



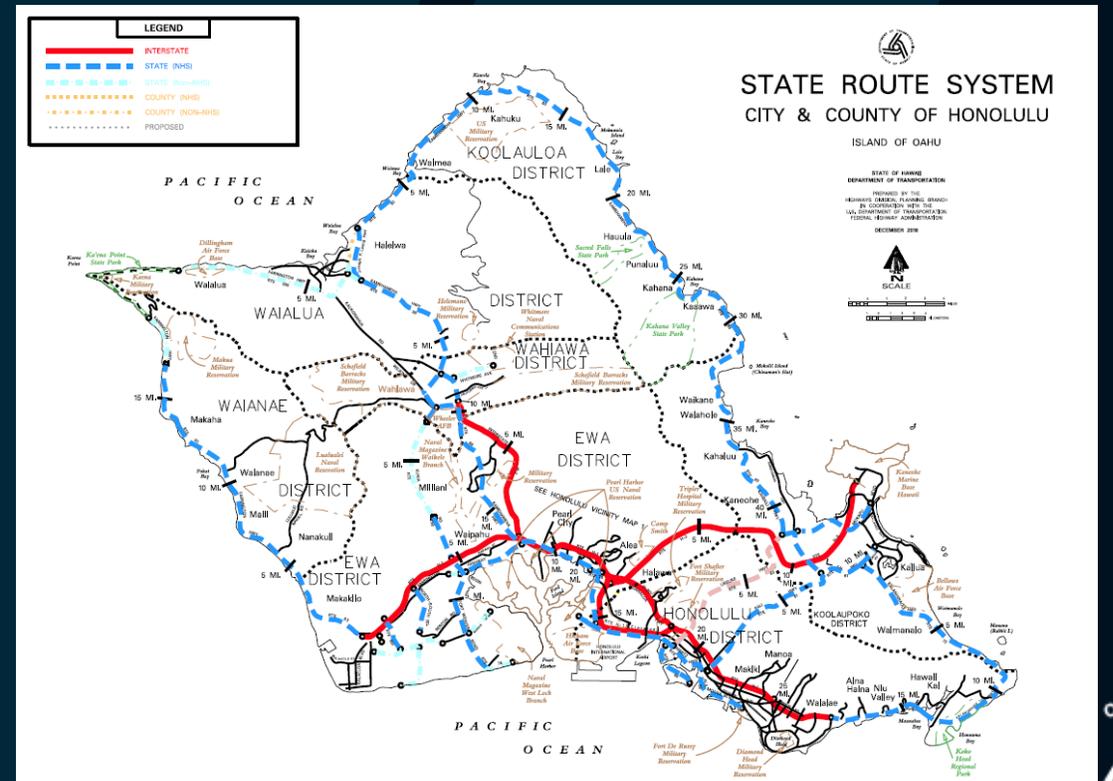
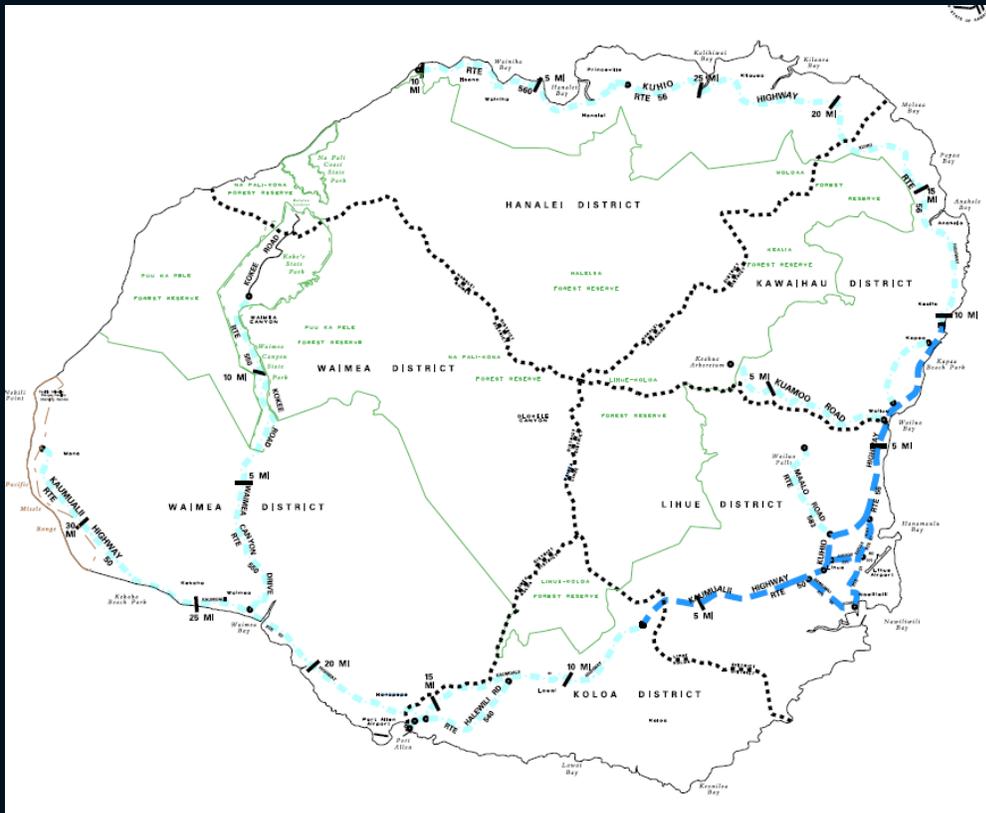
Adapting to Sea Level Rise: Strategies for Hawaii's Coastal Highways

Today's Topics

- Plan for the future
- Current coastal highway protection
- Extreme events
- Policy for coastal highways



Hawaii's Belt Road System



Statewide Highway Shoreline Protection Study

Updates 2003 study with new methodology.

2019 Study currently under review. To be released within the next two weeks.

Study identifies and prioritize state roads in need of immediate and short-term erosion control/shoreline remediation measures, as well as sites that should be monitored.

Oahu mobilization anticipated Summer 2019. Immediate mitigations complete within one calendar year.

Methodology

- Sites are evaluated using Coastal Road Erosion Susceptibility Index (CRESI)
- CRESI uses 11 different variables (Beach Geomorphology, Coast Geomorphology, Erodeable Volume, Slope, Coast ground cover & structures, Road base/subgrade, Armoring, Relative sea level change rate, Shoreline accretion/erosion rate, Mean tidal change, and Significant wave height).
- Expected traffic impacts (of the use of the roadway being effected by coastal erosion) and surrounding land use of the site will be added to final calculations.

Priority Level/Tier Rankings

Tier 1 Immediate.

- Repairs recommended within 12 months.

Tier 2 Short-term.

- Repairs recommended within 1-5 years.

Tier 3 Long-term management.

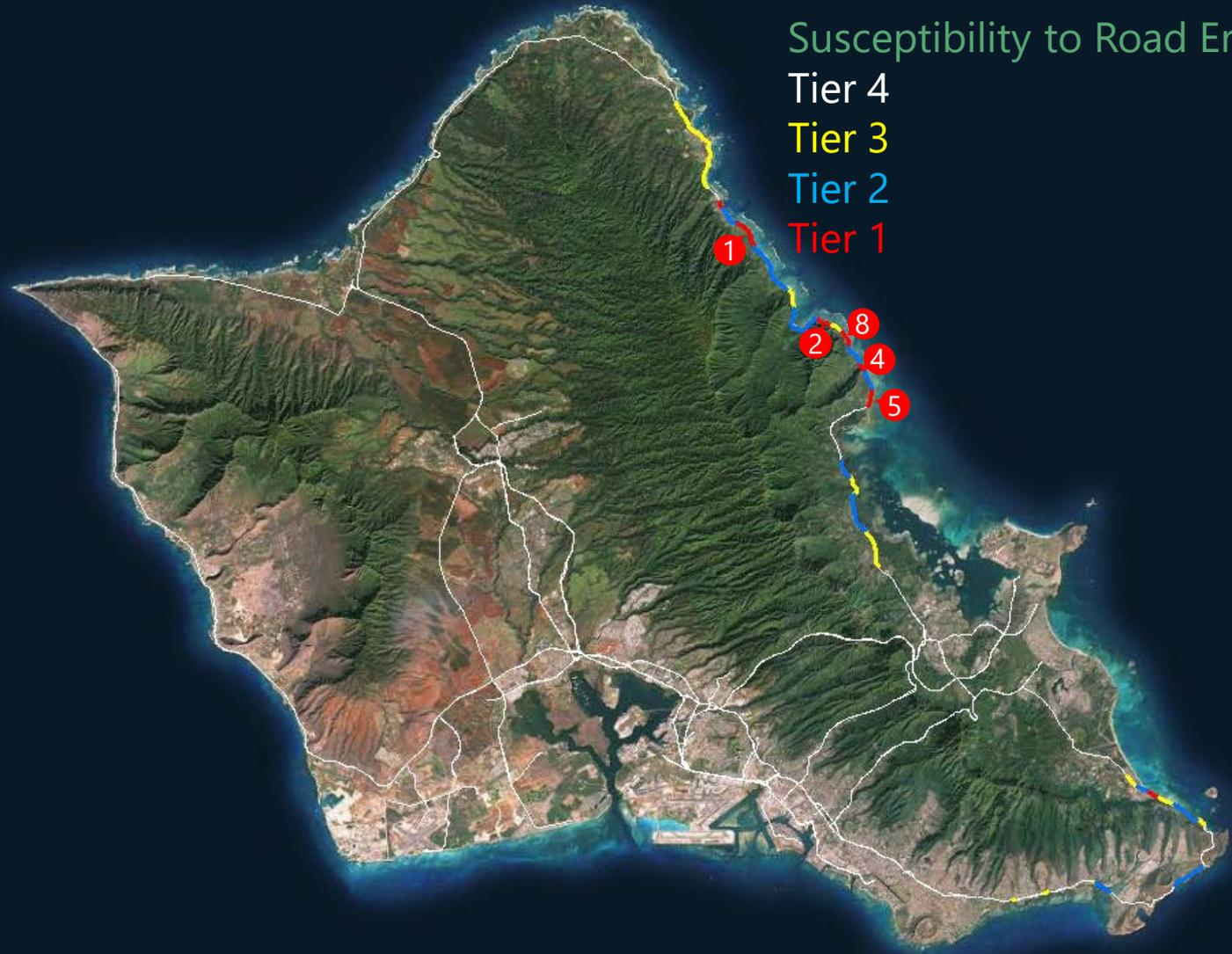
- 5 – 10 years
- Monitor existing shoreline improvements and consider additional evaluation.

Tier 4 Periodic monitoring.

- Beyond 10 years
- Site will remain on inventory with periodic monitoring.

Susceptibility to Road Erosion

- Tier 4
- Tier 3
- Tier 2
- Tier 1



Sources: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Comparison of Final and Preliminary Top 10

1. Oahu #7 (Kamehameha Highway in Hauula at Pokiwai Road)
2. Maui #4 (Honoapiilani Highway in Mopua – Before Olowalu)
3. Oahu #4 (Kamehameha Highway in Kaaawa at Puakenikeni Road)
4. Kauai #2 (Kuhio Highway in Waikoko)
5. Oahu #17 (Kalaniana'ole Highway in Waimanalo)
6. Molokai #2 & #3 (Kamehameha V Highway in Kaluaaha)
7. Molokai (Kamehameha V Highway in Pukoo) – Note, not considered in preliminary report
8. Oahu #5 & #6 (Kamehameha Highway in Kaaawa)
9. Oahu #1 (Kamehameha Highway in Kualoa)
10. Oahu #3 (Kamehameha Highway in Kaaawa vicinity of Kalaeoio Beach Park)

FINAL

1. Oahu #7 (Kamehameha Highway in Hauula at Pokiwai Road)
2. Oahu #6 (Kamehameha Highway in Kaaawa at Crouching Lion)
3. Maui #4
4. Oahu #4 (Kamehameha Highway in Kaaawa at Puakenikeni Road)
5. Oahu #3 (Kamehameha Highway in Kaaawa vicinity of Kalaeoio Beach Park)
6. Molokai #2
7. Molokai #3
8. Oahu #5 (Kamehameha Highway in Kaaawa vicinity of Makaua Village)
9. Kauai #2
10. Molokai #4

PRELIMINARY



Adjustments to the Report

- Make it clear that these are preliminary recommendations. HDOT will coordinate with Office of Planning on land use implications of the various recommendations.
- Adjust adaptation cost-benefit table to reflect that community input will be considered.





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.

Route 83 (Hauula/Pokiwai Road)

Before (KITV Photo)

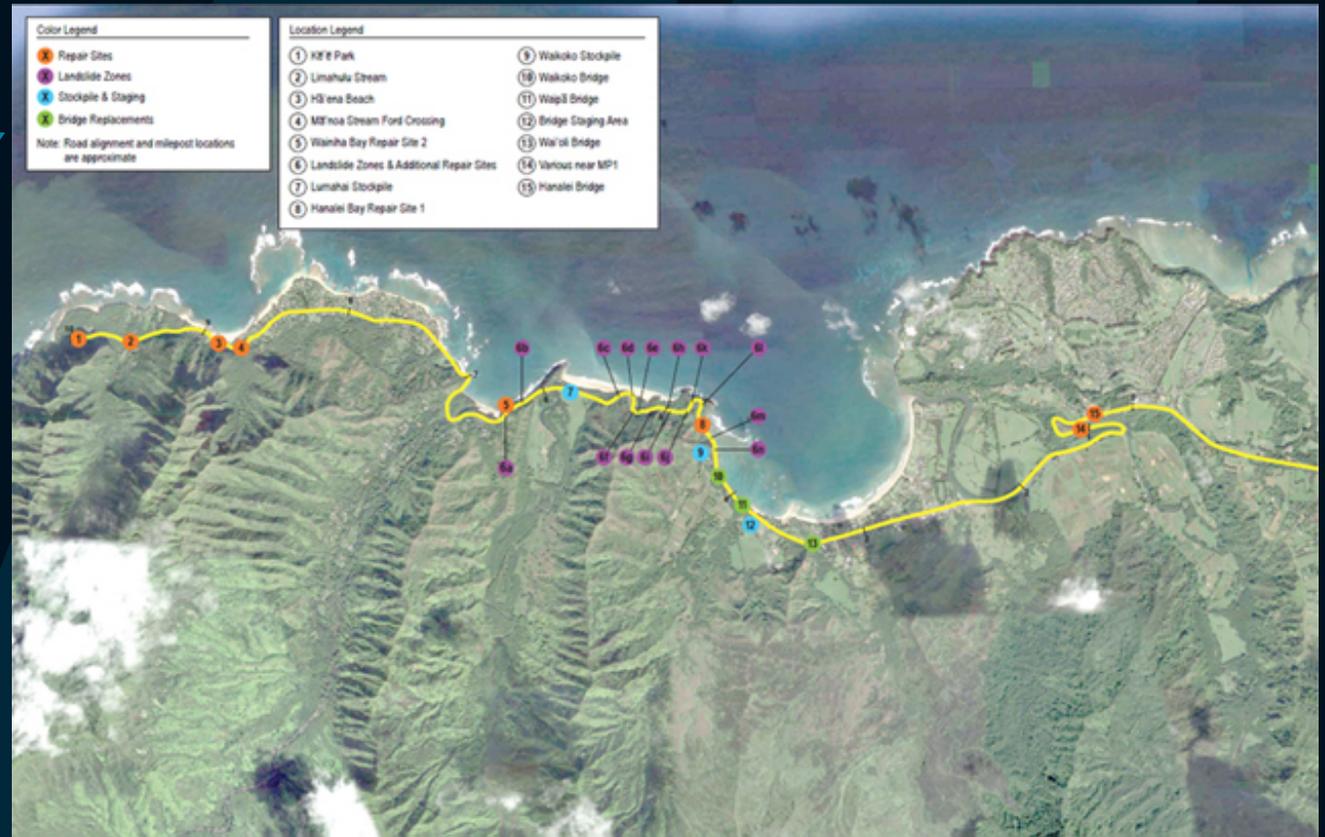


After (HDOT Photo)



April Flood

- Historic flooding April 14 & 15 caused multiple landslides and washed out portions of Route 560 on Kauai.
- Route 560 is the only way in and out for approximately 600 people.
- Landslides and rockfalls were also seen in East Oahu, but were cleared on April 14.









Kuhio Highway at Wainiha Bay









Hurricane Lane



Hana Highway Bridge Improvements

- CFL partnership project to replace/rehabilitate 6 bridges on Hana Highway.
- State maintained portion of Hana Highway includes 43 bridges and 12 large culverts.



Highway drainage criteria

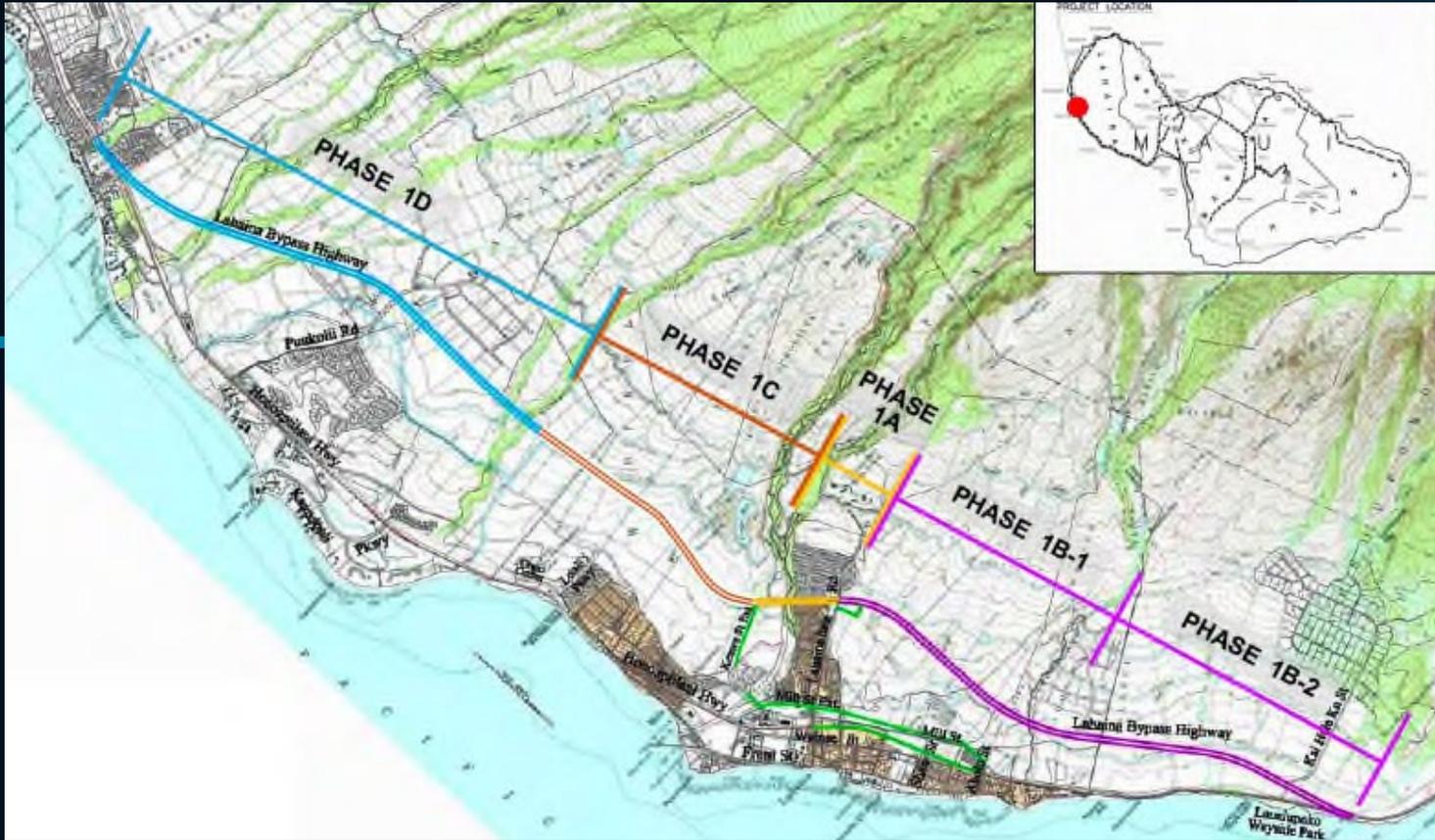
- Ensures uniformity for drainage design statewide with separate criteria for operations/maintenance and temporary drainage during construction.
- Updated in 2010. Typically updated every 12 years.
- Focused on surface/stream runoff. Does not account for SLR or rising groundwater.
- Will be updated every 5 years.
- Drainage improvements progressing on H-1 and H-201



Statewide Rockfall Prioritized List

1. Kamehameha Highway (Route 83), MM 5.4-5.52 \$20 Million
2. Hawaii Belt Road (Route 19), MM 21.04-21.49 \$11.7 Million
3. Hawaii Belt Road (Route 19), MM 25.77-26.06 \$7.19 Million
4. **Kuhio Highway (Route 56), MM 24.79-25.01 \$8.21 Million**
5. Hawaii Belt Road (Route 19), MM 21.6-21.85 \$1.03 Million
6. **Kuhio Highway (Route 560), MM 0.66-1.17 \$20.1 Million**
7. Honoapiilani Highway (Route 30), MM 10.33-10.44 \$2.57 Million
8. **Pali Highway (Route 61), MM 5.95-6.04 \$2.52 Million**
9. **Pali Highway (Route 61), MM 5.69-5.9 \$20.3 Million**
10. **Pali Highway (Route 61), MM 6.04-6.55 \$10.7 Million**





Realignment cost example

Costs to date for completed phases of the Honoapiilani Highway Realignment (Lahaina Bypass)

- Phase 1A - \$80 M
- Phase 1B-1 - \$35 M
- Phase 1B-2 - \$45 M

Total estimate including design, construction and R/W: \$450 M

What can we do?

- Create policies for adaptation, protection or managed retreat that take communities and funding into account.
- Work with experts to prioritize sites and design mitigation measures.
- Work with stakeholders on land use, access, and other considerations.
- Future decisions for roads require more than just DOT buy-in. Need alignment with State, County and Fed agencies and community.





Mahalo

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