W						
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W						
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W						
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W						
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W						
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W						
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W						
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W						
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W						
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W						
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W						
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W						
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W					X	X
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W					X	●
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W						
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W						
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W						
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W						
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W						
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W						
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W						
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W						
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W						
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W						
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W						
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W						
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W						
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W						
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W						
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W						
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W						
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W						
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W						
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W						
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W						
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W						
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W						
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W						
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W						
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W						
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W						
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W						
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W						
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W						
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W						
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W						
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W						
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W						
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W						
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W						
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W						
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W						
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W						
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W						
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W						
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W						
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W						
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W						
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W						
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W						
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W						
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W						
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W						
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W						
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W						
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W						
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W						
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W						
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W						
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W						
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W						
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W						
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W						
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W						
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W						
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W						
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W						
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W						
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W						
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W						
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W						
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W						
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W						
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W						
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W						
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W						
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W						
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W						
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W						
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W						
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W						
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W						
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W						
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W						
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W						
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W						
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W						
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W						
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W						
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W						
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W						
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W						
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W						
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W						
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W						
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W						
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W						
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W						
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W						
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W						
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W						
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W						
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W						
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W						
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W					X	X
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W						
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W						
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W						
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W						
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W						
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W						
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W						
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W						
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W						
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W						X
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W						●
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W						
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W						
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W						
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W						X
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W						
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W						
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W						
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W						
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W						X

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W						X
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W				X	X	●
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W						●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W						●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W						X
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W						
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W						
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W						
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W						
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W						
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W						
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W						X
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W						
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W						
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W						
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W						
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W						
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W						
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W						
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W						
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W						
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W						
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W						
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W						
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W						
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W						
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W						
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W						
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W						

Table 3.5. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2050[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W						
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W						
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W						

[1] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

[2] Holgate, S.J., Matthews, A., Woodworth, P.L., Rickards, L.J., Tamisiea, M.E., Bradshaw, E., et al. (2013). New Data Systems and Products at the Permanent Service for Mean Sea Level. *Journal of Coastal Research* , 29(3), 493–504. https://doi.org/10.2112/JCOASTRES-D-12-00175.1 ; PSMSL. (2018). Tide Gauge Data. Retrieved from https://www.psmsl.org/data/obtaining/ ; Mertz, F., Pujol, M.-I., and Faugère, Y. (2018). Product user manual (Version 4.0). Copernicus Marine Environment Monitoring Service. Retrieved from http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf

[3] Sweet, W.V., Kopp, R.E., Weaver, C.P., Obeysekera, J., Horton, R.M., Thieler, E.R., and Chris, Z. (2017). Global and Regional Sea Level Rise Scenarios for the United States (Tech. Rep. NOS CO-OPS 083), Silver Spring, MD: National Oceanic and Atmospheric Administration.

Table 3.6. Sea level rise inundation by 2100 for six different scenarios (i.e. lowest, low, intermediate, high, highest, extreme) based on historical[2] and projected[3] data (1905-2050) from the Ocean Hazards Database[1] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.
The "**X**" indicates inundation between mileposts, rather than at the milepost (filled circles).

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W						●
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W						●
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W					X	X
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W					●	●
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W				X	X	X
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W					X	●
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W					X	X
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W				X	●	●
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W				●	●	●
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W				X	●	●
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W				●	●	●
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W				●	●	●
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W				●	●	●
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W				●	●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W			X	X	●	●
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W				●	●	●
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W				●	●	●
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W				X	●	●
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W					●	●
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W				X	●	●
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W				●	●	●
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W				X	X	X
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W				●	●	●
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W					●	●
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W				X	●	●
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W				●	●	●
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W				●	●	●
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W					●	●
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W				X	X	X
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W				●	●	●
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W				●	●	●
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W				●	●	●
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W				●	●	●
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W						
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W			X	X	X	X
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W			●	●	●	●
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W				●	●	●
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W					X	X
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W				X	●	●
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W			●	●	●	●
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W			●	●	●	●
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W						
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W					X	●
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W						
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W						
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W						
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W						X
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W						●
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W						
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W						
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W						
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W						●
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W						
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W						
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W						
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W						
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W			●	●	●	●
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W			X	●	●	●
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W			X	●	●	●
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W				X	X	X
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W					●	●
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W						X
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W						
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W						
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W						X
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W						
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W					X	X
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W					●	●
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W					●	●
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W						
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W						
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W					X	X
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W					X	●
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W						●
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W					X	X
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W					●	●
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W						
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W					X	●
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W					●	●
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W				X	●	●
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W				●	●	●
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W					●	●
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W					●	●
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W					●	●
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W						
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W						
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W						
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W						
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W						X
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W						●
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W						
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W						
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W						
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W						
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W						
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W						
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W						
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W						
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W				X	●	●
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W						
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W						
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W						
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W						
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W						
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W						
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W						
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W						
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W						
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W						
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W						
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W						
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W						
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W						
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W						
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W						
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W						X
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W					X	X
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W					●	●
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W						●
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W					X	●
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W					●	●
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W						●
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W					X	●
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W					●	●
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W						
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W						
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W						
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W						
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W						
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W						
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W			X	X	●	●
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W			●	●	●	●
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W				●	●	●
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W				●	●	●
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W				●	●	●
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W				●	●	●
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W				●	●	●
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W				●	●	●
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W				●	●	●
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W				●	●	●
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W				●	●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W				X	●	●
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W						
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W						
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W						
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W						
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W				X	X	●
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W				●	●	●
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W				●	●	●
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W				●	●	●
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W				●	●	●
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W				●	●	●
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W				●	●	●
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W				X	●	●
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W				●	●	●
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W					●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W				X	●	●
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W					●	●
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W					●	●
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W					●	●
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W				●	●	●
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W					X	X
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W					●	●
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W					●	●
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W					●	●
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W					X	X
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W					●	●
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W						X
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W						●
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W						●
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W						X

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W						●
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W						X
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W						●
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W					X	●
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W					●	●
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W						X
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W						
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W						
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W				X	X	X
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W				●	●	●
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W				X	X	X
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W						
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W						
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W						
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W						

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W						
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W						
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W						
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W						
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W						
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W				X	●	●
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W				●	●	●
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W				X	X	●
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W				X	X	X
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W				●	●	●
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W				X	●	●
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W				●	●	●
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W				X	●	●
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W				●	●	●
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W						●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W						
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W						
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W						
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W					●	●
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W					X	●
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W				X	●	●
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W					●	●
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W						●
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W					X	●
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W						●
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W						
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W						
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W					X	X
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W						X
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W				X	X	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W				●	●	●
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W				X	●	●
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W				●	●	●
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W				X	●	●
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W					●	●
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W					●	●
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W						
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W						
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W						
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W						
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W						
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W				●	●	●
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W						X
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W					X	●
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W					●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W					●	●
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W					X	●
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W					●	●
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W					●	●
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W					●	●
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W					●	●
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W					X	X
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W						
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W			●	●	●	●
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W					●	●
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W				X	●	●
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W						●
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W						
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W			X	●	●	●
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W				●	●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W			X	●	●	●
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W				X	●	●
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W				●	●	●
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W			●	●	●	●
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W			X	●	●	●
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W			●	●	●	●
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W				●	●	●
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W			X	●	●	●
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W			●	●	●	●
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W			●	●	●	●
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W			●	●	●	●
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W				X	●	●
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W				X	X	●
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W				X	X	●
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W			X	●	●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W			X	●	●	●
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W			●	●	●	●
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W			●	●	●	●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W			●	●	●	●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W			●	●	●	●
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W						
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W						
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W						X
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W						●
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W						
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W			X	X	X	X
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W			●	●	●	●
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W			X	●	●	●
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W			X	●	●	●
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W			●	●	●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W						X
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W				X	X	X
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W				●	●	●
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W					●	●
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W				X	●	●
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W			X	●	●	●
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W				●	●	●
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W				●	●	●
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W				X	●	●
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W					X	●
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W				X	●	●
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W				X	X	●
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W			X	●	●	●
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W			●	●	●	●
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W				●	●	●

Table 3.6. (continued)

Milepost	State Route	Island	Study Area	GPS	Sea Level Rise Inundation by 2100[1]					
					Lowest Scenario	Low Scenario	Intermediate Scenario	High Scenario	Highest Scenario	Extreme Scenario
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W				●	●	●
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W					X	●
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W						●

[1] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

[2] Holgate, S.J., Matthews, A., Woodworth, P.L., Rickards, L.J., Tamisiea, M.E., Bradshaw, E., et al. (2013). New Data Systems and Products at the Permanent Service for Mean Sea Level. *Journal of Coastal Research* , 29(3), 493–504. https://doi.org/10.2112/JCOASTRES-D-12-00175.1 ; PSMSL. (2018). Tide Gauge Data. Retrieved from https://www.psmsl.org/data/obtaining/ ; Mertz, F., Pujol, M.-I., and Faugère, Y. (2018). Product user manual (Version 4.0). Copernicus Marine Environment Monitoring Service. Retrieved from http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf

[3] Sweet, W.V., Kopp, R.E., Weaver, C.P., Obeysekera, J., Horton, R.M., Thieler, E.R., and Chris, Z. (2017). Global and Regional Sea Level Rise Scenarios for the United States (Tech. Rep. NOS CO-OPS 083), Silver Spring, MD: National Oceanic and Atmospheric Administration.

Table 3.7. Maximum annually recurring significant wave height (ft) and peak wave period (sec), based on historical data[1] (2010-2018), from the Ocean Hazards Database[2] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W	●					●
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W	●				●	
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W	●				●	
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W		●				●
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W	●					●
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W	●				●	
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W	●				●	
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W		●			●	
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W		●			●	
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W	●				●	
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W	●				●	
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W	●				●	
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W	●				●	
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W	●					●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W	●				●	
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W	●				●	
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W	●				●	
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W	●				●	
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W	●				●	
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W	●				●	
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W	●				●	
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W	●					●
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W	●				●	
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W	●					●
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W	●					●
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W	●					●
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W	●					●
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W	●					●
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W	●					●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W	●					●
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W	●					●
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W	●				●	
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W	●				●	
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W	●				●	
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W	●				●	
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W	●				●	
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W	●				●	
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W	●				●	
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W	●				●	
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W	●				●	
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W	●				●	
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W	●				●	
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W						
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W	●				●	
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W	●				●	
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W	●				●	
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W	●				●	
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W	●				●	
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W	●				●	
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W	●					●
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W	●					●
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W	●					●
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W	●				●	
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W	●				●	
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W	●				●	
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W		●			●	
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W		●			●	
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W		●			●	

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W	●					●
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W	●					●
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W	●					●
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W	●					●
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W	●					●
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W	●					●
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W	●					●
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W	●					●
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W	●					●
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W	●					●
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W	●					●
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W	●					●
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W	●					●
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W		●				●
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W		●				●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W		●				●
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W	●					●
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W	●					●
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W	●					●
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W		●				●
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W	●					●
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W		●				●
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W		●				●
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W	●					●
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W	●					●
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W	●					●
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W	●					●
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W	●					●
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W	●					●
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W						●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W						●
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W						●
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W	●					●
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W		●				●
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W		●				●
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W		●				●
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W		●				●
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W	●					●
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W	●					●
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W		●				●
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W		●				●
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W	●					●
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W	●					●
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W		●				●
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W		●				●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W	●					●
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W	●					●
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W		●				●
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W	●					●
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W		●				●
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W		●				●
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W		●				●
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W		●				●
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W		●				●
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W		●				●
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W		●				●
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W		●				●
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W		●				●
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W		●				●
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W		●				●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W		●				●
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W		●				●
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W		●				●
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W	●					●
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W		●				●
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W	●			●		
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W	●			●		
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W	●			●		
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W	●			●		
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W	●				●	
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W	●					●
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W		●				●
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W		●				●
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W		●				●
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W		●				●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W		●				●
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W			●	●		
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W			●	●		
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W		●				●
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W	●					●
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W	●					●
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W	●				●	
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W	●				●	
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W	●				●	
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W	●					●
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W	●					●
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W	●					●
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W	●				●	
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W	●				●	
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W	●					●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W	●					●
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W	●				●	
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W	●				●	
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W	●				●	
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W	●				●	
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W	●					●
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W	●					●
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W	●					●
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W	●			●		
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W	●					●
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W	●					●
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W	●					●
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W	●					●
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W	●			●		
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W	●			●		
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W		●		●		
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W		●		●		
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W		●		●		
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W		●		●		
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W		●		●		
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W	●			●		
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W	●			●		
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W	●					●
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W	●					●
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W	●					●
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W		●		●		
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W	●					●
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W	●			●		
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W		●		●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W		●		●		
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W	●			●		
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W	●			●		
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W	●			●		
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W	●			●		
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W	●					●
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W	●					●
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W	●					●
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W	●					●
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W	●					●
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W	●					●
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W	●					●
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W	●					●
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W		●		●		
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W	●					●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W	●					●
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W	●					●
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W	●					●
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W	●					●
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W		●				●
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W	●					●
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W	●					●
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W	●					●
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W		●				●
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W	●					●
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W	●					●
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W	●					●
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W	●					●
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W	●					●
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W	●					●

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W	●					●
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W		●				●
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W		●			●	
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W		●				●
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W		●				●
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W		●				●
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W	●					●
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W	●					●
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W	●					●
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W	●					●
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W	●					●
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W	●					●
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W	●				●	
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W	●			●		
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W	●				●	
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W	●				●	
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W	●				●	
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W	●				●	
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W	●				●	
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W	●				●	
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W	●				●	
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W		●			●	
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W	●					●
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W	●					●
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W		●			●	
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W	●					●
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W	●			●		
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W	●			●		
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	**Significant Wave Height 7 to 21 ft**	**Significant Wave Height > 21 ft**	**Peak Wave Period < 4 sec**	**Peak Wave Period 4 to 11 sec**	**Peak Wave Period > 11 sec**
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W	●			●		
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W	●					●
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W	●					●
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W	●					●
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W	●					●
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W	●					●
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W		●		●		
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W	●					●
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W	●			●		
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W	●			●		
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W	●			●		
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W	●			●		
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W	●			●		
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W	●			●		
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W	●			●		
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W	●			●		
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W	●			●		
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W	●			●		
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W	●			●		
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W	●			●		
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W	●			●		
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W	●			●		
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W	●			●		
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W	●			●		
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W	●			●		
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W	●			●		
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W	●			●		
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W	●					●
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W	●					●
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W	●			●		
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W	●					●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W	●					●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W	●					●
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W	●			●		
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W	●			●		
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W	●			●		
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W	●			●		
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W	●			●		
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W	●			●		
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W	●			●		
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W	●			●		
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W		●		●		
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W	●			●		

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W	●					●
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W	●					●
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W	●			●		
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W	●			●		
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W	●				●	
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W	●				●	
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W	●					●
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W	●				●	
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W	●				●	
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W	●				●	
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W	●				●	
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W	●				●	
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W	●				●	
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W	●				●	
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W	●				●	

Table 3.7. (continued)

Milepost	State Route	Island	Study Area	GPS	Maximum Annually Recurring Wave Characteristics[1]					
					Significant Wave Height < 7 ft	Significant Wave Height 7 to 21 ft	Significant Wave Height > 21 ft	Peak Wave Period < 4 sec	Peak Wave Period 4 to 11 sec	Peak Wave Period > 11 sec
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W		●			●	
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W		●			●	
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W		●			●	

[1] Anderson, T.R., Fletcher, C.H., Barbee, M.M., Romine, B.M., Lemmo, S., and Delevaux, J.M.S. (2018). Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports* , 8(1), 1–14. https://doi.org/10.1038/s41598-018-32658-x. ; PacIOOS (Pacific Islands Ocean Observing System). (2018). Wave Forecast. Retrieved from http://www.pacioos.hawaii.edu/waves-category/model/ (November 2018)
[2] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.8. Bathymetric description along the peak wave direction (i.e. open, sheltered, interisland) based on 2016 data[1], from the Ocean Hazards Database[2] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W	●		
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W	●		
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W	●		
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W	●		
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W	●		
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W	●		
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W	●		
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W	●		
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W	●		
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W	●		
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W	●		
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W	●		
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W	●		
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W	●		
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W	●		
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W	●		
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W	●		
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W	●		
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W	●		
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W	●		
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W	●		
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W	●		
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W	●		
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W	●		
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W	●		
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W	●		
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W	●		
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W	●		
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W	●		
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W	●		
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W	●		
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W	●		
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W	●		
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W		●	
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W		●	
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W		●	
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W		●	
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W		●	
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W		●	
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W		●	
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W			
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W		●	

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W	●		
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W	●		
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W	●		
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W	●		
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W	●		
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W	●		
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W	●		
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W	●		
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W	●		
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W		●	
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W		●	
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W	●		
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W			●
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W			●
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W			●

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W		●	
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W		●	
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W		●	
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W	●		
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W	●		
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W	●		
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W	●		
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W	●		
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W	●		
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W	●		
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W	●		
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W	●		
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W	●		
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W	●		
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W	●		
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W	●		
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W	●		
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W	●		
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W	●		
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W	●		
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W	●		
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W	●		
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W		●	
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W		●	
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W		●	
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W	●		
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W	●		
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W	●		
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W	●		
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W	●		
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W		●	
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W		●	
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W	●		
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W	●		
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W	●		
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W	●		
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W	●		
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W	●		
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W	●		
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W	●		
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W	●		
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W	●		
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W	●		
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W	●		
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W	●		
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W	●		
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W	●		
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W	●		
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W	●		
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W	●		
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W		●	
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W	●		
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W		●	
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W	●		
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W	●		
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W	●		
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W	●		
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W	●		
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W	●		
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W	●		
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W	●		
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W		●	
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W		●	
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W		●	
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W		●	
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W	●		
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W	●		
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W	●		
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W	●		
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W	●		
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W	●		
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W	●		
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W	●		
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W	●		
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W	●		
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W			●
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W			●
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W			●
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W			●
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W			●
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W			●
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W			●
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W			●
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W			●
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W			●

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W			●
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W	●		
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W	●		
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W	●		
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W	●		
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W	●		
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W			●
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W	●		
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W			●
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W			●
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W			●
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W			●
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W			●
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W			●
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W			●

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W			●
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W			●
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W			●
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W			●
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W			●
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W		●	
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W		●	
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W		●	
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W		●	
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W		●	
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W		●	
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W		●	
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W		●	
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W		●	
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W		●	

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W		●	
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W		●	
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W		●	
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W		●	
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W		●	
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W		●	
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W		●	
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W		●	
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W		●	
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W		●	
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W		●	
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W		●	
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W		●	
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W		●	
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W		●	

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W			●
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W			●
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W		●	
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W		●	
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W	●		
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W		●	
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W		●	
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W		●	
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W		●	
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W		●	
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W		●	
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W		●	
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W		●	
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W		●	
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W		●	

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W		●	
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W	●		
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W	●		
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W	●		
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W	●		
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W	●		
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W	●		
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W	●		
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W	●		
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W	●		
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W	●		
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W	●		
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W	●		
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W	●		
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W	●		
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W	●		
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W	●		
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W	●		
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W	●		
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W	●		
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W	●		
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W	●		
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W	●		
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W	●		
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W	●		
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W	●		
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W	●		
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W	●		
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W	●		

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W	●		
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W	●		
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W	●		
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W	●		
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W	●		
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W	●		
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W	●		
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W	●		
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W	●		
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W	●		
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W	●		
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W	●		
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W			●
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W			●
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W			●

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W			●
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W			●
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W		●	
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W		●	
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W		●	
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W			●
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W		●	
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W			●
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W			●
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W			●
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W			●
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W			●
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W			●
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W			●
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W			●

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W			●
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W			●
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W			●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W			●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W			●
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W			●
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W			●
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W	●		
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W			●
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W			●
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W			●
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W			●
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W			●
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W			●
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W			●

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W			●
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W			●
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W			●
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W			●
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W			●
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W			●
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W			●
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W			●
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W			●
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W		●	
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W		●	
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W		●	
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W		●	
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W		●	
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W		●	

Table 3.8. (continued)

Milepost	State Route	Island	Study Area	GPS	Bathymetry[1] along Peak Wave Direction		
					Open to Ocean	Sheltered to Open Ocean	Interisland Channel
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W		●	
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W		●	
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W		●	

[1] Hawaii Mapping Research Group. (2016, July). Main Hawaiian Islands Multibeam Bathymetry and Backscatter Synthesis. Retrieved from http://www.soest.hawaii.edu/hmrg/multibeam/bathymetry.php. (February 14, 2019).

[2] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.9. Mean shoreline change rate (ft/yr) based on historical and projected data[1] (2008-2100) and resistance to erosion based on distance (ft) and armoring[2], from the Ocean Hazards Database[3] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W		●			●	
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W		●			●	
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W		●			●	
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W		●			●	
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W		●			●	
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W		●			●	
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W		●			●	
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W		●			●	
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W		●			●	
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W		●			●	
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W		●		●		
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W		●			●	
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W		●			●	
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W	●				●	
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W		●			●	
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W		●			●	
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W		●			●	
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W	●				●	
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W	●				●	
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W		●			●	
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W		●			●	
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W		●		●		
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W		●			●	
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W		●			●	●
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W		●		●		
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W		●		●		
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W		●			●	
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W		●			●	
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W		●			●	
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W		●		●		
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W		●			●	●
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W		●			●	
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W	●				●	
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W		●			●	
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W		●			●	
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W		●			●	
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W		●			●	
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W		●			●	
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W		●		●		
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W		●			●	
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W	●				●	●
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W	●				●	●

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W		●			●	
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W		●			●	
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W		●			●	
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W		●		●		
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W		●		●		
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W		●			●	
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W		●			●	
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W		●		●		
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W		●			●	
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W		●			●	
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W		●			●	
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W		●			●	
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W		●			●	
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W		●			●	
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W		●		●		
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W		●			●	
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W		●			●	
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W		●			●	
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W		●			●	
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W	●				●	●
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W		●			●	
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W		●			●	
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W		●			●	
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W		●			●	
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W		●			●	
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W		●			●	
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W		●			●	
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W		●			●	
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W		●			●	
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W		●			●	
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W		●			●	
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W		●			●	
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W		●			●	
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W		●			●	
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W		●			●	
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W		●			●	
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W		●			●	
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W		●			●	●
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W	●				●	●
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W		●			●	
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W		●			●	
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W		●			●	
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W		●			●	
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W		●			●	
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W		●			●	
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W		●			●	
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W		●			●	
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W		●			●	
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W		●			●	
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W		●			●	
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W		●			●	
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W		●			●	
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W		●			●	
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W		●			●	
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W		●			●	
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W		●			●	
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W		●			●	
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W		●			●	
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W		●			●	
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W		●			●	
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W		●			●	
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W		●			●	
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W		●			●	
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W		●			●	
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W		●			●	
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W		●			●	
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W		●			●	
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W		●			●	
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W		●			●	
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W		●			●	
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W		●			●	
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W		●			●	
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W		●			●	
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W		●			●	
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W		●			●	
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W		●			●	
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W			●	●		●
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W		●			●	
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W		●			●	
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W		●			●	
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W			●		●	
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W		●			●	
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W		●			●	
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W		●			●	
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W		●			●	
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W	●				●	●
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W		●			●	
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W		●			●	
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W		●			●	
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W		●			●	
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W		●			●	
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W		●			●	
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W		●			●	
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W		●			●	
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W		●			●	
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W		●			●	
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W		●			●	
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W		●			●	
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W		●			●	
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W	●				●	●
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W	●				●	●
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W	●				●	●
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W	●				●	●
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W		●			●	
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W		●			●	
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W		●			●	●
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W		●			●	
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W		●		●		
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W		●		●		
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W		●			●	
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W		●			●	
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W		●			●	
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W		●			●	
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W		●			●	
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W		●			●	
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W		●		●		
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W		●			●	
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W		●			●	
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W		●		●		
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W		●			●	
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W		●			●	
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W		●			●	
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W		●			●	
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W		●			●	
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W		●			●	
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W		●		●		
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W		●			●	●

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W		●			●	
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W		●			●	
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W		●			●	
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W		●			●	
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W		●			●	
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W	●				●	
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W	●				●	●
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W		●			●	
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W	●				●	
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W		●			●	●
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W		●			●	●
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W		●			●	●
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W		●			●	
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W		●			●	
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W		●			●	
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W		●			●	●
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W		●			●	
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W		●			●	
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W		●			●	
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W	●				●	●
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W	●			●		●
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W		●			●	
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W		●			●	
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W		●			●	
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W		●			●	
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W		●			●	
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W		●		●		
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W		●			●	
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W	●			●		●

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W		●			●	
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W		●			●	
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W		●			●	
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W			●		●	
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W		●			●	
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W		●			●	
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W		●			●	
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W		●			●	
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W		●		●		
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W		●			●	
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W		●			●	
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W		●			●	
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W		●			●	
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W		●			●	
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W		●			●	
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W		●			●	●
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W		●			●	
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W		●			●	
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W		●			●	
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W		●			●	
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W		●			●	
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W	●				●	●
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W		●			●	
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W		●			●	
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W		●			●	
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W	●				●	
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W		●			●	
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W		●			●	
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W		●		●		●
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W		●		●		●
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W		●		●		●
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W		●			●	
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W			●	●		●
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W			●		●	●
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W		●			●	
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W			●		●	
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W	●			●		●
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W		●			●	
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W		●			●	
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W		●			●	
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W		●			●	
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W		●			●	
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W		●			●	

Table 3.9. (continued)

					Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
Milepost	**State Route**	**Island**	**Study Area**	**GPS**	**Erosion < 0 ft/yr & N/A with Hardening**	**Erosion 0 to 5.0 ft/yr & N/A without Hardening**	**Erosion > 5.0 ft/yr**	**Road Distance from Shoreline < 50 feet**	**Road Distance from Shoreline > 50 feet**	**Armoring - Hardened**
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W		●			●	
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W		●			●	
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W		●			●	
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W		●		●		
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W		●			●	
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W		●			●	
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W		●			●	
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W		●			●	
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W		●			●	
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W		●			●	
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W		●			●	
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W		●			●	
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W		●			●	
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W		●			●	
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W		●		●		

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W		●			●	
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W		●			●	
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W		●			●	
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W		●			●	
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W		●			●	
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W		●			●	
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W		●			●	
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W		●			●	
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W		●			●	
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W		●			●	
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W		●			●	
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W		●		●		
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W		●			●	
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W		●			●	
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W		●		●		

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W		●		●		
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W		●			●	
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W		●			●	
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W		●		●		
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W		●		●		
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W		●			●	
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W		●			●	
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W		●		●		
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W		●		●		
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W		●		●		
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W		●		●		
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W	●			●		●
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W		●		●		
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W		●		●		
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W		●			●	

Table 3.9. (continued)

Milepost	State Route	Island	Study Area	GPS	Mean Shoreline Change Rate[1]			Resistance to Erosion[2]		
					Erosion < 0 ft/yr & N/A with Hardening	Erosion 0 to 5.0 ft/yr & N/A without Hardening	Erosion > 5.0 ft/yr	Road Distance from Shoreline < 50 feet	Road Distance from Shoreline > 50 feet	Armoring - Hardened
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W		●			●	
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W		●		●		
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W		●			●	

[1] Anderson, T.R., Fletcher, C.H., Barbee, M.M., Romine, B.M., Lemmo, S., and Delevaux, J.M.S. (2018). Modeling multiple sea level rise stresses reveals up to twice the land at risk compared to strictly passive flooding methods. *Scientific Reports* , 8(1), 1–14. https://doi.org/10.1038/s41598-018-32658-x.

[2] Brandes, H., Doygun, O., Rossi, C., Francis, O., Yang, L., and Togia, H. (2019) Coastal Road Exposure Susceptibility Index (CRESI) for the State of Hawaii Statewide Coastal Highway Program Report. Department of Civil and Environmental Engineering, University of Hawai'i at Manoa, doi: 10.17632/frr3fsx3j6.2.

[3] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.10. Storm surge inundation for Category 1-4 storms based on hypothetical data[1] and tsunami inundation based on historical and hypothetical data[2], from Ocean Hazards Database[3] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.
The "**X**" indicates inundation between mileposts, rather than at the milepost (filled circles).

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W					●	●
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W					●	●
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W	X	X			●	●
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W	●	X			●	●
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W					●	●
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W					●	●
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W	X	X	X	X	●	●
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W	●	X	X		●	●
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W	●	●	●		●	●
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W	●	●	X	X	●	●
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W	●	●	X		●	●
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W	●	●	●		●	●
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W	●	●	●	X	●	●
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W	●	●	●	X	●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W	●	●	X		●	●
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W	●	●	●	●	●	●
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W	●	●	●	●	●	●
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W	●	●			●	●
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W	●	X	X		●	X
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W	●	●	X	X	●	●
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W	●	●	●	●	●	
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W	X				●	X
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W	●				●	X
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W	●				●	●
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W	X	X			●	●
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W	●	●	X		●	●
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W	●	●	●		●	●
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W	●	●	X		●	●
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W					●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W	X	X	X	X	●	X
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W	●	●	●	●	●	●
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W	●	●	●	●	●	●
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W	●	●	●	●	●	●
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W	●	●	●	●	●	●
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W						
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W	X	X	X	X	X	X
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W	●	●	●	●	●	●
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W	●	●	●	●	●	●
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W	X				X	
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W	●	●	X	X	●	X
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W	●	●	●	●	●	●
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W	●	●	●	●	●	●
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W					●	
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W						

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W	X	X			●	
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W					●	X
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W					●	●
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W					●	X
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W					●	●
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W					●	●
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W					X	X
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W					●	●
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W					●	●
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W					●	●
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W					X	
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W					●	X
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W					●	X
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W					●	●
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W	X	X	X	X	●	

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	**Category 3 Storms**	**Category 2 Storms**	**Category 1 Storms**	**Hypothetical Scenario**	**Historical Scenario**
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W	●	●	●	●	●	●
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W	●	●	●	X	●	●
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W	●	●	●	X	●	●
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W	X	X	X		●	X
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W	●				●	●
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W					●	
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W					●	
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W					●	
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W					●	
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W					●	
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W					●	
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W					●	
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W					●	
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W					●	
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W					●	

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W					●	
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W					●	X
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W					●	●
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W					●	●
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W					●	●
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W					●	●
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W					●	●
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W					●	●
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W	X				●	●
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W	●	X			●	●
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W	●	●			●	●
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W	●				●	X
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W	●	X			●	●
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W	●	●			●	
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W					●	

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1] Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Tsumani Inundation[2] Hypothetical Scenario	Historical Scenario
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W					●	X
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W					●	
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W					●	
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W					●	
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W					X	
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W					●	X
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W					●	X
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W					●	●
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W					●	●
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W					●	●
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W					X	
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W					●	
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W					●	
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W					●	X
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W					●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W	X				●	●
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W					●	●
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W					●	●
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W					●	●
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W					●	●
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W					●	●
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W					●	●
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W					X	
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W					●	X
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W					●	X
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W					●	
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W					●	X
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W					●	●
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W					●	●
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W					●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W					●	●
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W					●	●
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W					●	●
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W					●	X
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W					●	●
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W					●	●
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W					●	●
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W					●	●
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W					●	●
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W					●	●
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W					●	●
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W					●	●
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W					●	X
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W					●	●
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W					●	X

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W					●	●
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W					X	
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W					●	●
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W						
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W	●	●	X	X	●	●
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W	●	●	●	●	●	●
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W	●	●	●		●	●
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W	●	●	●		●	●
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W	●	●	X		●	●
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W	●	●			●	●
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W	X	X			●	●
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W	X	X	X		●	●
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W	●	●	X		●	●
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W	●	X	X		●	●
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W	●	●	X		●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W	●	●	●		●	●
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W						
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W						
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W					X	
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W					●	X
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W	X				●	●
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W	X	X			●	●
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W	●	●			●	●
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W	●	●			●	●
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W	X	X			●	●
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W					●	●
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W					●	●
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W	X				●	●
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W	X				●	●
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W	●				●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W	●				●	●
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W	X				●	●
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W					●	●
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W	X				●	●
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W	●	●			●	●
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W					●	X
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W					●	●
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W					●	●
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W					●	●
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W					●	X
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W					●	●
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W					●	X
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W					●	●
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W					●	●
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W					●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W					●	●
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W					●	●
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W					●	●
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W					●	●
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W					●	●
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W					●	X
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W					●	●
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W					●	X
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W					●	●
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W					●	●
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W					●	●
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W					●	●
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W					●	●
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W					●	●
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W					●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W					X	
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W					●	
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W					X	
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W					●	X
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W						
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W	●	X			●	●
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W	●	●			●	●
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W	X				●	●
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W	X	X	X		●	●
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W	●				●	●
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W	●				●	●
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W	●	●			●	●
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W	●	●			●	●
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W	●	●			●	●
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W	X				●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W					●	X
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W						
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W						
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W	●				●	●
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W	X				●	●
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W	X	X	X	X	●	●
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W	X	X	X	X	●	●
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W	X	X	X		●	●
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W	X	X			●	●
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W	●	●	●	●	●	●
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W					●	●
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W					●	
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W	●	●			●	X
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W					●	●
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W	X	X	X	X	●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W	●	●	●	●	●	●
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W	●	●	X	X	●	●
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W	●	●	●	●	●	●
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W	●	●	●	X	●	●
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W	●	●	●		●	●
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W	●				●	●
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W					●	●
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W					●	●
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W					●	X
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W					●	●
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W						
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W	●	●			●	●
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W					●	X
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W	X	X			●	●
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W	●	●			●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W	●	●			●	●
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W	●				●	●
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W	●	●			●	●
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W	●				●	●
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W	●				●	●
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W					●	●
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W					●	●
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W					●	●
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W	●	●	●	●	●	●
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W	●	●	●	●	●	●
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W	●	●	●	●	●	●
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W	●	●	●		●	●
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W	X	X	X		●	
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W	●	●	●	●	●	●
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W	●	●	●	●	●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W	●	●	●	●	●	●
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W	●	●	●	X	●	●
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W	●	●	●	●	●	●
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W	●	●	●	●	●	●
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W	●	●	●	●	●	●
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W	●	●	●	●	●	●
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W	●	●	●	X	●	●
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W	●	●	●	X	●	●
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W	●	●	●	●	●	●
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W	●	●	●	●	●	●
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W	●	●	●	●	●	●
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W	●	●	X		●	●
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W	X	X	X		●	●
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W	X				●	●
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W	●	●	●	●	●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W	●	●	●	X	●	●
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W	●	●	●	●	●	●
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W	●	●	●	●	●	●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W	●	●	●	●	●	●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W	●	●	●	●	●	●
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W					X	X
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W					●	●
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W					●	X
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W					●	●
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W					●	●
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W	X	X	X	X	X	X
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W	●	●	●	●	●	●
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W	●	●	●	●	●	●
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W	●	●	●	●	●	●
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W	●	●	●	●	●	●

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W					●	●
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W	X	X	X	X	●	●
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W	●	●	●		●	●
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W	●				X	X
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W	X	X	X	X	●	●
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W	●	●	●	●	●	●
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W	●	X			X	●
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W	●	●	X		●	●
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W	●	X	X		●	●
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W					●	●
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W	X	X	X		●	X
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W	X	X	X		●	●
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W	●	●	X		●	●
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W	●	●	●	●	X	X
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W	●	●	●	●	●	X

Table 3.10. (continued)

Milepost	State Route	Island	Study Area	GPS	Storm Surge Inundation[1]				Tsumani Inundation[2]	
					Category 4 Storms	Category 3 Storms	Category 2 Storms	Category 1 Storms	Hypothetical Scenario	Historical Scenario
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W	●				●	●
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W					●	●
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W					●	●

[1] Zachry, B.C., Booth, W.J., Rhome, J.R., and Sharon, T.M. (2015). A National View of Storm Surge Risk and Inundation. *Weather, Climate, and Society* , 7(2), 109–117. DOI: http://dx.doi.org/10.1175/WCAS–D–14–00049.1. (Personal Communication)

[2] Cheung, K.F. (2009). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for Oahu. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2011). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Hawaii. Honolulu, HI: University of Hawaii ; Cheung, K.F. (2012). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Maui. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2013). Hawaii Tsunami Mapping Project: Data Sources, Procedures, and Products. Final Report for the County of Kauai. Honolulu, HI: University of Hawaii. ; Cheung, K.F. (2015). Hawaii Tsunami Mapping Project : Data Sources, Procedures, and Products for Extreme Aleutian Events. Final Report Prepared for the Hawaii Emergency Management Agency. Honolulu, HI: University of Hawaii (Personal Communication).

[3] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). “Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report”. Mendeley Data, doi: 10.17632/7p3hyypmjm

Table 3.11. Land use (i.e. public, business/industrial, residential) on the landward (mauka) and seaward (makai) sides of coastal state routes from the Ocean Hazards Database[1] (OHD) for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W		●			●	
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W		●		●		
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W			●			●
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W		●			●	
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W		●				●
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W			●	●		
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W		●				●
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W			●	●		
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W		●		●		
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W			●	●		
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W			●	●		
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W	●			●		
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W			●	●		
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W			●	●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W			●	●		
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W			●	●		
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W			●	●		
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W			●	●		
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W	●			●		
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W	●			●		
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W	●			●		
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W	●			●		
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W		●		●		
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W			●	●		
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W			●	●		
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W			●	●		
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W	●			●		
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W			●	●		
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W		●		●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W		●				●
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W		●				●
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W		●		●		
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W		●				●
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W		●		●		
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W		●			●	
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W		●				●
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W			●			●
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W			●	●		
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W			●			●
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W			●			●
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W			●	●		
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W		●				●
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W			●			●
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W			●			●

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W			●			●
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W			●			●
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W			●	●		
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W			●	●		
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W			●	●		
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W			●	●		
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W	●			●		
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W	●			●		
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W	●			●		
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W		●		●		
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W		●		●		
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W	●			●		
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W	●			●		
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W	●			●		
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W	●			●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W		●		●		
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W		●		●		
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W	●			●		
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W			●	●		
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W			●	●		
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W		●		●		
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W	●			●		
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W	●			●		
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W			●	●		
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W			●	●		
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W		●		●		
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W			●	●		
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W		●		●		
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W			●	●		
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W			●	●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W	●			●		
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W			●	●		
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W			●	●		
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W		●		●		
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W			●	●		
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W			●	●		
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W		●		●		
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W		●		●		
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W		●			●	
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W		●			●	
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W		●			●	
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W			●	●		
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W		●			●	
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W			●			●
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W			●			●

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W	●			●		
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W	●			●		
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W	●			●		
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W	●			●		
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W			●	●		
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W			●	●		
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W			●	●		
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W			●	●		
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W			●	●		
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W			●	●		
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W	●			●		
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W	●			●		
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W	●			●		
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W	●			●		
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W	●			●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W	●			●		
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W		●				●
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W		●		●		
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W		●		●		
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W	●			●		
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W		●			●	
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W		●		●		
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W	●			●		
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W	●			●		
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W			●	●		
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W			●	●		
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W			●		●	
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W	●			●		
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W	●			●		
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W	●					●

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W		●		●		
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W	●			●		
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W			●			●
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W	●			●		
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W			●	●		
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W		●			●	
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W		●		●		
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W	●			●		
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W	●			●		
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W	●			●		
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W		●		●		
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W		●		●		
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W			●			●
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W		●		●		
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W		●			●	

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W		●		●		
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W		●		●		
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W		●		●		
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W		●		●		
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W	●			●		
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W	●			●		
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W	●			●		
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W	●			●		
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W	●			●		
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W	●			●		
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W	●			●		
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W	●			●		
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W	●			●		
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W	●			●		
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W	●			●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W	●				●	
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W	●			●		
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W	●			●		
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W	●			●		
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W	●			●		
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W	●			●		
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W		●		●		
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W		●		●		
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W		●		●		
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W		●		●		
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W		●		●		
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W		●		●		
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W		●		●		
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W		●		●		
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W	●			●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W	●			●		
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W		●		●		
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W			●	●		
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W			●	●		
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W		●			●	
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W		●		●		
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W		●		●		
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W		●		●		
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W		●		●		
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W		●		●		
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W		●		●		
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W		●		●		
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W		●		●		
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W		●		●		
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W		●		●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W		●		●		
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W		●		●		
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W		●		●		
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W		●		●		
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W		●		●		
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W			●			●
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W			●			●
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W		●			●	
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W			●			●
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W	●					●
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W			●	●		
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W	●			●		
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W		●		●		
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W	●			●		
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W		●			●	

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W		●			●	
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W		●			●	
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W		●				●
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W			●		●	
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W		●			●	
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W		●		●		
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W		●		●		
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W	●				●	
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W	●				●	
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W	●			●		
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W	●			●		
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W		●		●		
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W	●			●		
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W	●			●		
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W		●		●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W			●			●
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W			●	●		
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W			●			●
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W			●	●		
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W		●				●
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W			●			●
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W		●			●	
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W		●		●		
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W		●		●		
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W			●	●		
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W	●			●		
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W	●			●		
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W	●			●		
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W		●		●		
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W		●		●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W	●				●	
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W		●			●	
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W					●	
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W					●	
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W					●	
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W				●		
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W		●		●		
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W	●			●		
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W	●			●		
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W	●			●		
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W		●				●
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W		●				●
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W			●			●
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W			●			●
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W			●	●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W			●	●		
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W			●	●		
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W		●		●		
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W		●		●		
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W			●	●		
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W			●	●		
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W			●	●		
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W		●			●	
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W	●			●		
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W			●			●
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W			●			●
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W			●	●		
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W			●			●
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W		●			●	
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W	●					●

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W	●					●
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W	●					●
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W			●	●		
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W			●	●		
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W	●					●
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W			●	●		
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W			●			●
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W			●			●
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W			●			●
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W		●		●		
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W			●	●		
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W			●	●		
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W			●			●
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W			●	●		
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W			●	●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W			●	●		
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W			●	●		
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W			●	●		
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W			●			●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W			●	●		
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W			●			●
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W			●			●
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W			●			●
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W		●			●	
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W			●			●
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W			●			●
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W			●	●		
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W			●			●
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W			●			●
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W			●	●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W	●			●		
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W		●				●
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W			●			●
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W			●	●		
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W		●		●		
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W			●			●
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W			●	●		
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W			●	●		
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W	●			●		
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W			●	●		
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W			●	●		
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W			●	●		
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W			●	●		
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W			●	●		
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W			●	●		

Table 3.11. (continued)

Milepost	State Route	Island	Study Area	GPS	Mauka Side of Road[1]			Makai Side of Road[1]		
					Public	Business / Industrial	Residential	Public	Business / Industrial	Residential
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W			●	●		
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W			●	●		
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W			●	●		

[1] Francis, Oceana; Yang, Linqiang; Togia, Harrison ; Tumino Di Costanzo, Giannicola. (2019). "Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report". Mendeley Data, doi: 10.17632/7p3hyypmjm

Chapter 4 – Adaptation Recommendations

At Milepost 6 along the Kuhio Highway, East Kauai.
Photo taken on June 6, 2019 by Francis, Togia and Yang.

4.1. Introduction: An Assessment of Adaptation Recommendations for State of Hawaii DOT coastal highways

Chapter 4 presents Adaptation Recommendations requested by the State of Hawaii Department of Transportation (HDOT) and supports the areas identified in the Coastal Road Susceptibility Index (CRESI), Chapter 1, of this report.

The HDOT has tasked the team to research and develop the methodology and criteria used to identify and prioritize sites for mitigation. We provide the criteria and process for selecting various mitigation solutions and the recommended adaptations for 302 mileposts on State of Hawaii DOT coastal highways. Our work is based on site visits to all 302 mileposts, the Ocean Hazards Classification Scheme (OHCS), and the Ocean Hazards Database (OHD) (Francis et al., 2019b) created for Chapter 3 of this report, road connectivity, and previous publications.

We present two new contributions, in Chapter 4, which are a cost-benefit analysis of adaptation options (Table 4.1) and adaptation recommendations (Figures 4.1-4.23; Table 4.2) for the State of Hawaii Statewide Coastal Highway Program Report.

Previous work relating directly to Chapter 4 is most recently done by Brandes and Francis (2018). Brandes and Francis (2018) identify in their report, the high priority sites (to be implemented in 2-4 years) and short-term priority sites (5-8 years), along with mitigation solutions for highly susceptible areas on HDOT coastal highways. Brandes and Francis (2018) was completed before the work in Chapter 1, Chapter 2, and Chapter 3 began. In Chapter 4 of the State of Hawaii Statewide Coastal Highway Program Report Version 1 (this report), we provide recommendations which address mid-term (9-15 years) to long-term (16-30 years) solutions.

Our study area specifically focuses on 302 mileposts in the HDOT coastal highway system, scattered throughout the State of Hawaii, identified as "susceptible" in Chapter 1 due to the condition of or proximity of the road to the ocean.

In the subsequent sections, we present the following. In Section 4.2, we introduce the methodology for the development of the cost-benefit and adaptation recommendations. In Section 4.3, we present and discuss the results for the cost-benefit and adaptation recommendations. In the following four sections, Sections 4.4, 4.5, 4.6, and 4.7, we present the future work, references, figures, and tables, respectively.

4.2. Methodology: Development of the Cost-Benefit and Adaptation Recommendations for State of Hawaii DOT coastal highways

4.2.1. Cost-Benefit: Introduction to adaptation options, cost, and feasibility of implementing

We prepare a cost-benefit table (Table 4.1) for engineering adaptation options that the HDOT can consider, which we base on personal communications and previous publications. We rank each identified section on a scale between 1 and 5, where: 1 = action assigned low value due to low level of support and/or benefit; 3 = action assigned medium value due to some level of support and/or benefit; and 5 = action assigned high value due to high level of support and/or benefits. Questions asked include social, technical, administrative, political, economic, and environmental considerations. Social considerations address social vulnerability. Technical considerations address whether or not it can be technically implemented and able to handle climate change impacts. Administrative considerations depend on the agency who will be implementing the adaptation option. Political depends on political support. Economic considerations address the cost effectiveness and existing funding. Environmental considerations address whether the adaptation option will help the environment.

We include several types of adaptation options which fall under five general categories: relocate (R), protect (P), accommodate (A), monitor (no action) (M); and a combination of relocate, protect, and/or accommodate (C).

Relocate (R) is to move away from the water. Green spaces or wetlands can be restored to establish or maintain fresh water buffer areas. The road is also protected against long-term climate change impacts (e.g., sea level rise). However, obtaining development rights, where the land is privately owned, can be an issue. Relocate can be divided into two sub-categories: Road relocation to an old road (O) and Road relocation to a new road (N). From these two sub-categories, there are two alternatives which are: R-O and R-N.

Protect (P) is to keep the water out. A hard structure, such as a seawall or revetment, may be built or protection may involve a soft (natural) approach such as a dune, or beach nourishment. Hard and soft protections, to protect the road, provide a buffer between the ocean and road, but can affect coastal erosion. Protect (P) can be divided into three sub-categories: Beach Nourishment (SB); Living Dunes (SD); and Hard Protection-Revetment, Seawall (H). From these three sub-categories, there are three alternatives which are: P-SB, P-SD, and P-H.

Accommodate (A) is the ability to live with the water. The road is elevated, flood control is improved, and wetlands and natural environment are enhanced. Accommodate (A) can be divided into four sub-categories:

Vegetative cover/existing green space (GO); Wetland construction (WN); Wetland restoration (WO); and Elevated development (E). From these four sub-categories, there are four alternatives which are: A-GO, A-WN, A-WO, and A-E.

Combination (C) brings together the alternatives from Relocate (R), Protect (P), and/or Accommodate (A). We introduce three combination sub-categories for susceptible coastal roads: Hard protection/Elevated road (H-E); Hard/Soft protection (H-SD); and Relocate/Add green space (R-G). From these three combination sub-categories, there are three alternatives which are: C-H-E, C-H-SD, and C-R-G.

Monitor or no action (M) is to leave the road alone and/or monitor the site periodically.

To assign a rank number to “Benefit,” we use several methods which include previous publications, Onat et al. (2018) and Francis et al. (2019a), as well as personal communication with agencies, residents, and public users (Francis et al., 2019b). To assign a rank number to the “Cost,” we use several previous publications which include: Eastern Research Group (2013); Abe (2019); Beavers et al. (2016); and Applied Coastal Research and Engineering, Inc. (2017).

4.2.2. Adaptation Recommendations at 302 mileposts on the State of Hawaii DOT coastal highways considered “susceptible”

For the adaptation recommendations, we use six alternatives which include: R-N, P-SD, P-H, C-H-E, C-H-SD, and M. We prepare maps (Figures 4.1-4.23) showing one of these six alternatives at each milepost and summarize these adaptation recommendations (Table 4.2). This is based on site visits to all 302 mileposts; the Ocean Hazards Classification Scheme (OHCS) and Ocean Hazards Database (OHD) (Francis et al., 2019b) created for Chapter 3 of this report; road connectivity; and personal communications (Francis et al., 2019b).

To prepare the adaptation recommendations, we identify susceptible parts of the highways. Next, we prepare the ocean hazards data and maps for those identified mileposts, and make a site visit to each milepost, using data and maps for: elevation transects; sea level rise (SLR) inundation; maximum annually recurring waves; shoreline change; tsunami inundation; storm surge inundation; and natural benthic habitat that we create for this project (Francis et al., 2019b). While in the field we are often approached by long-time residents, to whom we talk, learn from, and share our knowledge of ocean hazards in their areas with. We also evaluate how the SLR and storm surge inundation affect certain areas and what the road connectivity is for those areas.

4.3. Results and Discussion: Cost-Benefit and Adaptation Recommendations for State of Hawaii DOT coastal highways

4.3.1. Cost-Benefit

From the cost-benefit (Table 4.1), we see that the highest costs are associated with new construction.

For alternatives, the highest costs are associated with wetlands. Although wetlands are natural, desirable, and allow water to be accommodated, the cost is the highest for these alternatives: A-WN and A-WO. However, once wetlands are in place, they need little maintenance. Wetlands can adapt to SLR, storm surge, and mitigate erosion. As a natural, non-evasive option, many of the rural communities in the State of Hawaii favor this option.

Another green alternative includes adding a green space (A-GO), such as a park or vegetation, which is a much less expensive option: A-GO. Vegetative cover (A-GO) is an option for beach areas where wind and water erosion are issues. Vegetative cover is popular on Hawaii’s beaches and provide a buffer between the road and the beach, and provides shade from the sun. Many indigenous Hawaiian plants grow naturally by the beach and need little maintenance. A-GO is a popular alternative at Sunset Beach, North Shore, Oahu, as found in Onat et al. (2018), and where there is a living dune restoration project currently underway which we observed during a site visit in spring 2019.

Two popular alternatives are beach nourishment (P-SB) and living dunes (P-SD). The cost is low, however maintenance (i.e., replenishment) needs to be applied every few years. P-SB and P-SD protect against storm surge, however, often after one storm surge event, these soft protection measures require replenishment.

Road relocation includes the alternatives: relocation to an old road (R-O), relocation to a new road (R-N), and a combination of relocation and adding a green space (C-R-G). Road relocation is an expensive option, but a permanent one, and can be considered when a road needs to be abandoned due to permanent inundation, such as SLR. Adding a green space (e.g., beach park, bike pathway) can greatly enhance the usability of the area.

Hard protection includes alternatives: hard protection–revetment/seawall (P-H) and combination-hard/soft protection (C-H-SD). Costs range greatly and are higher than soft protection but offer a more stable solution during high wave events. Alternative C-H-SD is recommended for popular beach areas for aesthetic purposes and when hardened protection is needed from high wave events.

Elevate includes alternatives: elevate road (A-E) and combination-hard protection/elevated road (C-H-E). The costs are high for these alternatives, given the cost and availability of gravel for building a pad. Both A-E and C-H-E present the next best alternatives to mitigate against SLR and storm surge, if relocation cannot be done, where C-H-E is most often used in SLR and storm surge inundation areas.

No action/monitor (M) has no cost and is used where there is no road susceptibility or little to no ocean hazard exists.

4.3.2. Adaptation Recommendations

Although our recommendations depend on a number of factors, we use the general following guidelines, from Francis et al. (2019b), when recommending an adaptation:

1. For areas under SLR inundation:
   - Mileposts that are either cutoff or inundated under SLR by 2050 or under 1, 2, 3, ft SLR are considered for Relocation (R). Mileposts falling within these ranges were either in the 3 ft SLR inundation and/or 2050 SLR inundation under high, highest and extreme scenarios. These mileposts include: 1 MP: 36, East Shore, Oahu (cutoff); 2 MPs: 1, 1+0.50 East Maui, Maui; and 12 MPs: 0+0.53, 3, 3+0.75, 5+0.38, 8+0.21, 8+0.63, 9, 9+0.41, 10, 10+0.06, 14+0.70, 16 Molokai, Molokai (Tables 3.4 and 3.5).
   - When Relocation (R) is difficult, given either the topography or difficulty in acquiring the development rights to the land (depending on land use), elevate road (E) is recommended.
2. For areas under storm surge inundation:
   - Hardened protection is recommended (seawall or revetment) (P-H)

3. For areas under tsunami inundation:
   - An evacuation route is recommended
4. For areas that have a combination of SLR, storm surge and erosion:
   - Elevate road and harden is recommended (C-H-E)

The main alternatives we recommend for the 302 mileposts are: Alternative R-N (Road relocation to a new road); Alternative P-SD (Living dunes); Alternative P-H (Hard protection); Alternative C-E-H (Combination-elevate road and hard protection); Alternative C-H-SD (Combination-hard/soft protection) or Alternative M (No action or monitor) (Table 4.2).

Alternative R-N (Road relocation to a new road) is recommended for MP 35+0.54 to MP 36 along Route 83, East Shore, Oahu; and MP 1 to MP 3+0.14, Route 310, East Maui, Maui. We find 2050 SLR and storm surge inundation in these areas. There is also land available to move the road inland.

Alternative P-SD (Living dunes) is recommended for the area at MP 11+0.64, Route 30, West Maui, Maui. With an existing beach there, creating a dune is considered suitable protection from the ocean while maintaining the natural look of the beach.

Alternative P-H (Hardening) is a popular recommendation and we found the need for hardening throughout HDOT coastal highways. These areas where chosen for hardening due to one or more reasons: failure of existing armoring; road susceptibility; sinkholes; and/or wave action, erosion, and storm surge.

Alternative C-E-H (Hardening/elevate road) is recommended for MP 27+0.79 to MP 31+0.09 along Route 83, East Shore, Oahu. This area is not affected by 2050 SLR. But due to the high wave action and erosion, proximity of the road to the ocean, road relocation being impossible, and other alternatives being too costly (i.e., tunneling), we recommend elevating the road and hardening. Elevate/hardening can be constructed by raising the road with a gravel pad and building hardened protection on both sides of the road. Even a 3 ft road elevation makes a difference between inundation or no inundation.

Alternative C-H-SD (Hardening/soft protection) is recommended for MP 24+0.21 to MP 24+0.48 along Route 83, East Shore, Oahu; and MP 8+0.67 to MP 8+0.80 along Route 83, North Shore, Oahu. These areas are chosen for C-H-SD due to high wave action and/or storm surge activity. Also, these areas are popular beaches so there is a high desire to protect while maintaining a natural look. This recommended alternative would consist of constructing a dune with a revetment buried underneath. The dune would be actively monitored, maintained, and offer a natural look, while the revetment would serve to protect the road during storm surge and high wave events.

Alternative M is chosen where ocean hazards are not present, the road is not susceptible, the shoreline is inaccessible (e.g., private property), and/or the milepost is just a marker. This includes many of the mileposts. In some areas, mileposts marked the only beach access, therefore, although there may be sand overtopping onto the road the milepost is given an M if there appears to be no road susceptibility.

4.4. Future Work for Chapter 4, Adaptation Recommendations

For Chapter 4, DOT requested no changes be made from Version 1.

For the benefit-cost, the values for benefits will be confirmed and further researched. Additional references will be provided, as needed. We will also add discussion of the benefits and benefit/cost ratio for each alternative in Table 4.1.

We will provide conceptual drawings of the adaptation options after input from HDOT.

4.5. References

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4.6. Table of Figures (Figures 4.1 – 4.23)

Figure 4.19. Pauwalu to Kalaekapu adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.20. Waimea to Kokole Point adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.21. Wailua to Kealia adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.22. Hanalei to Waikoko adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.23. Hilo Bay area adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

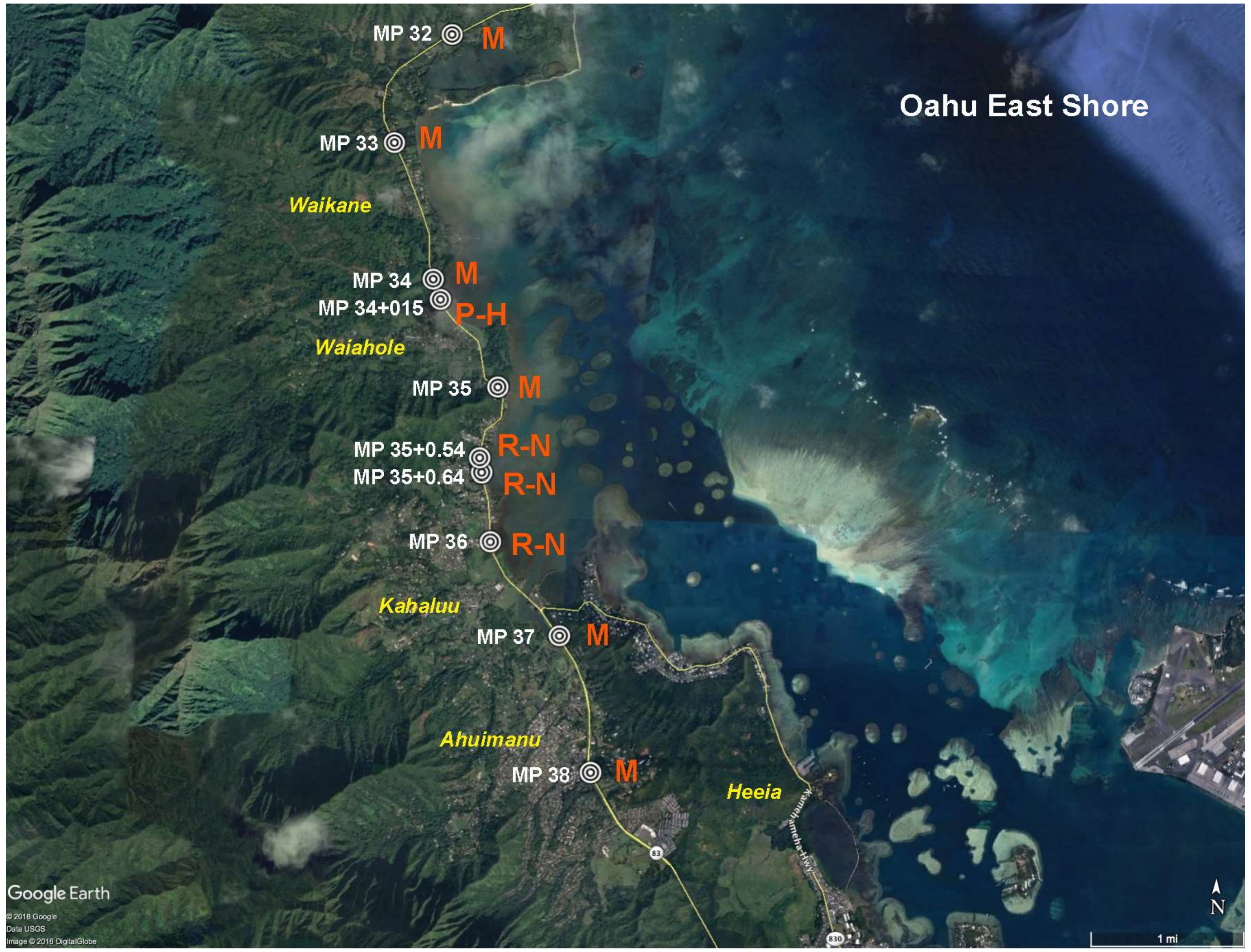

Figure 4.1. Heeia to Kualoa adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

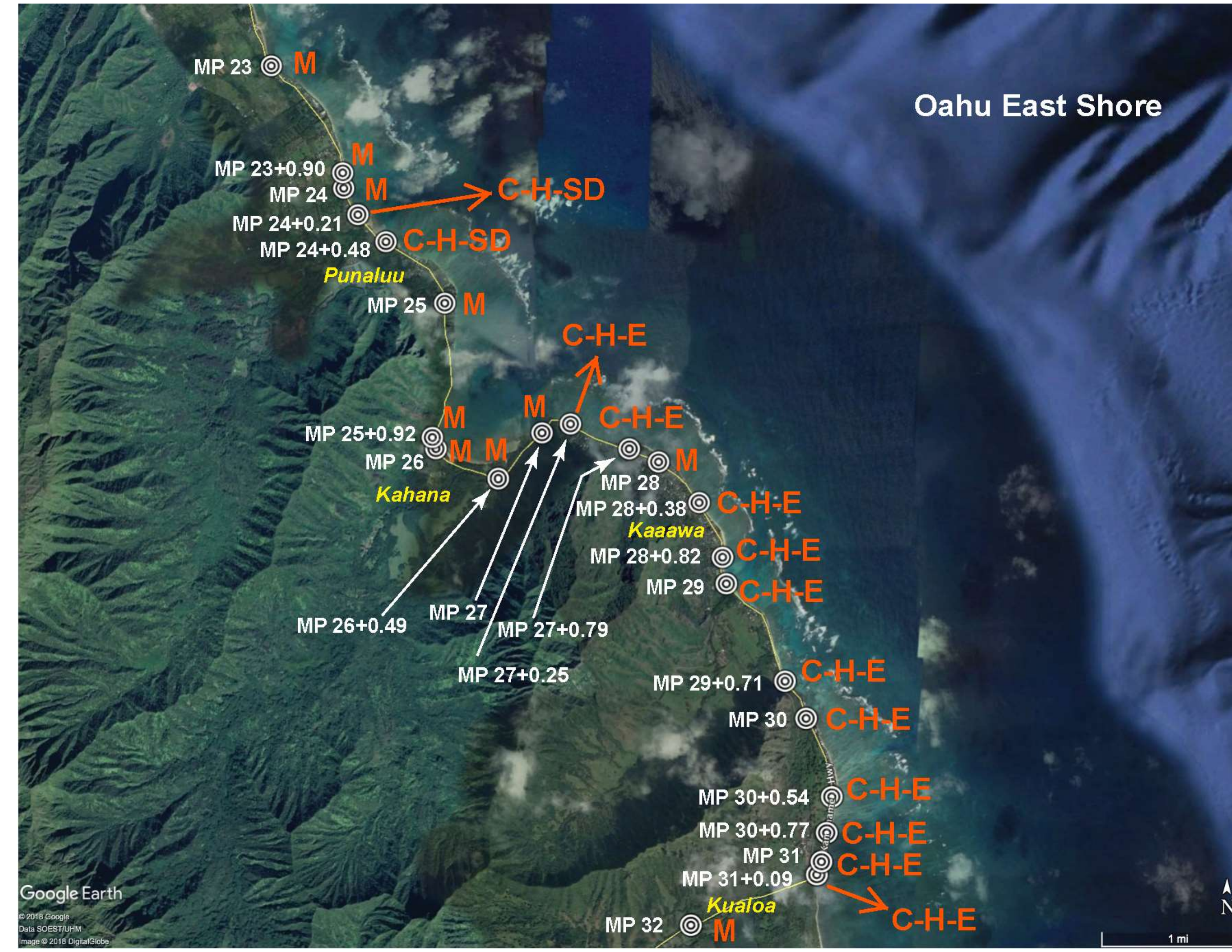

Figure 4.2. Kualoa to Punaluu adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

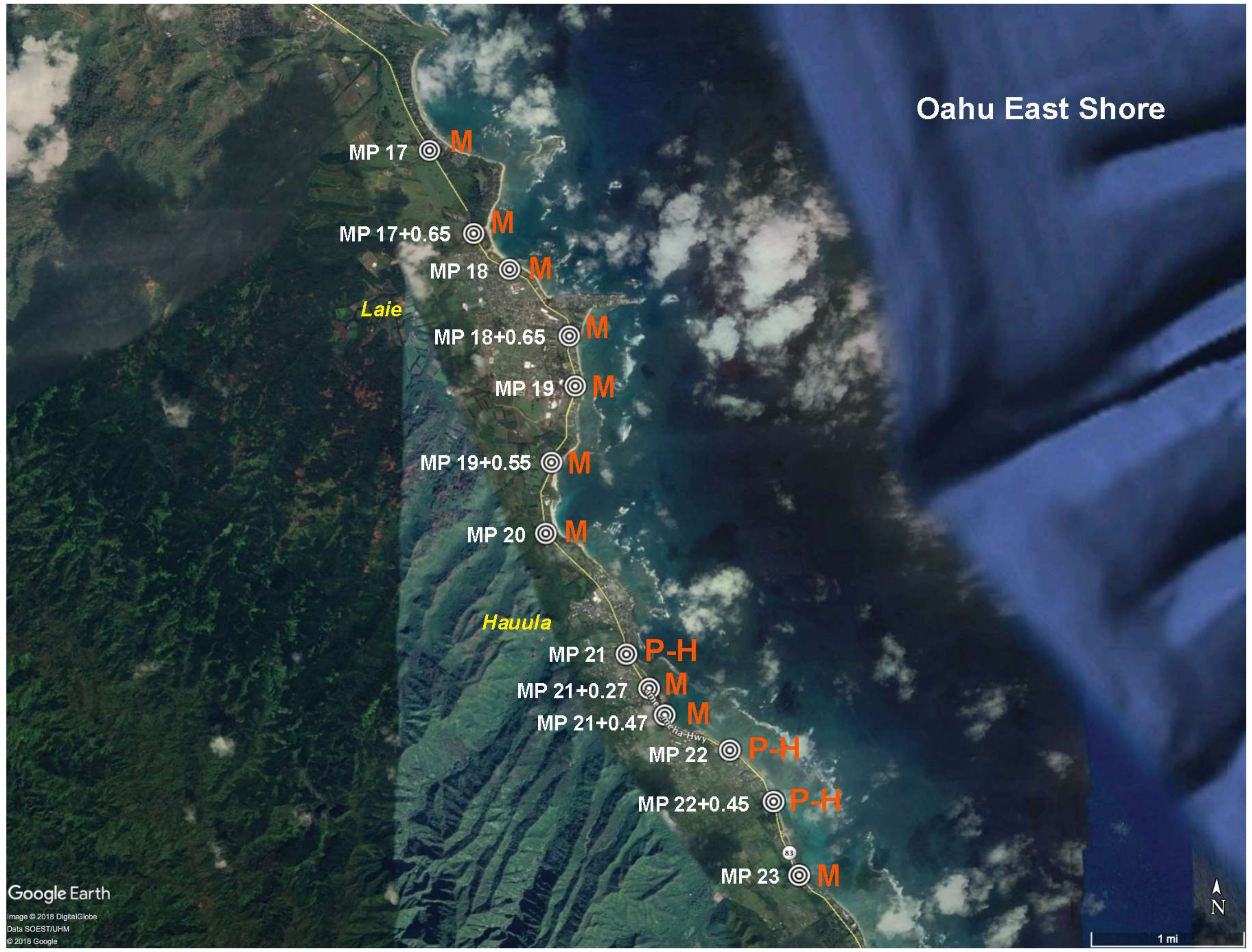

Figure 4.3. Hauula to Laie adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

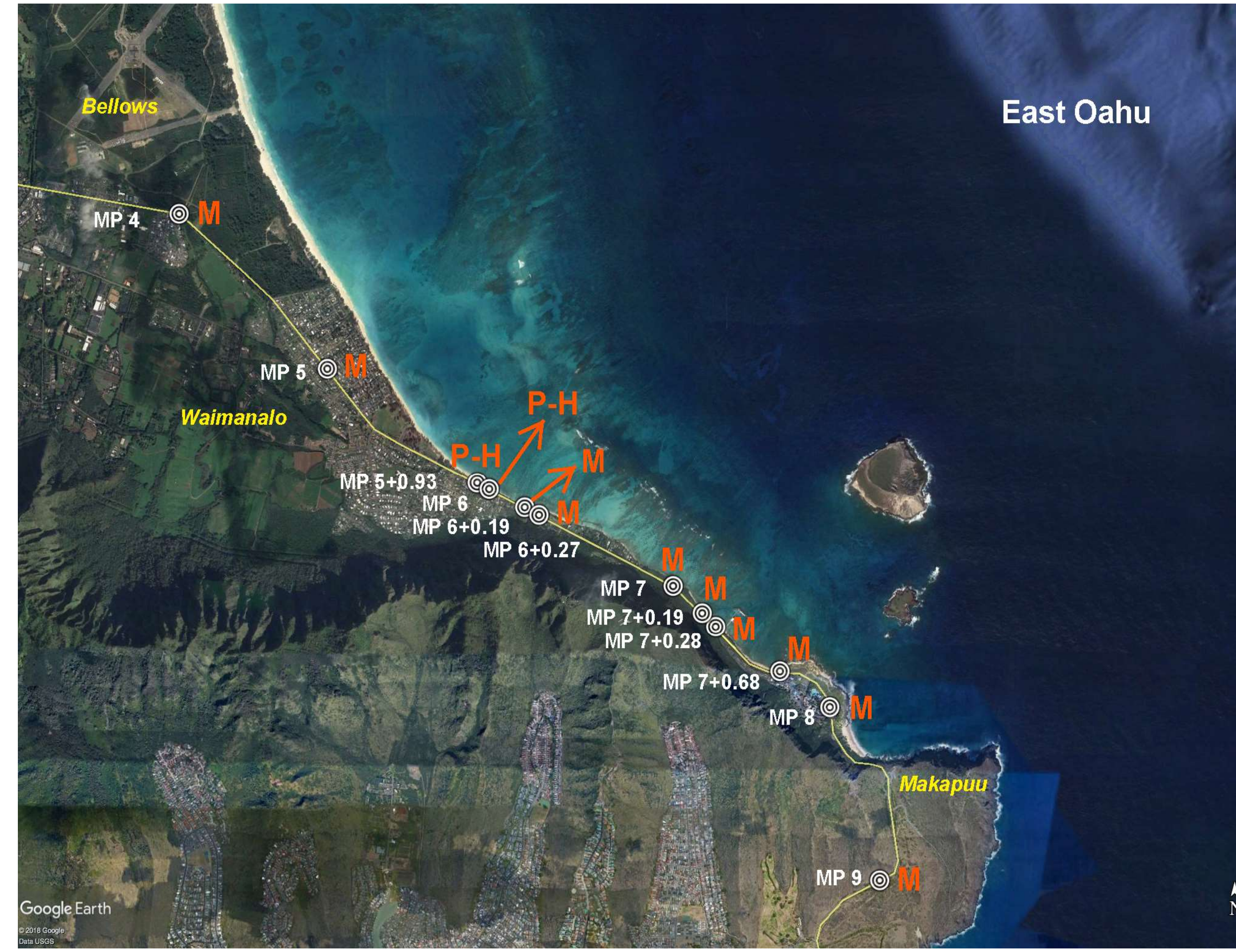

Figure 4.4. Waimanalo to Makapuu adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

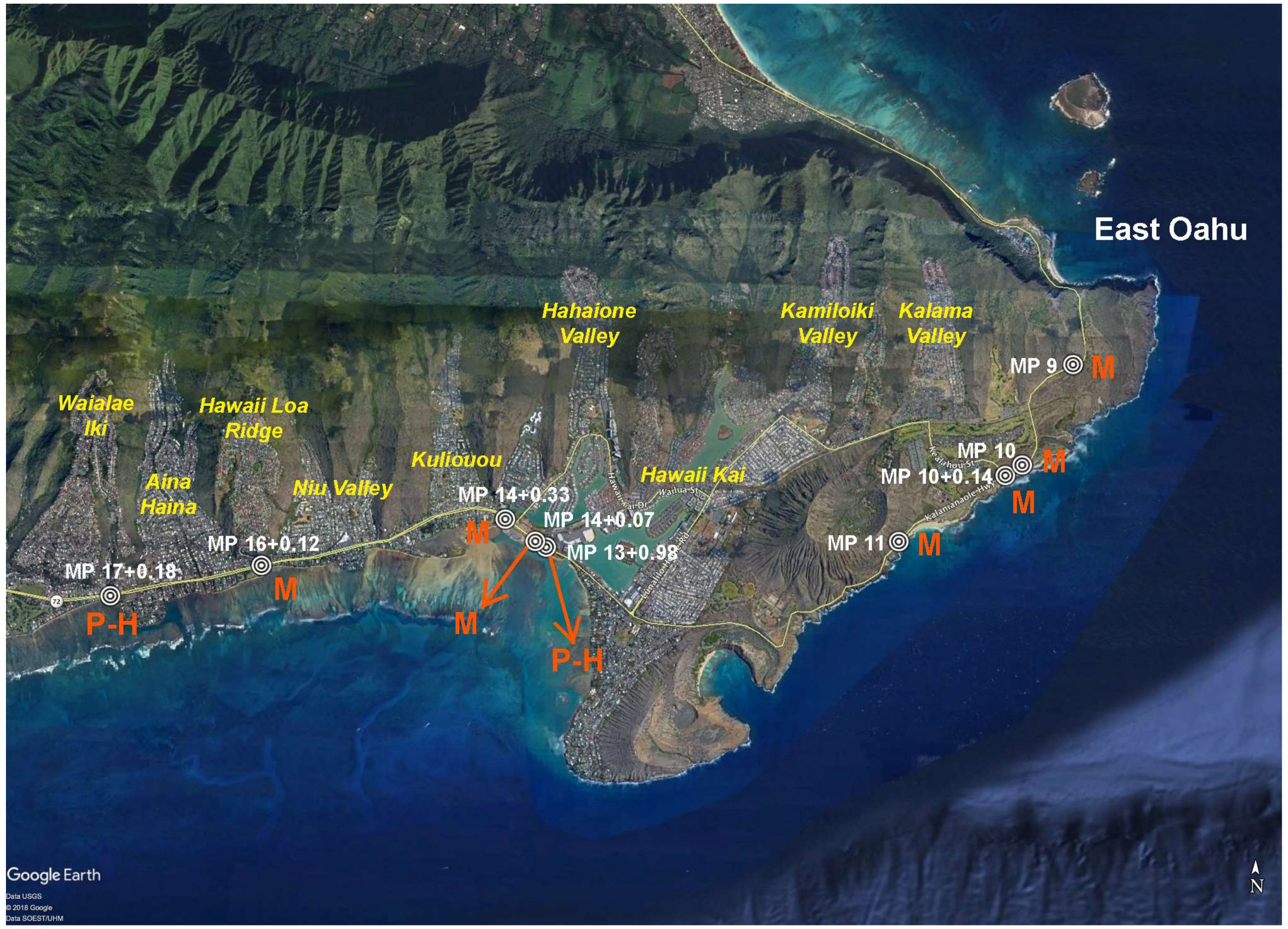

Figure 4.5. Makapuu to Kahala adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.6. HECO Plant to Nanakuli adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

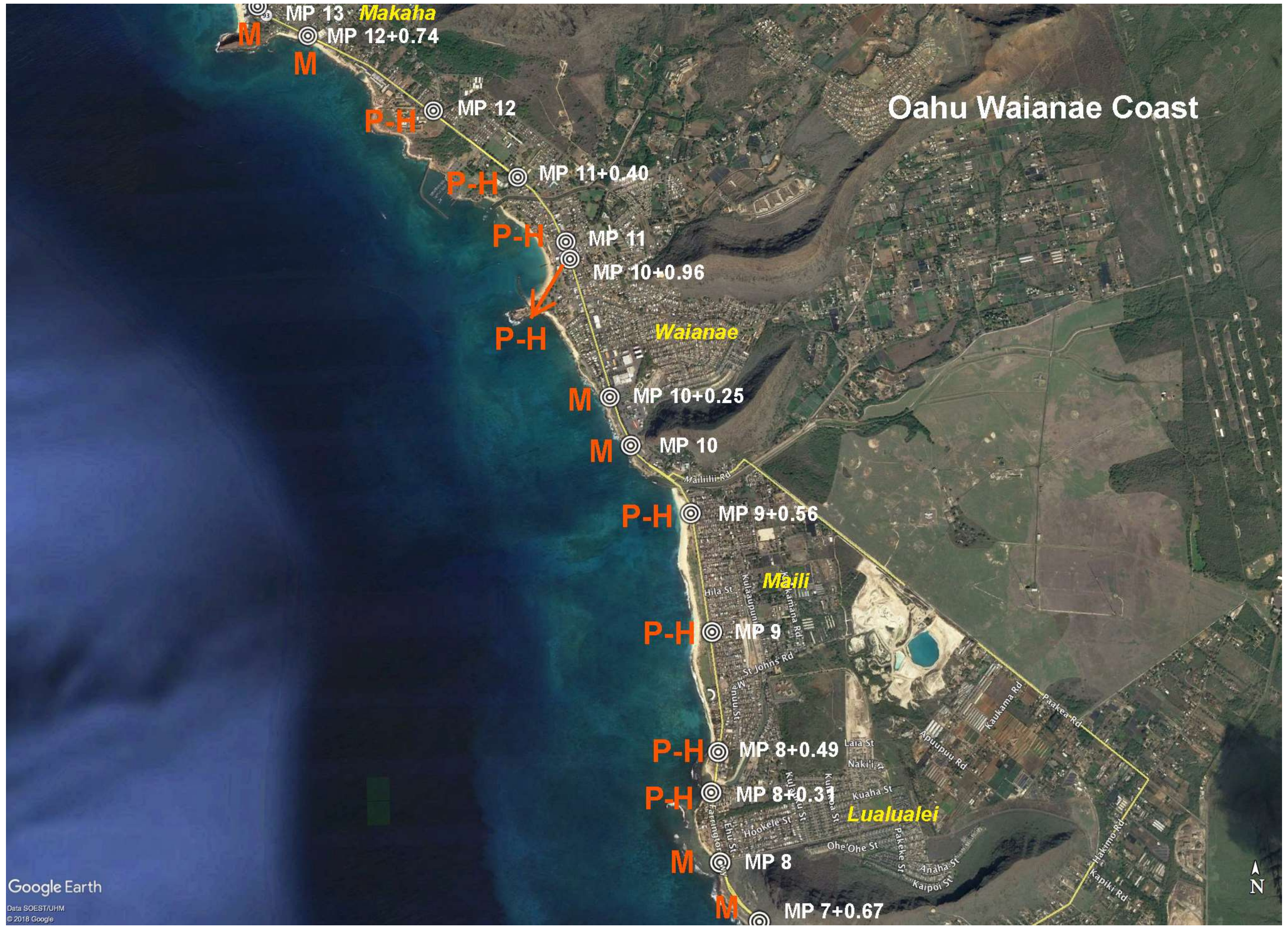

Figure 4.7. Lualualei to Makaha adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

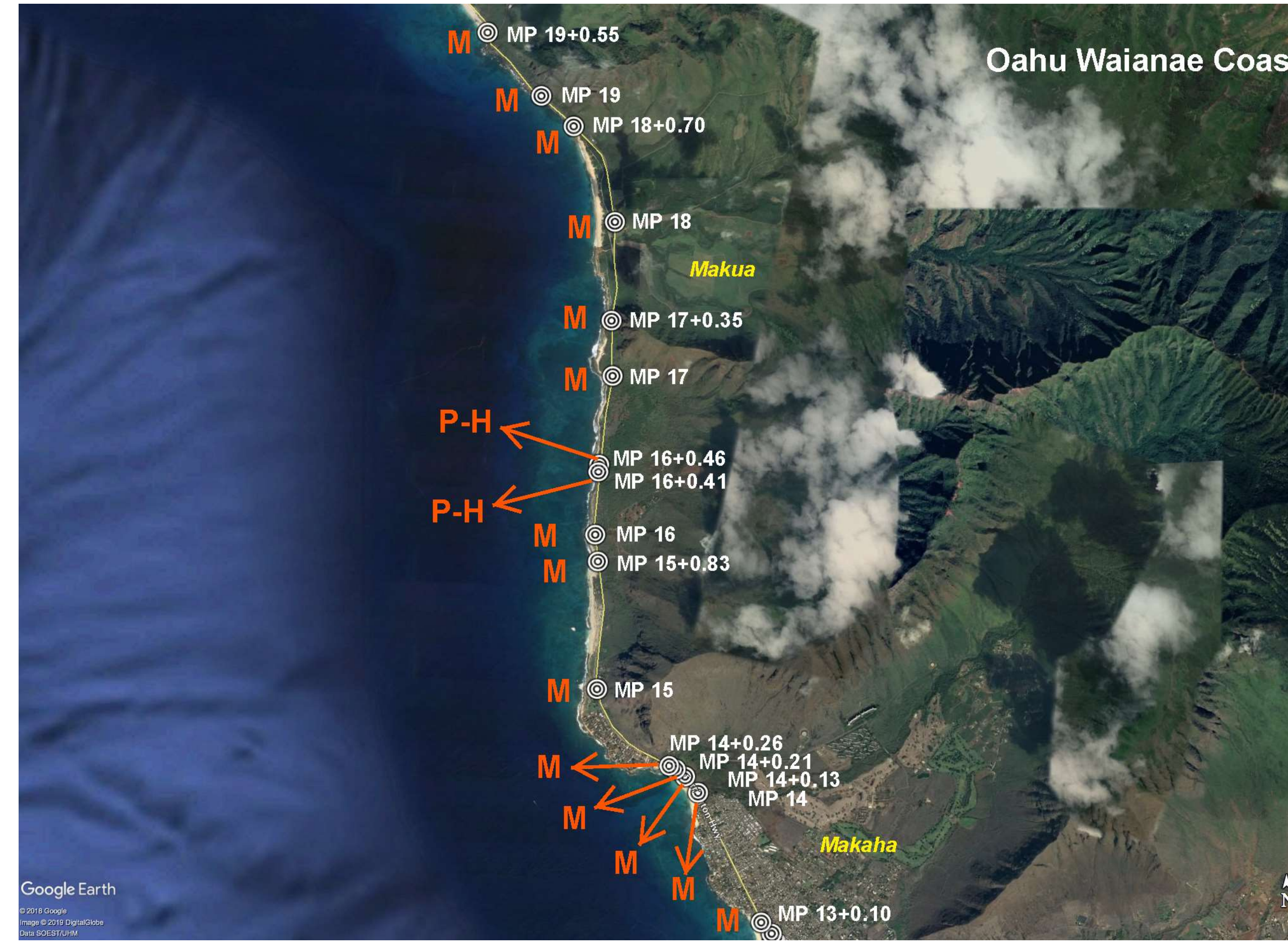

Figure 4.8. Makaha to Makua adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

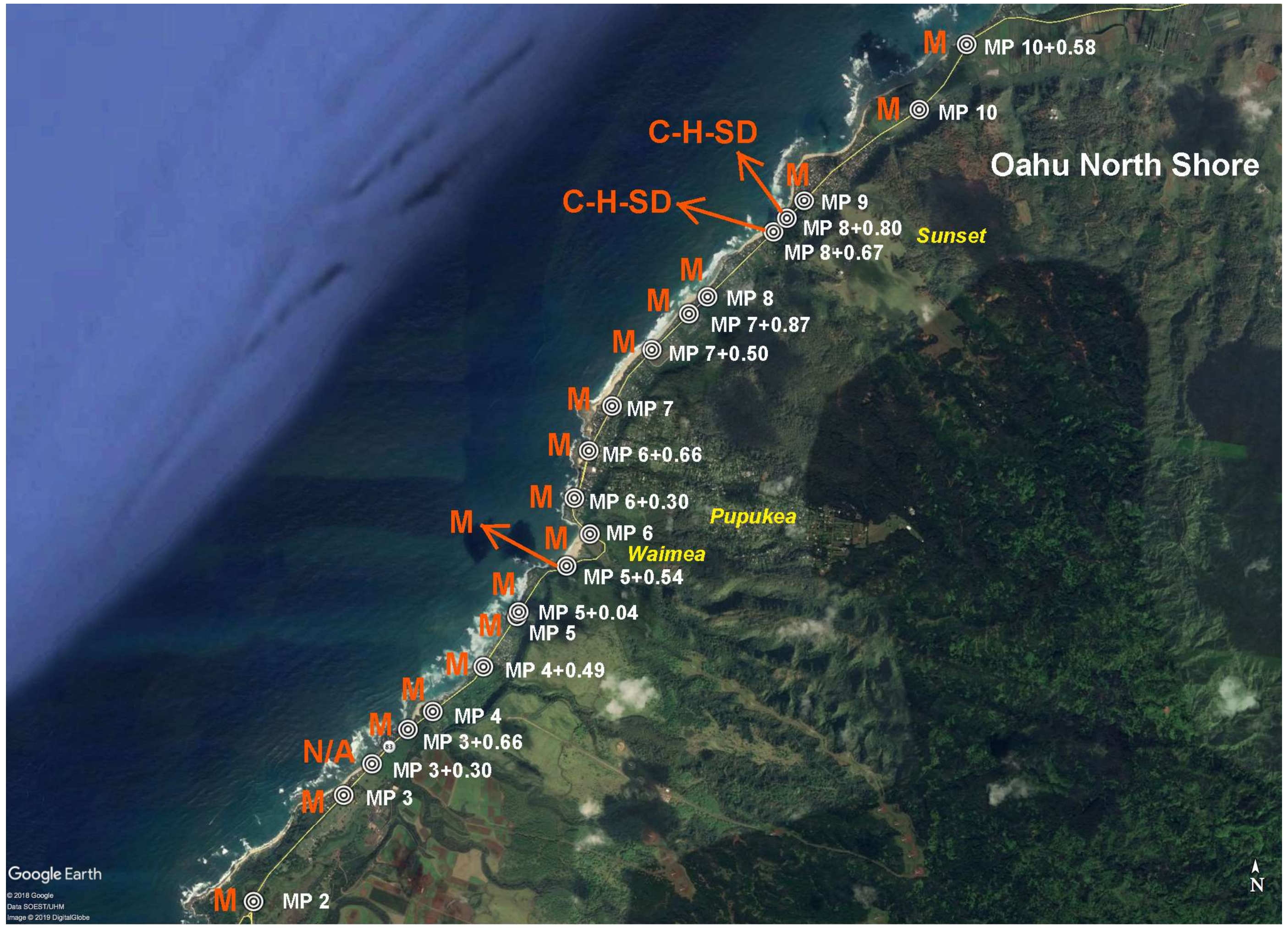

Figure 4.9. Oahu North Shore adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

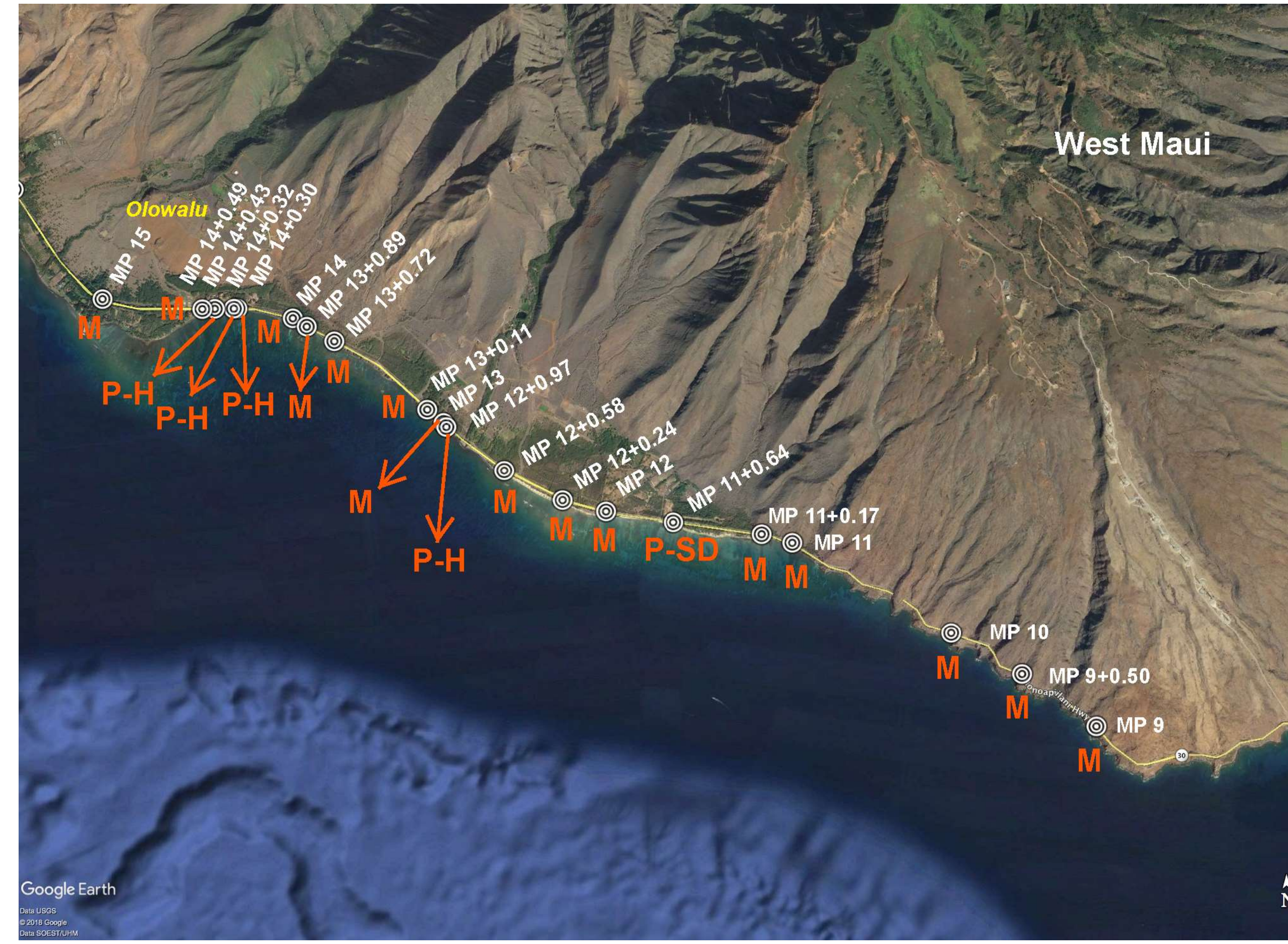

Figure 4.10. Maalaea to Olowalu adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

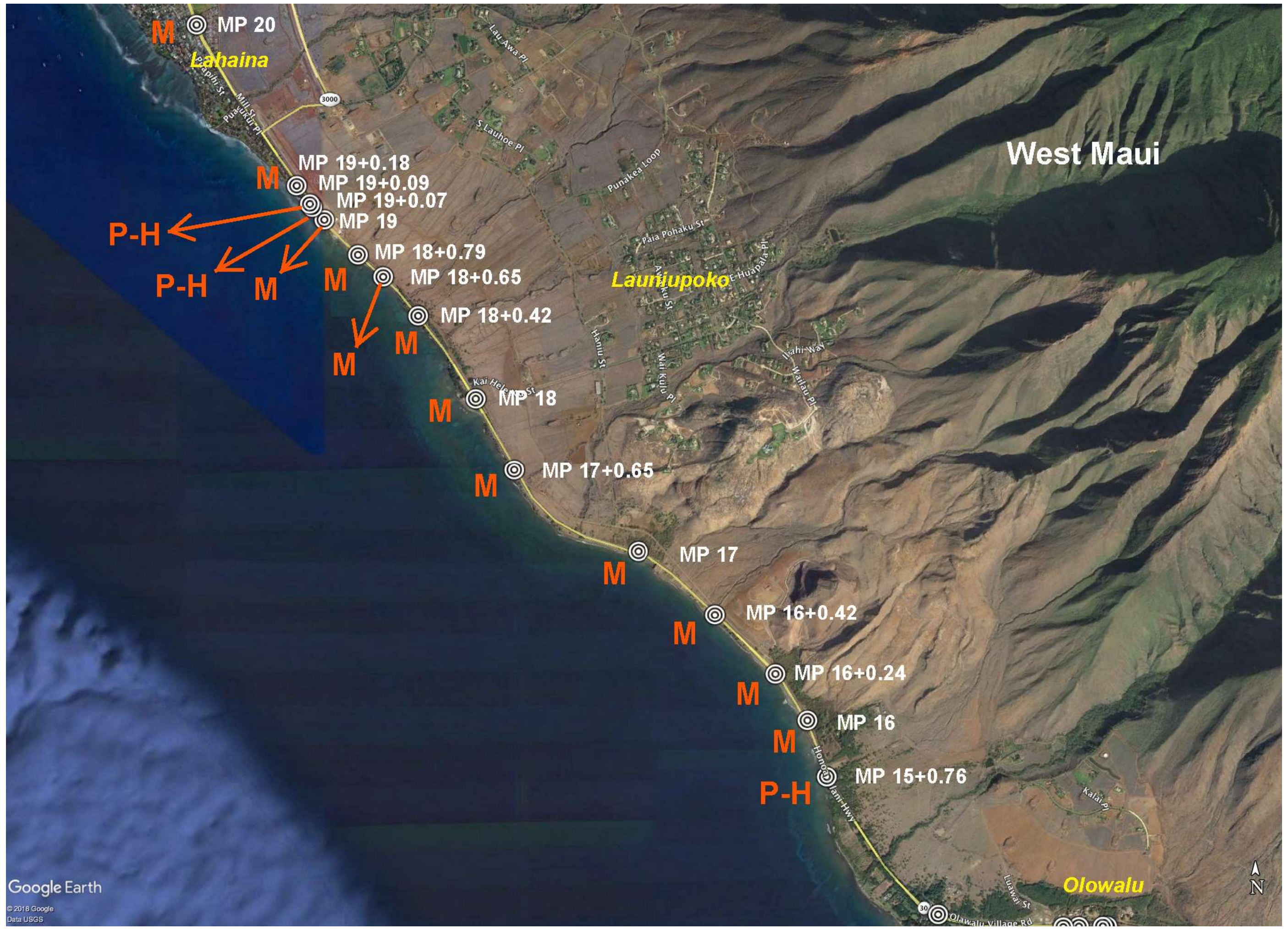

Figure 4.11. Olowalu to Lahaina adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

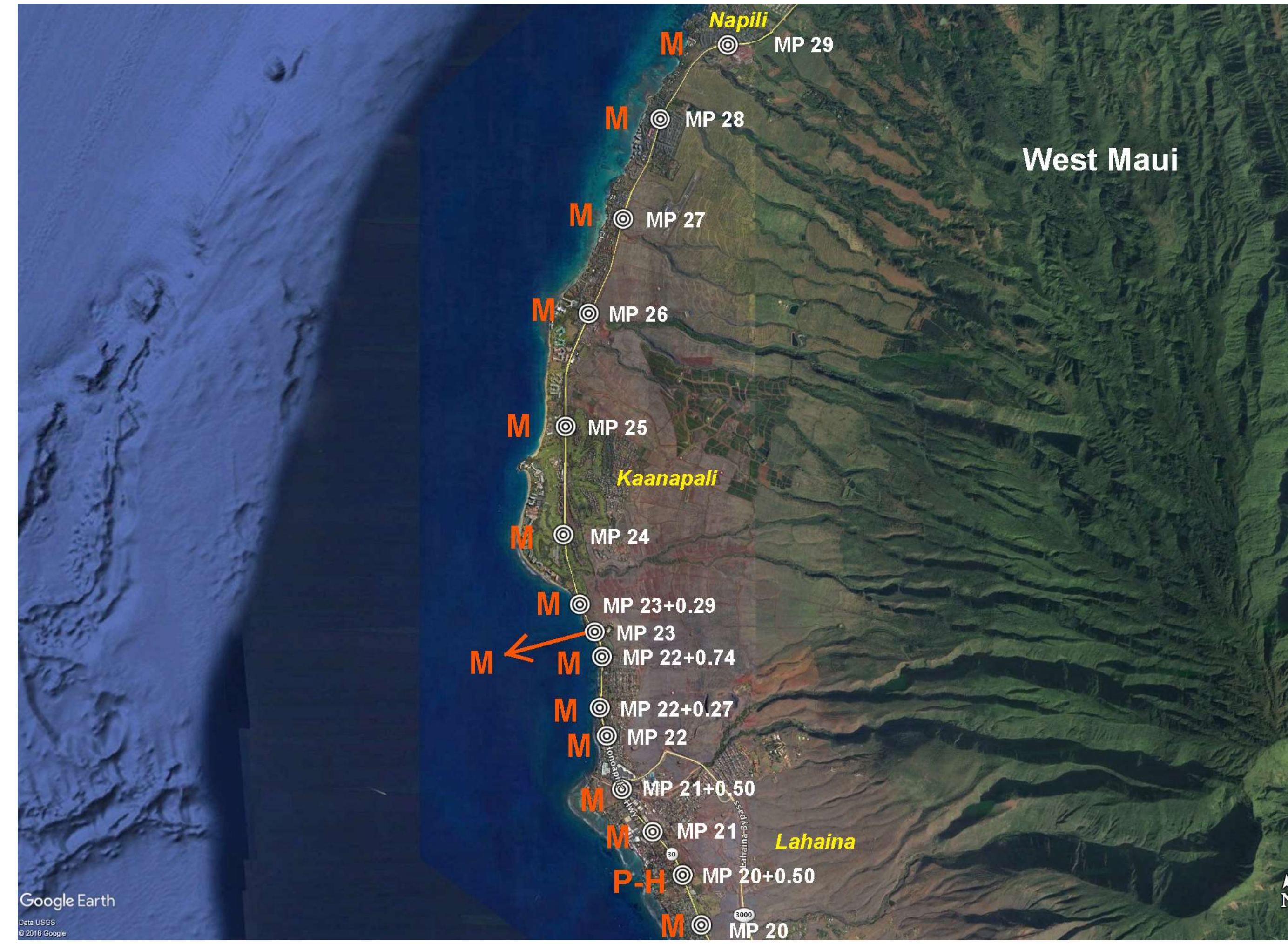

Figure 4.12. Lahaina to Napili adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

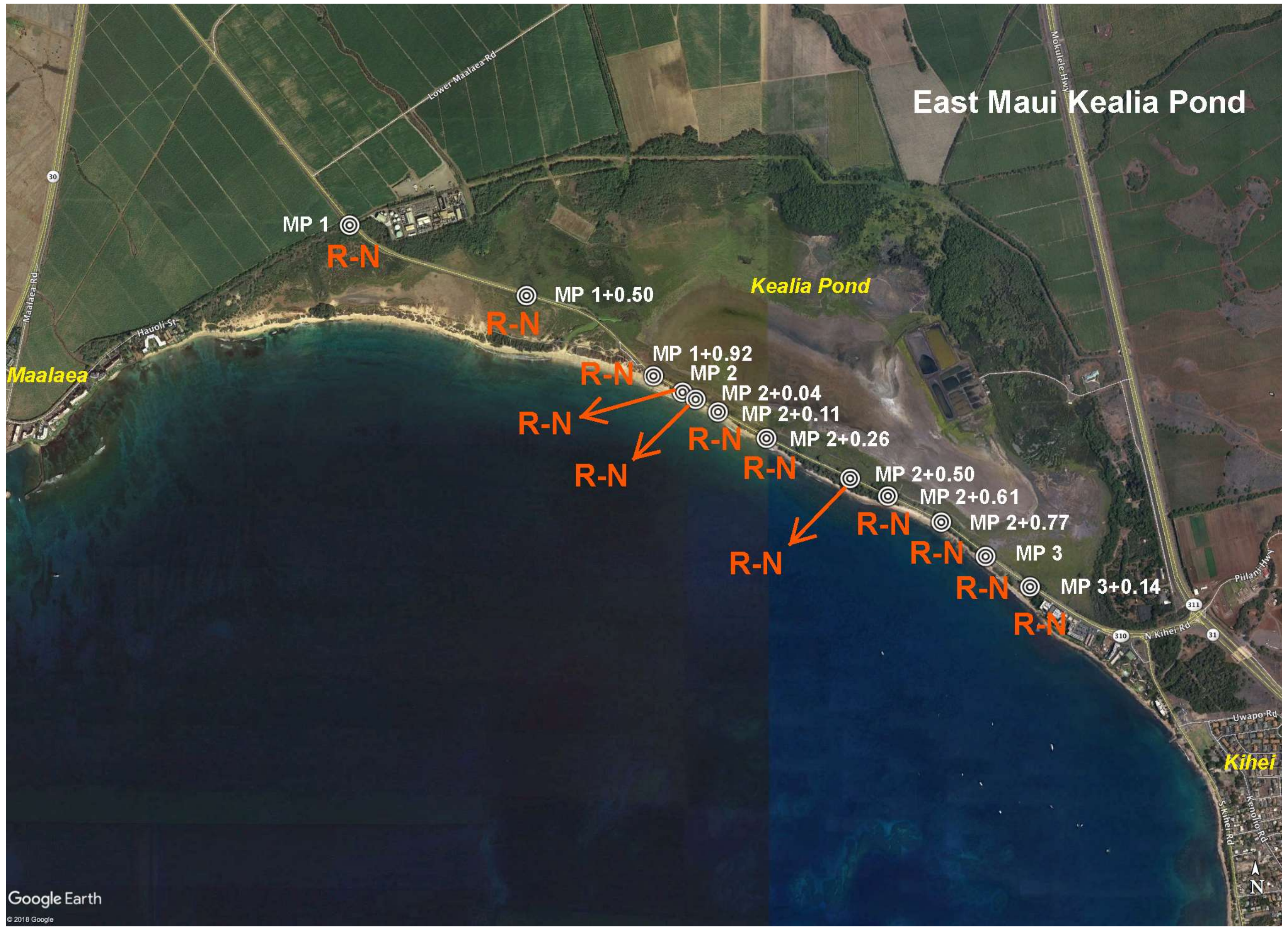

Figure 4.13. Maalaea to Kihei adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.14. Kahului Harbor adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

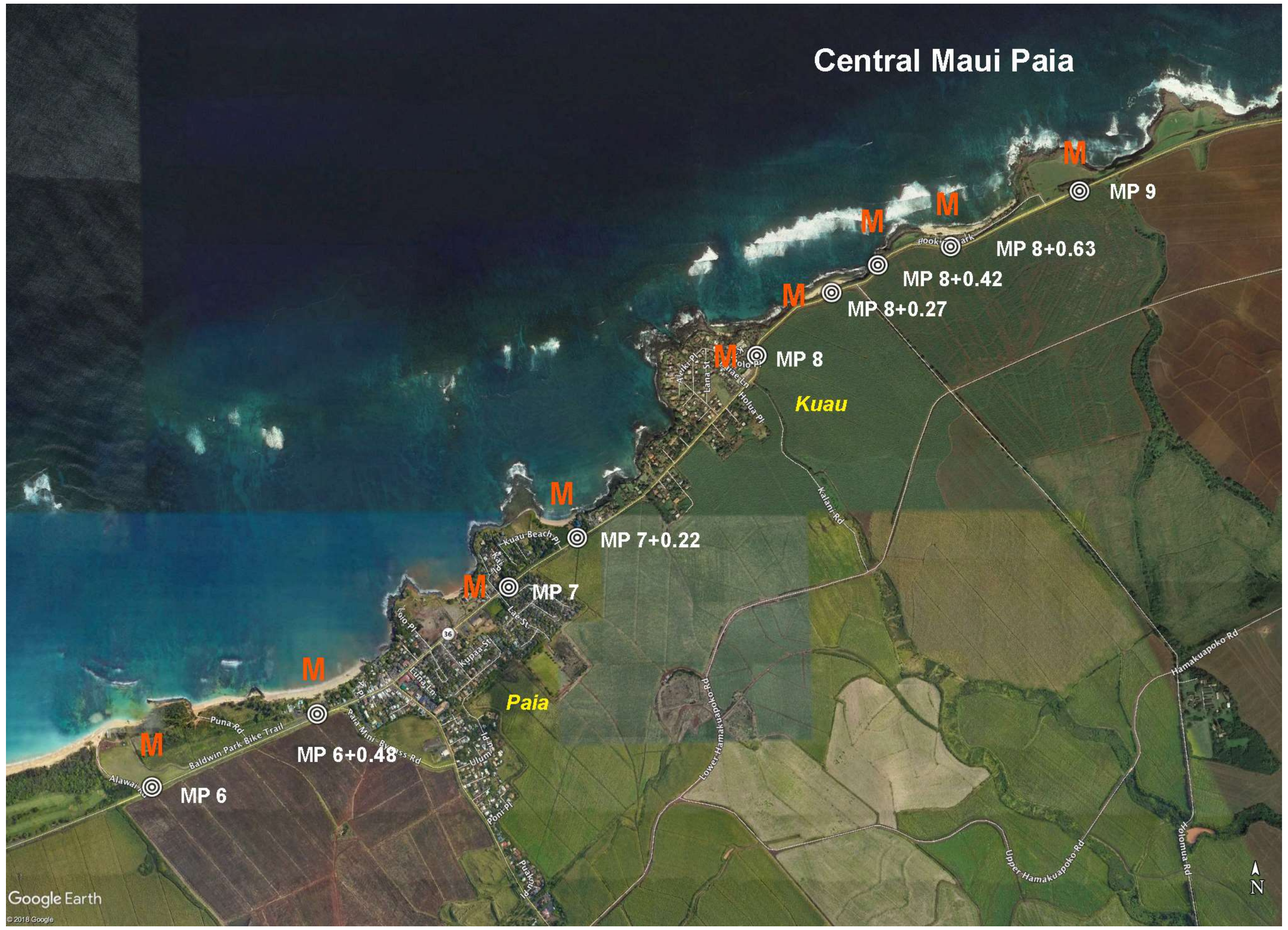

Figure 4.15. Paia to Kuau adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

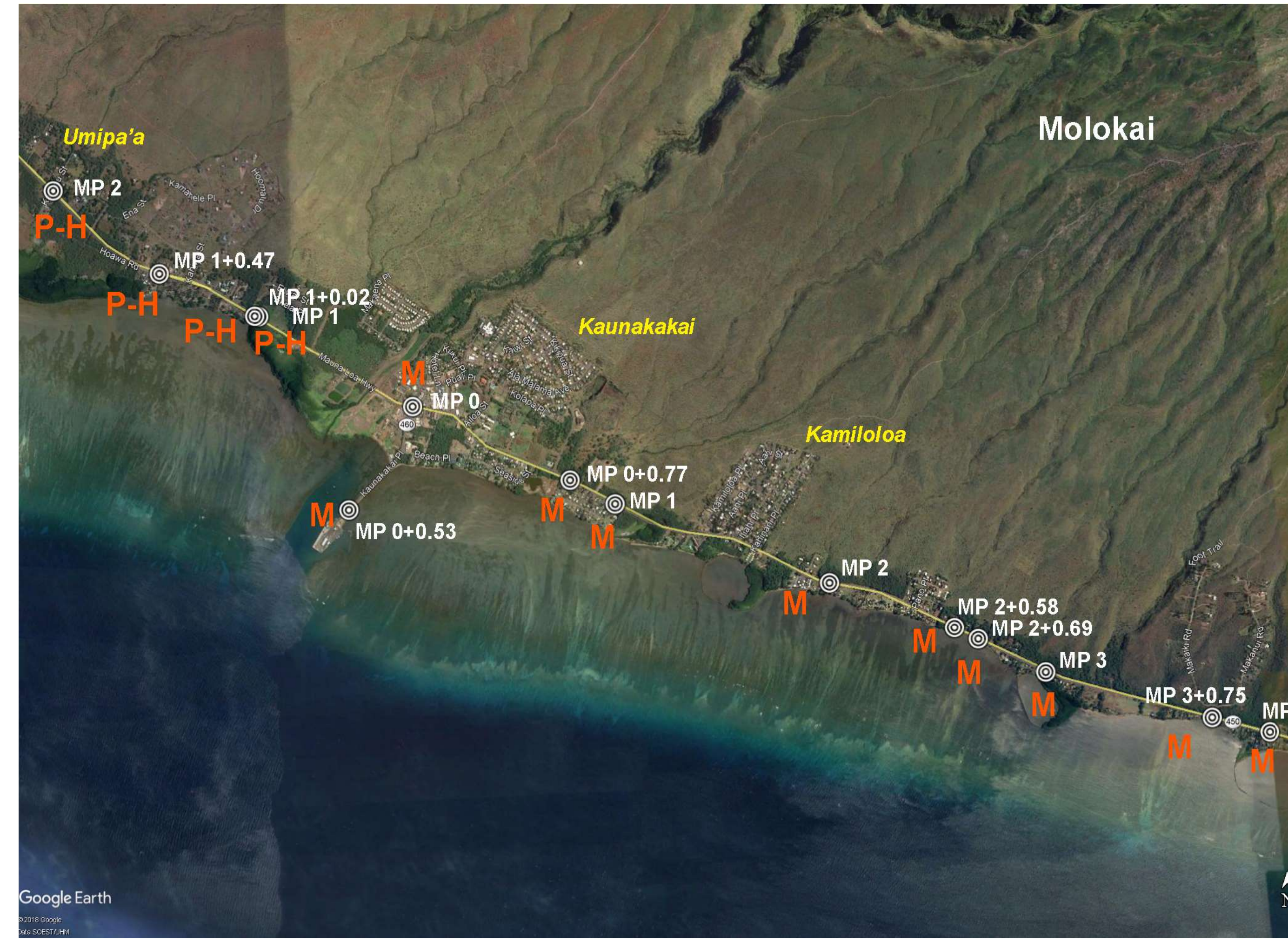

Figure 4.16. Kaunakakai area adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.17. Kawela Gulch to Kamalo adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

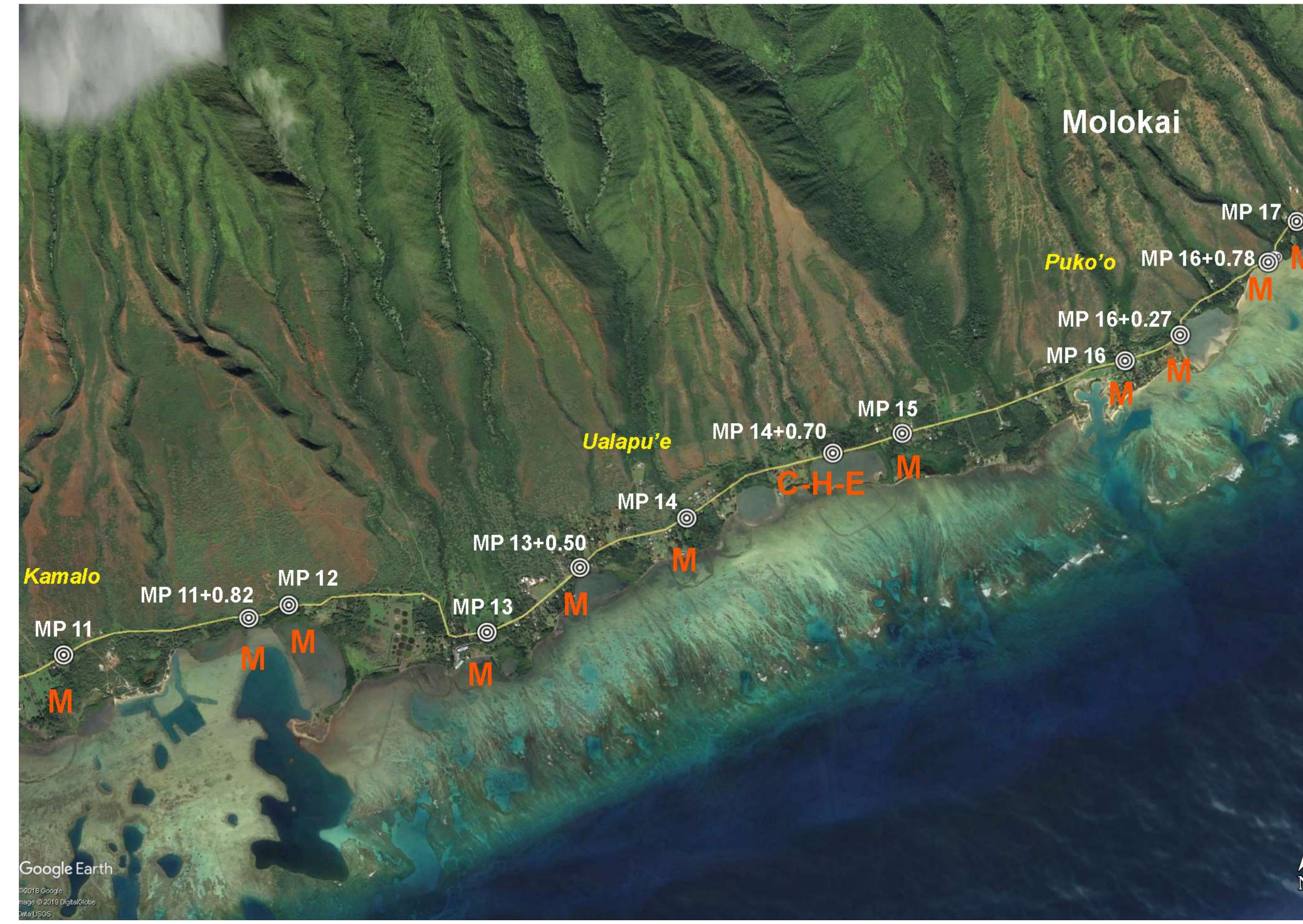

Figure 4.18. Kamalo to Puko'o adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

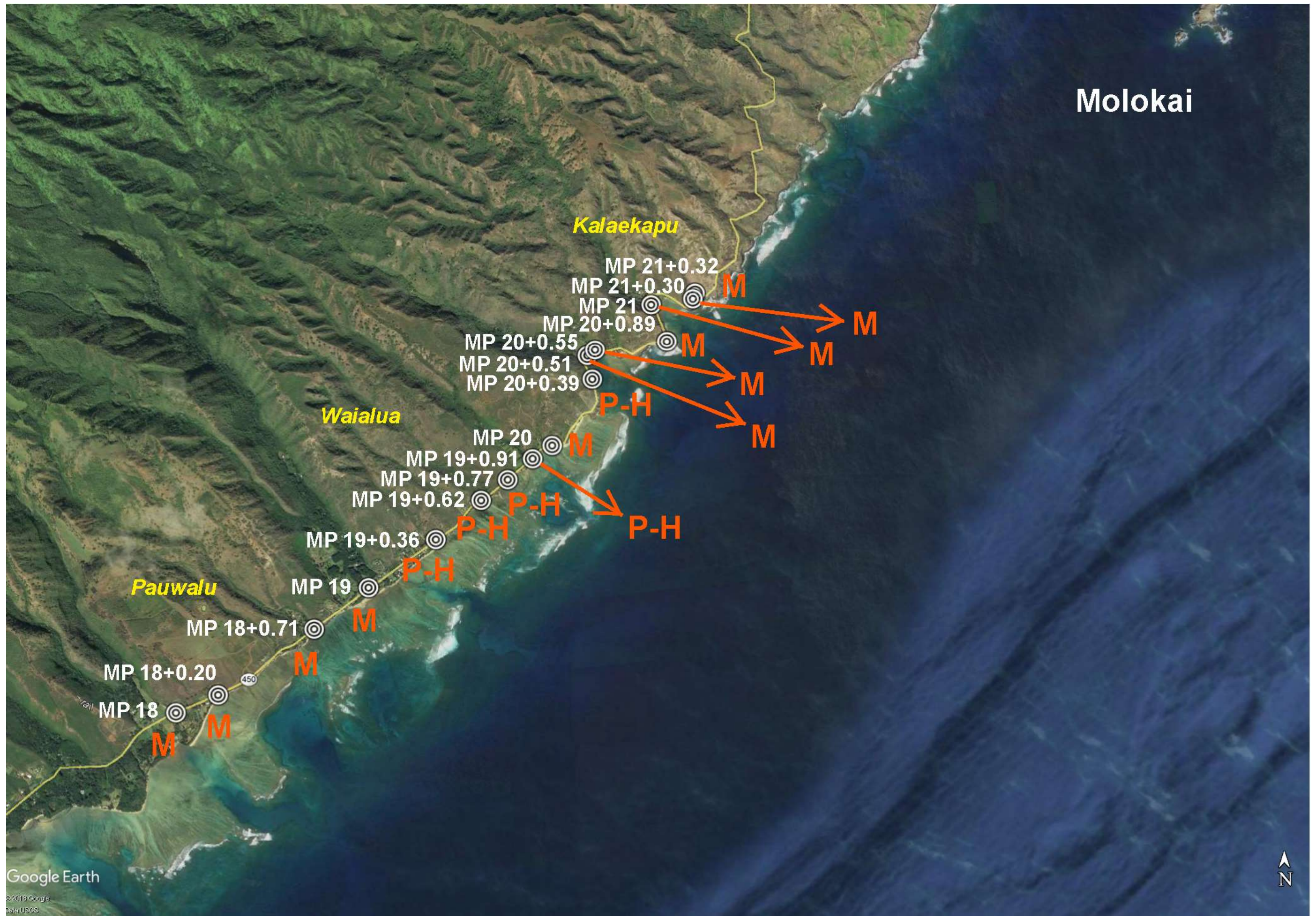

Figure 4.19. Pauwalu to Kalaekapu adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

Figure 4.20. Waimea to Kokole Point adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

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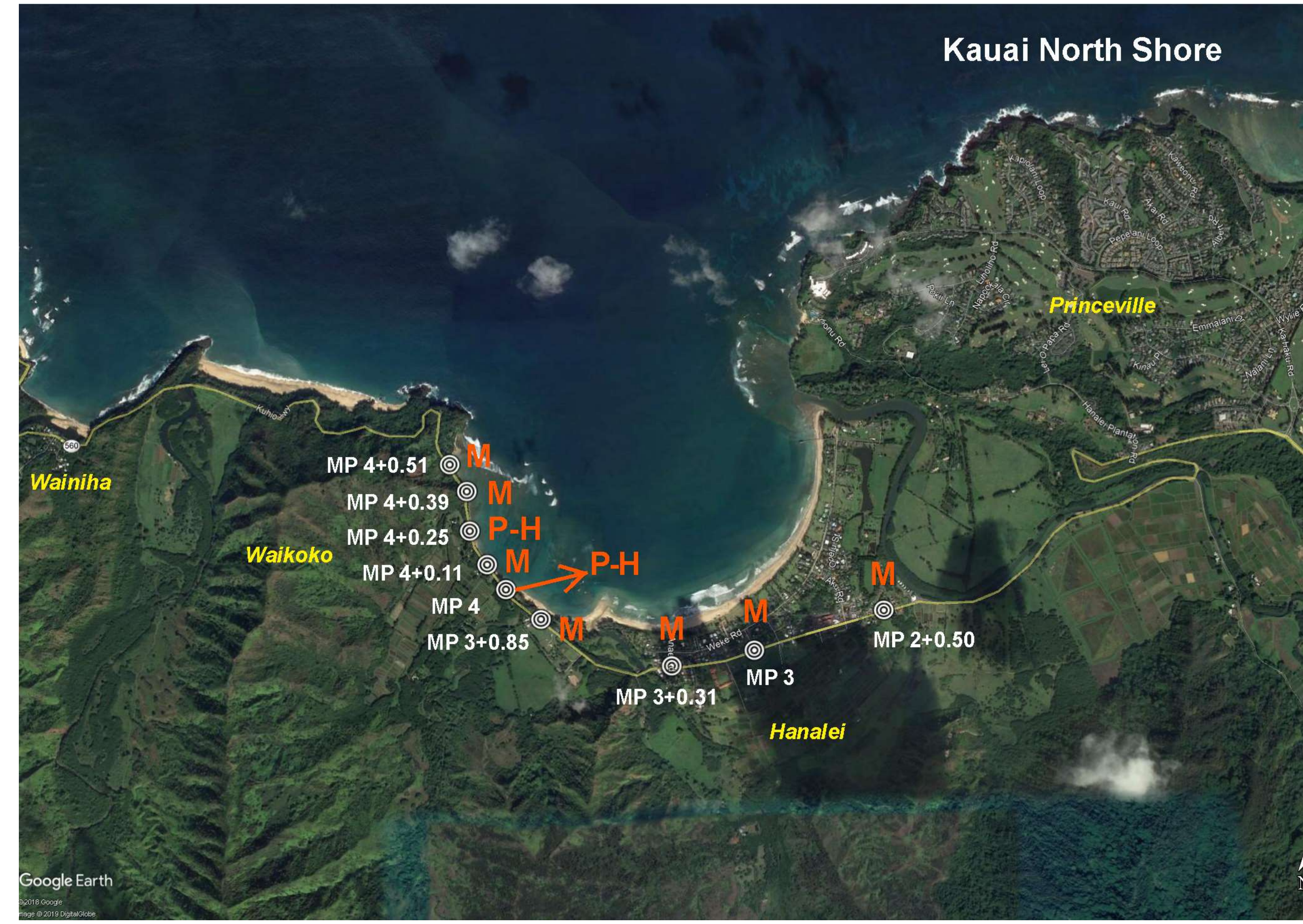

Figure 4.22. Hanalei to Waikoko adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

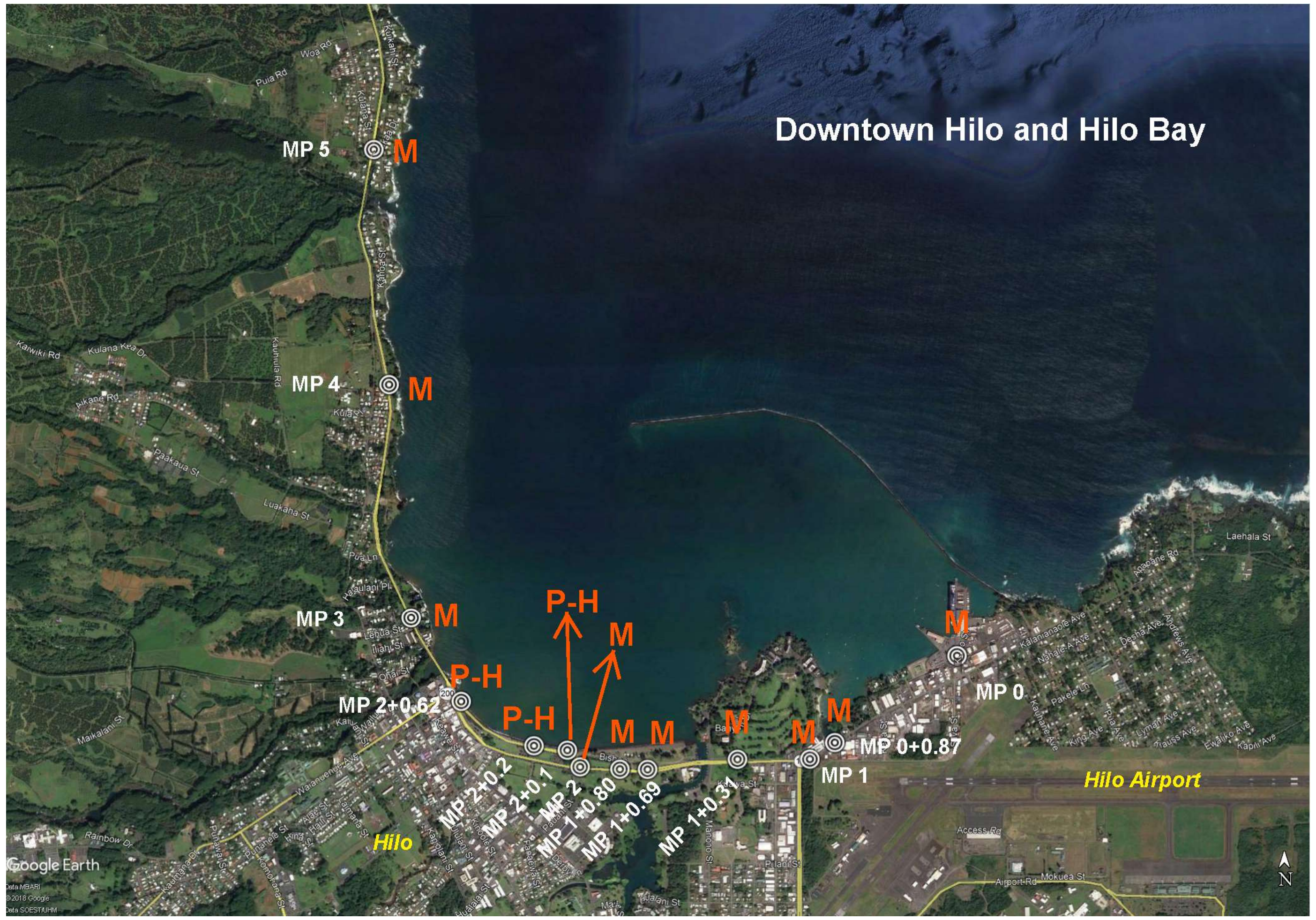

Figure 4.23. Hilo Bay area adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report (for table version, see Table 4.2). R-N is road relocation to new road; P-SD is living dunes; P-H is hard protection; C-H-E is elevate/hard protection; C-H-SD is hard/soft protection; M is no action/monitor.

4.7. Table of Tables

Table 4.1. Cost-Benefit for engineering adaptation options for the State of Hawaii Statewide Coastal Highway Program Report. (B: Benefit, C: Cost, B/C: Benefit to Cost ratio, the ranking goes as 1 (lowest) to 5 (highest).

Table 4.2. Table of adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts (for map version, see Figure 4.1).

Table 4.1. Cost-Benefit for engineering adaptation options for the State of Hawaii Statewide Coastal Highway Program Report.
(B: Benefit, C: Cost, B/C: Benefit to Cost ratio, the ranking goes as 1 (lowest) to 5 (highest))

Type	Action	Legend	Relocate - R					
			Road relocation - to old road (O)			**Road relocation - to new road (N)**		
			Alternative R-O			**Alternative R-N**		
			Hazards: Sea level rise; storm surge			**Hazards:** Sea level rise; storm surge		
			Cost: 35,000[1,2] USD / LF			Cost: 70,000[2] USD / LF		
			O&M: Monitor every few years			O&M: Monitor every few years		
			B[6,7]	C[1,2]	B/C	B[6,7]	C[1,2]	B/C
Social	Will the action lead to an increased in social resilience?	S1	5	3	1.7	5	3	1.7
	Is the action equitable?	S2	4	5	0.8	4	5	0.8
Technical	Can the action be implemented from a technical point of view?	T1	4	4	1	3	4	0.8
	Can the action handle a range of climate change impacts?	T2	5	4	1.3	5	5	1
Administrative	Does your agency/organization have the operational control to implement this action?	A1	4	5	0.8	3	5	0.6
Political	Can this action be implemented in a timely manner?	P1	3	5	0.6	1	5	0.2
	Does this action have political support?	P2	4	3	1.3	4	3	1.3
Economic	Is it cost effective? Does the benefit exceed the cost?	E1	5	4	1.3	5	3	1.7
	Does funding exisit or can it be acquired to finance the action?	E2	3	4	0.8	2	4	0.5
Environmental	Will the action increase the resilience of the natural environment?	EN1	5	4	1.3	4	3	1.3
	Are there any positive side effects on the environment of the action?	EN2	5	3	1.7	4	3	1.3

Table 4.1. (continued)

Type	Action	Legend	**Protect - P**								
			Soft Protection - Beach nourishment (SB)			**Soft Protection - Living dunes (SD)**			**Hard Protection - Revetment, Seawall Repair/New (H)**		
			Alternative P-SB			**Alternative P-SD**			**Alternative P-H**		
			Hazards: Storm surge			**Hazards:** Storm surge			**Hazards:** Storm surge		
			Cost: 1,000[1,3] USD / LF			Cost: 2,000[1,3] USD / LF			Cost:$4,000[1,2] /$10,000[3] USD / LF		
			O&M: Replace every few years			O&M: Replace every few years			O&M: Monitor every few years		
			B[5]	C[1,3]	B/C	B[5]	C[1,3]	B/C	B[5,6,7]	C[1,2,3]	B/C
Social	Will the action lead to an increased in social resilience?	S1	4	1	4	4	1	4	2	3	0.7
Social	Is the action equitable?	S2	4	4	1	4	4	1	3	3	1
Technical	Can the action be implemented from a technical point of view?	T1	5	1	5	5	1	5	3	4	0.8
Technical	Can the action handle a range of climate change impacts?	T2	2	4	0.5	2	4	0.5	5	3	1.7
Administrative	Does your agency/organization have the operational control to implement this action?	A1	5	2	2.5	5	2	2.5	5	4	1.3
Political	Can this action be implemented in a timely manner?	P1	4	2	2	4	2	2	3	4	0.8
Political	Does this action have political support?	P2	5	1	5	5	1	5	3	4	0.8
Economic	Is it cost effective? Does the benefit exceed the cost?	E1	4	3	1.3	4	3	1.3	4	4	1
Economic	Does funding exisit or can it be acquired to finance the action?	E2	5	1	5	5	1	5	3	4	0.8
Environmental	Will the action increase the resilience of the natural environment?	EN1	2	4	0.5	2	4	0.5	3	3	1
Environmental	Are there any positive side effects on the environment of the action?	EN2	3	5	0.6	3	5	0.6	2	4	0.5

Table 4.1. (continued)

Type	Action	Legend	Accomodate - A											
			Floodable Development - Vegetative Cover or Existing Green Space (GO)			**Floodable Development - Wetland Construction (WN)**			**Floodable Development - Wetland Restoration (WO)**			**Elevated Development - road (E)**		
			Alternative A-GO			**Alternative A-WN**			**Alternative A-WO**			**Alternative A-E**		
			Hazards: Sea level rise; storm surge			**Hazards:** Sea level rise; storm surge			**Hazards:** Sea level rise; storm surge			**Hazards:** Sea level rise; storm surge		
			Cost: 1,000[3] USD / AC			Cost: 150,000[1] USD / AC			Cost: 80,000[1] USD / AC			Cost: 7,600[1,3] USD / LF		
			O&M: Monitor every few years			O&M: Monitor every few years			O&M: Monitor every few years			O&M: Monitor every few years		
			B[5]	C[1,3]	B/C	B[6]	C[1]	B/C	B[6]	C[1]	B/C	B[7]	C[1,3]	B/C
Social	Will the action lead to an increased in social resilience?	S1	5	2	2.5	3	4	0.8	3	4	0.8	5	5	1
	Is the action equitable?	S2	5	5	1	5	5	1	5	5	1	1	1	1
Technical	Can the action be implemented from a technical point of view?	T1	3	3	1	3	5	0.6	3	5	0.6	5	5	1
	Can the action handle a range of climate change impacts?	T2	3	2	1.5	5	5	1	5	5	1	5	5	1
Administrative	Does your agency/organization have the operational control to implement this action?	A1	4	1	4	2	5	0.4	2	5	0.4	5	5	1
Political	Can this action be implemented in a timely manner?	P1	5	1	5	1	5	0.2	1	5	0.2	5	5	1
	Does this action have political support?	P2	4	2	2	3	3	1	3	3	1	4	5	0.8
Economic	Is it cost effective? Does the benefit exceed the cost?	E1	5	1	5	3	3	1	3	3	1	4	5	0.8
	Does funding exisit or can it be acquired to finance the action?	E2	4	2	2	3	4	0.8	3	4	0.8	3	5	0.6
Environmental	Will the action increase the resilience of the natural environment?	EN1	5	2	2.5	5	2	2.5	5	2	2.5	4	5	0.8
	Are there any positive side effects on the environment of the action?	EN2	5	1	5	5	2	2.5	5	2	2.5	4	3	1.3

Table 4.1. (continued)

Type	Action	Legend	Combination - C								
			Combination - Hard Protection / Elevate road (H-E)			Combination - Hard / Soft Protection (H-SD)			Combination - Relocate / Add Green Space (R-G)		
			Alternative C-H-E			Alternative C-H-SD			Alternative C-R-G		
			Hazards: Sea level rise, storm surge			**Hazards:** Storm surge			**Hazards:** Sea level rise; storm surge		
			Cost: \$12,000[1,3,4] USD / LF			Cost: 5,000[1,3] USD / LF			Cost: 40,000[1,2,3] USD / LF		
			O&M: Monitor every few years			O&M: Replace every few years			O&M: Monitor every few years		
			B	C[1,3,4]	B/C	B	C[1,3]	B/C	B	C[1,2,3]	B/C
Social	Will the action lead to an increased in social resilience?	S1	3.5	3	1.2	3	2	1.5	4	2	2
	Is the action equitable?	S2	2	3	0.7	4	5	0.8	4	4	1
Technical	Can the action be implemented from a technical point of view?	T1	4	4	1	4	3	1.3	4	2	2
	Can the action handle a range of climate change impacts?	T2	5	2	2.5	3	4	0.8	4	4	1
Administrative	Does your agency/organization have the operational control to implement this action?	A1	5	3	1.7	4	3	1.3	4	3	1.3
Political	Can this action be implemented in a timely manner?	P1	4	4	1	3	3	1	3	3	1
	Does this action have political support?	P2	3.5	4	0.9	4	4	1	3	3	1
Economic	Is it cost effective? Does the benefit exceed the cost?	E1	4	4	1	3	2	1.5	5	3	1.7
	Does funding exisit or can it be acquired to finance the action?	E2	3	4	0.8	4	3	1.3	3	2	1.5
Environmental	Will the action increase the resilience of the natural environment?	EN1	3.5	3	1.2	4	4	1	3	4	0.8
	Are there any positive side effects on the environment of the action?	EN2	3	4	0.8	4	4	1	5	3	1.7

Table 4.1. (continued)

Type	Action	Legend	Monitor - M		
			No Action / Monitor		
			Alternative M		
			Hazards: N/A		
			Cost: 0^3 USD w/ Future cost		
			O&M: Monitor every few years		
			B	C^3	B/C
Social	Will the action lead to an increased in social resilience?	S1	1	1	1
	Is the action equitable?	S2	1	1	1
Technical	Can the action be implemented from a technical point of view?	T1	1	1	1
	Can the action handle a range of climate change impacts?	T2	1	1	1
Administrative	Does your agency/organization have the operational control to implement this action?	A1	1	1	1
Political	Can this action be implemented in a timely manner?	P1	1	1	1
	Does this action have political support?	P2	1	1	1
Economic	Is it cost effective? Does the benefit exceed the cost?	E1	1	1	1
	Does funding exisit or can it be acquired to finance the action?	E2	1	1	1
Environmental	Will the action increase the resilience of the natural environment?	EN1	1	1	1
	Are there any positive side effects on the environment of the action?	EN2	1	1	1

Table 4.1. (continued)

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[7] Francis, O., Yang, L., Togia, H., and Tumino Di Costanzo, G. (2019b). Ocean Hazards Database (OHD) for the State of Hawaii Statewide Coastal Highway Program Report. Coastal Hydraulics Engineering Resilience (CHER) Lab, Department of Civil and Environmental Engineering, University of Hawai'i at Manoa. Mendeley Data, V2 http://dx.doi.org/10.17632/7p3hyypmjm.2

Table 4.2. Adaptation recommendations for the State of Hawaii Statewide Coastal Highway Program Report at 302 mileposts.

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	Soft Protection - Living dunes (SD)	Hard Protection - revetment, seawall (H)	Combination - Hard Protection / Elevate road (H-E)	Combination - Hard / Soft Protection (H-SD)	No Action / Monitor
					Alternative R-N	Alternative P-SD	Alternative P-H	Alternative C-H-E	Alternative C-H-SD	Alternative M
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
17	83	Oahu	East Shore	21° 39' 44.74" N 157° 56' 05.77" W						●
17+0.65	83	Oahu	East Shore	21° 39' 15.65" N 157° 55' 48.35" W						●
18	83	Oahu	East Shore	21° 39' 03.62" N 157° 55' 34.35" W						●
18+0.65	83	Oahu	East Shore	21° 38' 40.58" N 157° 55' 11.42" W						●
19	83	Oahu	East Shore	21° 38' 23.00" N 157° 55' 08.16" W						●
19+0.55	83	Oahu	East Shore	21° 37' 56.54" N 157° 55' 16.74" W						●
20	83	Oahu	East Shore	21° 37' 32.36" N 157° 55' 17.87" W						●
21	83	Oahu	East Shore	21° 36' 51.69" N 157° 54' 46.80" W			●			
21+0.27	83	Oahu	East Shore	21° 36' 40.08" N 157° 54' 38.54" W						●
21+0.47	83	Oahu	East Shore	21° 36' 31.22" N 157° 54' 32.52" W						●
22	83	Oahu	East Shore	21° 36' 20.16" N 157° 54' 08.14" W			●			
22+0.45	83	Oahu	East Shore	21° 36' 02.83" N 157° 53' 51.89" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
23	83	Oahu	East Shore	21° 35' 38.59" N 157° 53' 41.80" W						●
23+0.90	83	Oahu	East Shore	21° 35' 00.97" N 157° 53' 13.59" W						●
24	83	Oahu	East Shore	21° 34' 55.52" N 157° 53' 12.61" W						●
24+0.21	83	Oahu	East Shore	21° 34' 46.31" N 157° 53' 07.22" W					●	
24+0.48	83	Oahu	East Shore	21° 34' 37.05" N 157° 52' 56.39" W					●	
25	83	Oahu	East Shore	21° 34' 15.99" N 157° 52' 33.58" W						●
25+0.92	83	Oahu	East Shore	21° 33' 29.17" N 157° 52' 36.49" W						●
26	83	Oahu	East Shore	21° 33' 25.32" N 157° 52' 34.98" W						●
26+0.49	83	Oahu	East Shore	21° 33' 15.55" N 157° 52' 11.51" W						●
27	83	Oahu	East Shore	21° 33' 31.79" N 157° 51' 55.92" W						●
27+0.25	83	Oahu	East Shore	21° 33' 34.91" N 157° 51' 45.21" W				●		
27+0.79	83	Oahu	East Shore	21° 33' 26.83" N 157° 51' 23.11" W				●		

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
28	83	Oahu	East Shore	21° 33' 22.49" N 157° 51' 12.09" W						●
28+0.38	83	Oahu	East Shore	21° 33' 09.11" N 157° 50' 56.69" W				●		
28+0.82	83	Oahu	East Shore	21° 32' 50.50" N 157° 50' 47.52" W				●		
29	83	Oahu	East Shore	21° 32' 41.67" N 157° 50' 45.62" W				●		
29+0.71	83	Oahu	East Shore	21° 32' 08.73" N 157° 50' 23.54" W				●		
30	83	Oahu	East Shore	21° 31' 56.43" N 157° 50' 15.12" W				●		
30+0.54	83	Oahu	East Shore	21° 31' 30.01" N 157° 50' 05.60" W				●		
30+0.77	83	Oahu	East Shore	21° 31' 17.88" N 157° 50' 07.28" W				●		
31	83	Oahu	East Shore	21° 31' 08.11" N 157° 50' 08.62" W				●		
31+0.09	83	Oahu	East Shore	21° 31' 03.82" N 157° 50' 10.61" W				●		
32	83	Oahu	East Shore	21° 30' 45.90" N 157° 50' 56.33" W						●
33	83	Oahu	East Shore	21° 30' 06.97" N 157° 51' 16.40" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
34	83	Oahu	East Shore	21° 29' 19.01" N 157° 51' 00.49" W						●
34+0.15	83	Oahu	East Shore	21° 29' 11.98" N 157° 50' 57.50" W			●			
35	83	Oahu	East Shore	21° 28' 42.08" N 157° 50' 34.84" W						●
35+0.54	83	Oahu	East Shore	21° 28' 17.17" N 157° 50' 41.03" W	●					
35+0.64	83	Oahu	East Shore	21° 28' 12.14" N 157° 50' 40.13" W	●					
36	83	Oahu	East Shore	21° 27' 48.62" N 157° 50' 35.80" W	●					
37	83	Oahu	East Shore	21° 27' 16.66" N 157° 50' 09.94" W						●
38	83	Oahu	East Shore	21° 26' 30.78" N 157° 49' 57.06" W						●
4	72	Oahu	East Oahu	21° 20' 46.87" N 157° 42' 42.12" W						●
5	72	Oahu	East Oahu	21° 20' 09.45" N 157° 42' 01.04" W						●
5+0.93	72	Oahu	East Oahu	21° 19' 41.96" N 157° 41' 19.65" W			●			
6	72	Oahu	East Oahu	21° 19' 40.47" N 157° 41' 16.34" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
6+0.19	72	Oahu	East Oahu	21° 19' 36.20" N 157° 41' 06.57" W						●
6+0.27	72	Oahu	East Oahu	21° 19' 34.30" N 157° 41' 02.68" W						●
7	72	Oahu	East Oahu	21° 19' 17.41" N 157° 40' 25.53" W						●
7+0.19	72	Oahu	East Oahu	21° 19' 10.76" N 157° 40' 17.50" W						●
7+0.28	72	Oahu	East Oahu	21° 19' 07.50" N 157° 40' 13.76" W						●
7+0.68	72	Oahu	East Oahu	21° 18' 56.80" N 157° 39' 56.14" W						●
8	72	Oahu	East Oahu	21° 18' 48.38" N 157° 39' 42.11" W						●
9	72	Oahu	East Oahu	21° 18' 06.35" N 157° 39' 28.27" W						●
10	72	Oahu	East Oahu	21° 17' 29.74" N 157° 39' 47.43" W						●
10+0.14	72	Oahu	East Oahu	21° 17' 26.04" N 157° 39' 54.06" W						●
11	72	Oahu	East Oahu	21° 17' 01.24" N 157° 40' 34.52" W						●
13+0.98	72	Oahu	East Oahu	21° 16' 56.46" N 157° 42' 50.46" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
14+0.07	72	Oahu	East Oahu	21° 16' 58.37" N 157° 42' 54.71" W						●
14+0.33	72	Oahu	East Oahu	21° 17' 06.15" N 157° 43' 06.51" W						●
16+0.12	72	Oahu	East Oahu	21° 16' 47.47" N 157° 44' 40.08" W						●
17+0.18	72	Oahu	East Oahu	21° 16' 35.43" N 157° 45' 37.86" W			●			
3	93	Oahu	Waianae Coast	21° 21' 04.24" N 158° 07' 46.99" W						●
3+0.67	93	Oahu	Waianae Coast	21° 21' 37.73" N 158° 07' 53.80" W						●
4	93	Oahu	Waianae Coast	21° 21' 52.42" N 158° 08' 01.37" W						●
4+0.35	93	Oahu	Waianae Coast	21° 22' 09.58" N 158° 08' 09.09" W						●
5	93	Oahu	Waianae Coast	21° 22' 39.72" N 158° 08' 29.50" W						●
5+0.46	93	Oahu	Waianae Coast	21° 22' 56.74" N 158° 08' 47.86" W			●			
6	93	Oahu	Waianae Coast	21° 23' 16.50" N 158° 09' 09.11" W			●			
6+0.62	93	Oahu	Waianae Coast	21° 23' 39.20" N 158° 09' 34.01" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
7	93	Oahu	Waianae Coast	21° 23' 49.29" N 158° 09' 52.11" W						●
7+0.33	93	Oahu	Waianae Coast	21° 23' 53.08" N 158° 10' 09.61" W						●
7+0.67	93	Oahu	Waianae Coast	21° 24' 00.31" N 158° 10' 26.58" W						●
8	93	Oahu	Waianae Coast	21° 24' 13.74" N 158° 10' 36.37" W						●
8+0.31	93	Oahu	Waianae Coast	21° 24' 29.71" N 158° 10' 38.55" W			●			
8+0.49	93	Oahu	Waianae Coast	21° 24' 38.97" N 158° 10' 36.58" W			●			
9	93	Oahu	Waianae Coast	21° 25' 06.93" N 158° 10' 38.76" W			●			
9+0.56	93	Oahu	Waianae Coast	21° 25' 35.83" N 158° 10' 43.30" W			●			
10	93	Oahu	Waianae Coast	21° 25' 52.58" N 158° 10' 59.28" W						●
10+0.25	93	Oahu	Waianae Coast	21° 26' 04.63" N 158° 11' 04.79" W						●
10+0.96	93	Oahu	Waianae Coast	21° 26' 39.60" N 158° 11' 15.69" W			●			
11	93	Oahu	Waianae Coast	21° 26' 43.82" N 158° 11' 17.34" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
11+0.4	93	Oahu	Waianae Coast	21° 27' 00.85" N 158° 11' 30.06" W			●			
12	93	Oahu	Waianae Coast	21° 27' 17.88" N 158° 11' 53.68" W			●			
12+0.74	93	Oahu	Waianae Coast	21° 27' 38.35" N 158° 12' 28.31" W						●
13	93	Oahu	Waianae Coast	21° 27' 46.11" N 158° 12' 42.76" W						●
13+0.1	93	Oahu	Waianae Coast	21° 27' 50.14" N 158° 12' 46.29" W						●
14	93	Oahu	Waianae Coast	21° 28' 33.22" N 158° 13' 09.23" W						●
14+0.13	93	Oahu	Waianae Coast	21° 28' 38.80" N 158° 13' 13.65" W						●
14+0.21	93	Oahu	Waianae Coast	21° 28' 41.19" N 158° 13' 17.12" W						●
14+0.26	93	Oahu	Waianae Coast	21° 28' 42.36" N 158° 13' 19.54" W						●
15	93	Oahu	Waianae Coast	21° 29' 08.04" N 158° 13' 46.08" W						●
15+0.83	93	Oahu	Waianae Coast	21° 29' 50.72" N 158° 13' 45.28" W						●
16	93	Oahu	Waianae Coast	21° 29' 59.69" N 158° 13' 46.65" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
16+0.41	93	Oahu	Waianae Coast	21° 30' 20.81" N 158° 13' 45.09" W			●			
16+0.46	93	Oahu	Waianae Coast	21° 30' 23.29" N 158° 13' 44.81" W			●			
17	93	Oahu	Waianae Coast	21° 30' 52.81" N 158° 13' 40.41" W						●
17+0.35	93	Oahu	Waianae Coast	21° 31' 11.37" N 158° 13' 40.31" W						●
18	93	Oahu	Waianae Coast	21° 31' 44.55" N 158° 13' 39.58" W						●
18+0.7	93	Oahu	Waianae Coast	21° 32' 16.47" N 158° 13' 54.14" W						●
19	93	Oahu	Waianae Coast	21° 32' 26.31" N 158° 14' 06.02" W						●
19+0.55	93	Oahu	Waianae Coast	21° 32' 48.03" N 158° 14' 25.02" W						●
2	83	Oahu	North Shore	21° 36' 11.76" N 158° 05' 59.02" W						●
3	83	Oahu	North Shore	21° 36' 51.89" N 158° 05' 22.35" W						●
3+0.66	83	Oahu	North Shore	21° 37' 16.21" N 158° 04' 56.24" W						●
4	83	Oahu	North Shore	21° 37' 23.25" N 158° 04' 46.34" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
4+0.49	83	Oahu	North Shore	21° 37' 39.78" N 158° 04' 25.61" W						●
5	83	Oahu	North Shore	21° 37' 58.74" N 158° 04' 12.45" W						●
5+0.04	83	Oahu	North Shore	21° 38' 00.41" N 158° 04' 11.30" W						●
5+0.54	83	Oahu	North Shore	21° 38' 17.57" N 158° 03' 52.05" W						●
6	83	Oahu	North Shore	21° 38' 29.73" N 158° 03' 42.73" W						●
6+0.30	83	Oahu	North Shore	21° 38' 43.10" N 158° 03' 48.62" W						●
6+0.66	83	Oahu	North Shore	21° 39' 00.91" N 158° 03' 43.12" W						●
7	83	Oahu	North Shore	21° 39' 17.88" N 158° 03' 33.91" W						●
7+0.50	83	Oahu	North Shore	21° 39' 38.72" N 158° 03' 17.44" W						●
7+0.87	83	Oahu	North Shore	21° 39' 52.23" N 158° 03' 02.45" W						●
8	83	Oahu	North Shore	21° 39' 58.82" N 158° 02' 55.08" W						●
8+0.67	83	Oahu	North Shore	21° 40' 22.94" N 158° 02' 28.37" W					●	

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
8+0.80	83	Oahu	North Shore	21° 40' 28.08" N 158° 02' 22.94" W					●	
9	83	Oahu	North Shore	21° 40' 34.97" N 158° 02' 16.11" W						●
10	83	Oahu	North Shore	21° 41' 09.27" N 158° 01' 29.65" W						●
10+0.58	83	Oahu	North Shore	21° 41' 33.55" N 158° 01' 10.16" W						●
0	3400	Maui	Central Maui	20° 53' 25.68" N 156° 28' 23.58" W						●
0+0.05	3400	Maui	Central Maui	20° 53' 27.84" N 156° 28' 25.39" W						●
0+0.27	3400	Maui	Central Maui	20° 53' 34.46" N 156° 28' 35.07" W						●
0+0.48	3400	Maui	Central Maui	20° 53' 42.06" N 156° 28' 43.37" W			●			
0+0.71	3400	Maui	Central Maui	20° 53' 52.72" N 156° 28' 49.33" W						●
6	36	Maui	Central Maui	20° 54' 43.73" N 156° 23' 27.89" W						●
6+0.48	36	Maui	Central Maui	20° 54' 53.62" N 156° 23' 03.55" W						●
7	36	Maui	Central Maui	20° 55' 11.53" N 156° 22' 35.81" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	Soft Protection - Living dunes (SD)	Hard Protection - revetment, seawall (H)	Combination - Hard Protection / Elevate road (H-E)	Combination - Hard / Soft Protection (H-SD)	No Action / Monitor
					Alternative R-N	Alternative P-SD	Alternative P-H	Alternative C-H-E	Alternative C-H-SD	Alternative M
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
7+0.22	36	Maui	Central Maui	20° 55' 17.95" N 156° 22' 25.44" W						●
8	36	Maui	Central Maui	20° 55' 42.92" N 156° 21' 59.32" W						●
8+0.27	36	Maui	Central Maui	20° 55' 51.66" N 156° 21' 47.99" W						●
8+0.42	36	Maui	Central Maui	20° 55' 55.43" N 156° 21' 41.31" W						●
8+0.63	36	Maui	Central Maui	20° 55' 57.96" N 156° 21' 30.42" W						●
9	36	Maui	Central Maui	20° 56' 05.91" N 156° 21' 11.70" W						●
1	310	Maui	East Maui	20° 48' 02.70" N 156° 29' 48.63" W	●					
1+0.50	310	Maui	East Maui	20° 47' 52.99" N 156° 29' 22.44" W	●					
1+0.92	310	Maui	East Maui	20° 47' 41.84" N 156° 29' 03.52" W	●					
2	310	Maui	East Maui	20° 47' 39.59" N 156° 28' 59.23" W	●					
2+0.04	310	Maui	East Maui	20° 47' 38.60" N 156° 28' 57.28" W	●					
2+0.11	310	Maui	East Maui	20° 47' 36.88" N 156° 28' 53.95" W	●					

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
2+0.26	310	Maui	East Maui	20° 47' 33.20" N 156° 28' 46.78" W	●					
2+0.50	310	Maui	East Maui	20° 47' 27.62" N 156° 28' 34.35" W	●					
2+0.61	310	Maui	East Maui	20° 47' 25.14" N 156° 28' 28.80" W	●					
2+0.77	310	Maui	East Maui	20° 47' 21.53" N 156° 28' 20.86" W	●					
3	310	Maui	East Maui	20° 47' 16.83" N 156° 28' 14.25" W	●					
3+0.14	310	Maui	East Maui	20° 47' 12.56" N 156° 28' 07.71" W	●					
9	30	Maui	West Maui	20° 46' 42.14" N 156° 32' 26.01" W						●
9+0.50	30	Maui	West Maui	20° 46' 56.40" N 156° 32' 47.89" W						●
10	30	Maui	West Maui	20° 47' 07.78" N 156° 33' 08.59" W						●
11	30	Maui	West Maui	20° 47' 32.44" N 156° 33' 55.47" W						●
11+0.17	30	Maui	West Maui	20° 47' 35.17" N 156° 34' 04.30" W						●
11+0.64	30	Maui	West Maui	20° 47' 38.59" N 156° 34' 30.30" W		●				

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
12	30	Maui	West Maui	20° 47' 41.15" N 156° 34' 50.32" W						●
12+0.24	30	Maui	West Maui	20° 47' 44.70" N 156° 35' 02.95" W						●
12+0.58	30	Maui	West Maui	20° 47' 52.77" N 156° 35' 20.17" W						●
12+0.97	30	Maui	West Maui	20° 48' 04.80" N 156° 35' 37.20" W			●			
13	30	Maui	West Maui	20° 48' 05.69" N 156° 35' 38.28" W						●
13+0.11	30	Maui	West Maui	20° 48' 09.59" N 156° 35' 42.81" W						●
13+0.72	30	Maui	West Maui	20° 48' 28.38" N 156° 36' 10.18" W						●
13+0.89	30	Maui	West Maui	20° 48' 32.37" N 156° 36' 18.30" W						●
14	30	Maui	West Maui	20° 48' 34.35" N 156° 36' 22.56" W						●
14+0.30	30	Maui	West Maui	20° 48' 37.42" N 156° 36' 38.78" W			●			
14+0.32	30	Maui	West Maui	20° 48' 37.41" N 156° 36' 39.80" W			●			
14+0.43	30	Maui	West Maui	20° 48' 37.36" N 156° 36' 45.43" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
14+0.49	30	Maui	West Maui	20° 48' 37.30" N 156° 36' 49.08" W						●
15	30	Maui	West Maui	20° 48' 39.58" N 156° 37' 18.59" W						●
15+0.76	30	Maui	West Maui	20° 49' 10.00" N 156° 37' 44.59" W			●			
16	30	Maui	West Maui	20° 49' 22.18" N 156° 37' 49.51" W						●
16+0.24	30	Maui	West Maui	20° 49' 32.51" N 156° 37' 56.64" W						●
16+0.42	30	Maui	West Maui	20° 49' 45.50" N 156° 38' 10.85" W						●
17	30	Maui	West Maui	20° 49' 59.16" N 156° 38' 29.08" W						●
17+0.65	30	Maui	West Maui	20° 50' 17.34" N 156° 38' 58.13" W						●
18	30	Maui	West Maui	20° 50' 32.81" N 156° 39' 07.62" W						●
18+0.42	30	Maui	West Maui	20° 50' 51.20" N 156° 39' 20.73" W						●
18+0.65	30	Maui	West Maui	20° 50' 59.80" N 156° 39' 28.89" W						●
18+0.79	30	Maui	West Maui	20° 51' 04.62" N 156° 39' 34.81" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
19	30	Maui	West Maui	20° 51' 12.08" N 156° 39' 43.01" W						●
19+0.07	30	Maui	West Maui	20° 51' 15.05" N 156° 39' 45.53" W			●			
19+0.09	30	Maui	West Maui	20° 51' 15.77" N 156° 39' 46.09" W			●			
19+0.18	30	Maui	West Maui	20° 51' 19.81" N 156° 39' 49.12" W						●
20	30	Maui	West Maui	20° 51' 54.87" N 156° 40' 13.16" W						●
20+0.50	30	Maui	West Maui	20° 52' 19.07" N 156° 40' 23.13" W			●			
21	30	Maui	West Maui	20° 52' 40.11" N 156° 40' 38.78" W						●
21+0.50	30	Maui	West Maui	20° 53' 00.82" N 156° 40' 55.16" W						●
22	30	Maui	West Maui	20° 53' 26.78" N 156° 41' 02.95" W						●
22+0.27	30	Maui	West Maui	20° 53' 40.57" N 156° 41' 06.11" W						●
22+0.74	30	Maui	West Maui	20° 54' 05.38" N 156° 41' 04.94" W						●
23	30	Maui	West Maui	20° 54' 17.25" N 156° 41' 09.26" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	Soft Protection - Living dunes (SD)	Hard Protection - revetment, seawall (H)	Combination - Hard Protection / Elevate road (H-E)	Combination - Hard / Soft Protection (H-SD)	No Action / Monitor
					Alternative R-N	Alternative P-SD	Alternative P-H	Alternative C-H-E	Alternative C-H-SD	Alternative M
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
23+0.29	30	Maui	West Maui	20° 54' 31.00" N 156° 41' 16.49" W						●
24	30	Maui	West Maui	20° 55' 04.99" N 156° 41' 25.05" W						●
25	30	Maui	West Maui	20° 55' 58.02" N 156° 41' 24.52" W						●
26	30	Maui	West Maui	20° 56' 53.04" N 156° 41' 11.97" W						●
27	30	Maui	West Maui	20° 57' 39.18" N 156° 40' 54.37" W						●
28	30	Maui	West Maui	20° 58' 27.93" N 156° 40' 35.08" W						●
29	30	Maui	West Maui	20° 59' 04.61" N 156° 39' 58.97" W						●
0	19	Hawaii	Downtown Hilo	19° 43' 44.00" N 155° 03' 14.90" W						●
0+0.87	19	Hawaii	Downtown Hilo	19° 43' 25.23" N 155° 03' 43.05" W						●
1	19	Hawaii	Downtown Hilo	19° 43' 21.59" N 155° 03' 48.87" W						●
1+0.31	19	Hawaii	Downtown Hilo	19° 43' 21.61" N 155° 04' 05.78" W						●
1+0.69	19	Hawaii	Downtown Hilo	19° 43' 19.37" N 155° 04' 26.49" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
1+0.80	19	Hawaii	Downtown Hilo	19° 43' 19.42" N 155° 04' 32.89" W						●
2	19	Hawaii	Downtown Hilo	19° 43' 19.97" N 155° 04' 42.02" W						●
2+0.11	19	Hawaii	Downtown Hilo	19° 43' 23.55" N 155° 04' 44.94" W			●			
2+0.25	19	Hawaii	Downtown Hilo	19° 43' 24.50" N 155° 04' 52.70" W			●			
2+0.62	19	Hawaii	Downtown Hilo	19° 43' 34.06" N 155° 05' 09.50" W			●			
3	19	Hawaii	Hilo Bay	19° 43' 52.20" N 155° 05' 20.98" W						●
4	19	Hawaii	Hilo Bay	19° 44' 42.85" N 155° 05' 26.05" W						●
5	19	Hawaii	Hilo Bay	19° 45' 33.74" N 155° 05' 29.64" W						●
2+0.50	560	Kauai	Kauai North Shore	22° 12' 13.52" N 159° 29' 36.54" W						●
3	560	Kauai	Kauai North Shore	22° 12' 05.92" N 159° 30' 02.96" W						●
3+0.31	560	Kauai	Kauai North Shore	22° 12' 02.90" N 159° 30' 19.85" W						●
3+0.85	560	Kauai	Kauai North Shore	22° 12' 11.81" N 159° 30' 46.42" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
4	560	Kauai	Kauai North Shore	22° 12' 17.47" N 159° 30' 53.53" W			●			
4+0.11	560	Kauai	Kauai North Shore	22° 12' 22.21" N 159° 30' 57.38" W						●
4+0.25	560	Kauai	Kauai North Shore	22° 12' 28.51" N 159° 31' 00.91" W			●			
4+0.39	560	Kauai	Kauai North Shore	22° 12' 35.95" N 159° 31' 01.61" W						●
4+0.51	560	Kauai	Kauai North Shore	22° 12' 41.09" N 159° 31' 05.01" W						●
5	56	Kauai	East Kauai	22° 02' 03.50" N 159° 20' 28.84" W						●
6	56	Kauai	East Kauai	22° 02' 53.80" N 159° 20' 06.57" W						●
6+0.15	56	Kauai	East Kauai	22° 03' 01.14" N 159° 20' 03.44" W						●
7	56	Kauai	East Kauai	22° 03' 28.82" N 159° 19' 27.52" W						●
7+0.64	56	Kauai	East Kauai	22° 03' 56.39" N 159° 19' 09.27" W						●
8	56	Kauai	East Kauai	22° 04' 14.68" N 159° 19' 10.09" W			●			
8+0.45	56	Kauai	East Kauai	22° 04' 36.23" N 159° 19' 02.58" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
8+0.78	56	Kauai	East Kauai	22° 04' 49.04" N 159° 18' 50.31" W			●			
9	56	Kauai	East Kauai	22° 04' 56.85" N 159° 18' 44.72" W			●			
9+0.05	56	Kauai	East Kauai	22° 04' 58.86" N 159° 18' 42.83" W						●
9+0.36	56	Kauai	East Kauai	22° 05' 11.59" N 159° 18' 32.23" W						●
10	56	Kauai	East Kauai	22° 05' 41.29" N 159° 18' 24.90" W						●
10+0.26	56	Kauai	East Kauai	22° 05' 53.95" N 159° 18' 20.38" W						●
11	56	Kauai	East Kauai	22° 06' 31.41" N 159° 18' 08.46" W						●
24	50	Kauai	West Kauai	21° 57' 39.59" N 159° 41' 00.66" W						●
24+0.91	50	Kauai	West Kauai	21° 57' 41.23" N 159° 41' 51.80" W						●
25	50	Kauai	West Kauai	21° 57' 41.50" N 159° 41' 59.81" W						●
25+0.20	50	Kauai	West Kauai	21° 57' 39.35" N 159° 42' 10.50" W						●
25+0.26	50	Kauai	West Kauai	21° 57' 38.62" N 159° 42' 13.89" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
25+0.73	50	Kauai	West Kauai	21° 57' 48.65" N 159° 42' 37.38" W						●
25+0.79	50	Kauai	West Kauai	21° 57' 50.93" N 159° 42' 39.54" W						●
26	50	Kauai	West Kauai	21° 57' 58.59" N 159° 42' 48.05" W						●
26+0.16	50	Kauai	West Kauai	21° 58' 02.65" N 159° 42' 55.59" W						●
26+0.66	50	Kauai	West Kauai	21° 58' 10.76" N 159° 43' 22.17" W						●
27	50	Kauai	West Kauai	21° 58' 16.33" N 159° 43' 40.99" W						●
28	50	Kauai	West Kauai	21° 58' 49.44" N 159° 44' 22.91" W						●
0+0.53	460	Molokai	Molokai	21° 04' 58.89" N 157° 01' 36.07" W						●
1	460	Molokai	Molokai	21° 05' 41.15" N 157° 01' 58.12" W			●			
1+0.02	460	Molokai	Molokai	21° 05' 41.56" N 157° 01' 58.90" W			●			
1+0.47	460	Molokai	Molokai	21° 05' 50.85" N 157° 02' 22.13" W			●			
2	460	Molokai	Molokai	21° 06' 08.57" N 157° 02' 48.25" W			●			

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	Soft Protection - Living dunes (SD)	Hard Protection - revetment, seawall (H)	Combination - Hard Protection / Elevate road (H-E)	Combination - Hard / Soft Protection (H-SD)	No Action / Monitor
					Alternative R-N	Alternative P-SD	Alternative P-H	Alternative C-H-E	Alternative C-H-SD	Alternative M
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
0	450	Molokai	Molokai	21° 05' 21.62" N 157° 01' 20.52" W						●
0+0.77	450	Molokai	Molokai	21° 05' 05.47" N 157° 00' 42.34" W						●
1	450	Molokai	Molokai	21° 05' 00.31" N 157° 00' 31.37" W						●
2	450	Molokai	Molokai	21° 04' 43.02" N 156° 59' 39.23" W						●
2+0.58	450	Molokai	Molokai	21° 04' 33.23" N 156° 59' 08.79" W						●
2+0.69	450	Molokai	Molokai	21° 04' 30.68" N 156° 59' 02.97" W						●
3	450	Molokai	Molokai	21° 04' 23.50" N 156° 58' 46.60" W						●
3+0.75	450	Molokai	Molokai	21° 04' 13.60" N 156° 58' 06.13" W						●
4	450	Molokai	Molokai	21° 04' 10.50" N 156° 57' 52.69" W						●
4+0.54	450	Molokai	Molokai	21° 04' 01.93" N 156° 57' 23.87" W						●
5	450	Molokai	Molokai	21° 03' 56.95" N 156° 57' 00.28" W						●
5+0.38	450	Molokai	Molokai	21° 03' 47.82" N 156° 56' 41.93" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
6	450	Molokai	Molokai	21° 03' 41.23" N 156° 56' 07.29" W						●
6+0.16	450	Molokai	Molokai	21° 03' 40.41" N 156° 55' 58.74" W						●
7	450	Molokai	Molokai	21° 03' 36.31" N 156° 55' 12.18" W						●
8	450	Molokai	Molokai	21° 03' 24.40" N 156° 54' 18.13" W						●
8+0.21	450	Molokai	Molokai	21° 03' 21.85" N 156° 54' 06.87" W						●
8+0.63	450	Molokai	Molokai	21° 03' 19.72" N 156° 53' 43.20" W						●
9	450	Molokai	Molokai	21° 03' 12.18" N 156° 53' 24.34" W						●
9+0.41	450	Molokai	Molokai	21° 02' 58.26" N 156° 53' 06.77" W						●
10	450	Molokai	Molokai	21° 02' 51.09" N 156° 52' 35.54" W						●
10+0.06	450	Molokai	Molokai	21° 02' 50.92" N 156° 52' 32.08" W						●
11	450	Molokai	Molokai	21° 03' 17.87" N 156° 52' 01.15" W						●
11+0.82	450	Molokai	Molokai	21° 03' 26.13" N 156° 51' 16.84" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
12	450	Molokai	Molokai	21° 03' 29.09" N 156° 51' 07.17" W						●
13	450	Molokai	Molokai	21° 03' 22.84" N 156° 50' 19.66" W						●
13+0.50	450	Molokai	Molokai	21° 03' 37.36" N 156° 49' 57.39" W						●
14	450	Molokai	Molokai	21° 03' 48.31" N 156° 49' 31.74" W						●
14+0.70	450	Molokai	Molokai	21° 04' 02.82" N 156° 48' 56.63" W				●		
15	450	Molokai	Molokai	21° 04' 07.20" N 156° 48' 40.06" W						●
16	450	Molokai	Molokai	21° 04' 23.19" N 156° 47' 47.17" W						●
16+0.27	450	Molokai	Molokai	21° 04' 29.13" N 156° 47' 34.01" W						●
16+0.78	450	Molokai	Molokai	21° 04' 45.28" N 156° 47' 13.22" W						●
17	450	Molokai	Molokai	21° 04' 54.21" N 156° 47' 06.33" W						●
18	450	Molokai	Molokai	21° 05' 19.10" N 156° 46' 21.68" W						●
18+0.20	450	Molokai	Molokai	21° 05' 23.07" N 156° 46' 11.64" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	**Soft Protection - Living dunes (SD)**	**Hard Protection - revetment, seawall (H)**	**Combination - Hard Protection / Elevate road (H-E)**	**Combination - Hard / Soft Protection (H-SD)**	**No Action / Monitor**
					Alternative R-N	**Alternative P-SD**	**Alternative P-H**	**Alternative C-H-E**	**Alternative C-H-SD**	**Alternative M**
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
18+0.71	450	Molokai	Molokai	21° 05' 37.74" N 156° 45' 48.31" W						●
19	450	Molokai	Molokai	21° 05' 47.08" N 156° 45' 35.05" W						●
19+0.36	450	Molokai	Molokai	21° 05' 57.87" N 156° 45' 18.85" W			●			
19+0.62	450	Molokai	Molokai	21° 06' 06.67" N 156° 45' 08.01" W			●			
19+0.77	450	Molokai	Molokai	21° 06' 11.26" N 156° 45' 01.56" W			●			
19+0.91	450	Molokai	Molokai	21° 06' 15.94" N 156° 44' 55.65" W			●			
20	450	Molokai	Molokai	21° 06' 18.95" N 156° 44' 50.88" W						●
20+0.39	450	Molokai	Molokai	21° 06' 33.81" N 156° 44' 41.20" W			●			
20+0.51	450	Molokai	Molokai	21° 06' 39.10" N 156° 44' 42.39" W						●
20+0.55	450	Molokai	Molokai	21° 06' 40.42" N 156° 44' 40.66" W						●
20+0.89	450	Molokai	Molokai	21° 06' 42.32" N 156° 44' 23.46" W						●
21	450	Molokai	Molokai	21° 06' 50.63" N 156° 44' 27.22" W						●

Table 4.2. (continued)

Milepost	State Route	Island	Study Area	GPS	Relocate - R	Protect - P		Combination - C		Monitor - M
					Road relocation - to new road (N)	Soft Protection - Living dunes (SD)	Hard Protection - revetment, seawall (H)	Combination - Hard Protection / Elevate road (H-E)	Combination - Hard / Soft Protection (H-SD)	No Action / Monitor
					Alternative R-N	Alternative P-SD	Alternative P-H	Alternative C-H-E	Alternative C-H-SD	Alternative M
					Assessed by: 2050 SLR, 3ft SLR, and Road Connectivity	**Assessed by:** Site visit and Shoreline Change	**Assessed by:** Site visit and/or Storm surge Rank 1	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity	**Assessed by:** Site visit and/or Storm surge Rank 1 and Road Connectivity
					Hazards: Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** Storm surge	**Hazards:** Sea level rise; storm surge	**Hazards:** Storm surge	**Hazards:** N/A
21+0.30	450	Molokai	Molokai	21° 06' 51.89" N 156° 44' 17.13" W						●
21+0.32	450	Molokai	Molokai	21° 06' 53.13" N 156° 44' 16.54" W						●