10-2018

Memo: Sea Level Rise Analysis for Eureka-Arcata Corridor

Caltrans

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To: File

Date: October 26, 2018

File: Eureka-Arcata Route 101 Corridor Improvement Project
HUM 101 PM 79.9 / 86.3
01-36600 / 0100000127
01-0E000 / 0113000091
01-0C970 / 0113000094
01-0C930 / 0113000078
01-0F220 / 0115000092

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SUBJECT: SEA LEVEL RISE ANALYSIS FOR EUREKA-ARCATA CORRIDOR

This memo documents the rationale for decisions Caltrans made regarding the Eureka – Arcata Route 101 Corridor Improvement Project and long-term Sea Level Rise (SLR) planning for U.S. Highway 101 (US 101) between Eureka and Arcata. This memo begins with immediate design decisions regarding heights of structures on this current safety project, and then begins discussing various considerations for long-term planning.

Sea Level Rise Modeling

There are many different approaches to modeling projections on SLR. Caltrans is currently assuming the projections described in Humboldt Bay: Sea Level Rise, Hydrodynamic Modeling, and Inundation Vulnerability Mapping Final Report 2015, by Northern Hydrology and Engineering as the best projections available for the immediate local area. The report considers multiple modeling approaches and accounts for Vertical Land Movement differences across the Humboldt Bay coastline. For planning purposes, Caltrans is using the North Spit site and a projected SLR in the year 2100 is 3.2 feet (relative to the year 2000 Sea Level). Mean Annual Maximum Water (MAMW) high tide events within the Bay are currently 8.8 feet (North American Vertical Datum, NAVD) and, utilizing the 2100 SLR projections, elevation is expected to increase to 12.0 feet.

Indianola Cut-off Separate Grade Interchange

As currently designed, the grade separation at Indianola Cut-off would raise Indianaola Cut-off at US 101 to an approximate elevation of 12.0 feet, which is at the 2100 projected SLR plus MAMW.

Additionally, this US 101 structure can be elevated further if SLR occurs at a higher rate than projected. The rationale behind not building an even higher (more conservative) bridge is that the trapezoidal roadway prism on the approaches to the grade separation would get wider with additional height, leading to additional wetland fill and associated impacts to wildlife and hydrology. (See 'Sea Level Rise Design Height at Indianola Grade Change' memo 2017.)

Jacoby Creek Bridge

As currently designed, the new proposed South Bound (SB) Jacoby Creek Bridge has a roadway elevation of 13.8 feet, which is higher than the 2100 high projection for MAMW. This bridge is being designed to take into account future raising of the bridge slab and alteration of the bridge supports, potentially raising the elevation of the deck without completely reconstructing the bridge. (See 'Sea Level Rise Design Height at Jacoby Creek Bridge South' memo 2017.)

The Eureka-Arcata Corridor

When discussing vulnerability, it can be helpful to divide the corridor into separate sections. The corridor is almost six miles long, and the threats and complications vary.

Eureka Slough to the Old Mill - PMs 80.0 to 81.1

The highway in this area ranges from 9.1 feet to 14.5 feet. The railroad track paralleling the highway ranges from 9.4 to 10.8 feet. This area is at high risk and the railroad tracks on the bay side will be susceptible to high tides with just 1 to 2 feet of SLR.

Old Mill - PMs 81.1 to 81.9

The highway in this area ranges from 9.0 to 11.4 feet. The dike around the old mill ranges from 11 to 12 feet. The mill property and surrounding dike will act as a protection around this stretch of roadway. However, tidal inundation from any deficient levees at Fay Slough could threaten the highway from the landward side, depending on rainfall, drainage rates and tidal level.

Indianola Cut-off Area - PMs 81.9 to 83.2

The highway in this area ranges from 9.1 to 10.8 feet. The railroad track ranges from 10.5 to 10.6 feet. This stretch of highway and railroad levee have the lowest elevation within the corridor. Just 2 feet of SLR could inundate this entire area at MAMW.

Bracut - PMs 83.2 to 83.6

This area is the highest point within the corridor; the highway itself peaks at 21.9 feet. This area was previously the northern extent of the Indianola ridge that is believed to have been excavated to provide fill for the current highway prism. This area is high enough to not require any protection for some time and represents a break in watersheds, with the Freshwater/Fay/Eureka Slough complex to the south and Jacoby Creek/Gannon Slough to the north.

Jacoby Creek and Gannon Slough - PMs 83.6 to 85.0

The highway in this area ranges from 10.8 to 13.0 feet. The railroad track in this area ranges from 10.6 to 11.1 feet. The existing SB Jacoby Creek Bridge is 11.9 feet. This area is susceptible to inundation with 2 to 3 feet of SLR because of the low elevation of the railroad track, and the openings to the bay for Jacoby Creek and Gannon Slough. Additionally, natural flows from the creeks may back up during a high tide event, causing high water on the east side if the highway.

G Street North - PMs 85.0

The highway in this area ranges from 11 to 13 feet, then rises to the north. There is no longer protection nearby, but this area would rely on South G Street and the railroad track which seem to stay in the 10 to 11-foot range, allowing for inundation with 2 to 3 feet of SLR.

Long-Term Strategies for SLR

The District 1 Climate Change Vulnerability Assessment and Pilot Studies (2014) discusses various strategies to protect the infrastructure in place. The planning process that we are initiating now will delve further into these adaptation strategies, potentially developing new ones.

Protect in Place Options

Viaduct / Causeway

The causeway approach would raise the vulnerable segments of the highway and provide for hydrological connection under the highway between Arcata Bay and former tidelands. Allowing this connection would flood the former tidelands and restore extensive areas to saltmarsh. Those

former tidelands are now being used for residential, industrial, commercial, and agricultural purposes, which could create a conflict between current and future use the lands.

Elevate Infrastructure Above 2100 Water Levels

Raising the highway as a levee would have additional wetland fill as the roadway prism widens to accommodate the increase in height.

Build Levee

The building of a levee west/north of the highway would be a large fill of tidal flats, and likely require acquisition of the railroad from the North Coast Rail Authority. This alternative would have the advantage of protecting US 101, private commercial and agricultural lands, and other at-risk infrastructure, such as electrical utilities and water/sewer lines.

Increase Maintenance and Inspection Intervals

This option presents a no-build or wait-and-see approach, with no new infrastructure constructed and only management changes implemented. The increased maintenance refers to making sure drainage structures are functioning properly and more frequently inspecting the structures. This option does retain flexibility in that it does not commit Caltrans to a specific defense approach, and allows for continuing future planning and adaptation efforts.

Failure to adapt to the rising sea level would result in temporary closures of the highway during high water events. This occurred during the 2005 storm surge when the water reached 9.6 feet resulting in the roadway being closed for a few hours. This type of event will likely become more frequent in the future as sea level rises. Road closures could impact emergency response times, impact traffic circulation around the bay, and limit access to utilities during electrical outages or in response to natural gas, water or sewer leaks. The question becomes, “What would an acceptable frequency of closures be?”

Relocate Infrastructure

Caltrans could move the highway alignment inland to avoid impacts associated with SLR. Geographically, this new alignment would likely be near Old Arcata Road/Myrtle Avenue, as this road represents the transition from flat, low-lying former tidelands to the hillsides of the coastal range mountains. Any areas further inland would require significantly large cuts, fills, and bridges through mountainous terrain. Alternative areas closer to the current alignment would result in impacts to coastal wetlands, former tidelands, and would potentially remain susceptible to flooding

impacts from SLR. The impacts of constructing a new alignment near the existing alignment would also be substantially greater than maintaining the existing alignment.

There are several major issues with moving the alignment inland. The first is the cost of such a large acquisition of private agricultural and residential lands. The agricultural lands are small productive bottomland farms close to town. The residential lands are highly valued, many with larger lot sizes, a rural atmosphere, but still close enough to town for a reasonable daily commute. This would make acquisition of these lands for state use as a highway a major expense for the state, likely with delays associated with condemnation processes for many of the parcels.

The second major issue is that building a highway on a new alignment to present day standards and capacity would have extensive environmental impacts. Most of the land in this area is currently vegetated either in pasture, forest, agriculture, or residential landscaping. Much of this would need to be paved, cut or filled to make room for a four-lane highway, with additional lanes for access to side roads and communities such as Freshwater, Indianola and Bayside. This route would be longer than the current route, and likely have a larger overall footprint due to the length, inclusion of interchanges or stoplights, and traversing uneven terrain. Impacts to coastal wetlands would likely occur at Ryan Slough, Freshwater Creek, Jacoby Creek and Bayside.

The third major issue would be community impacts. This new route would have to originate somewhere in Eureka. Caltrans previously attempted to create a limited access bypass through or around Eureka and the effort was eventually abandoned. A new proposal for realignment would likely reinitiate concerns and the highly controversial issues brought forth previously. The route could use the existing alignment, and expand Myrtle Avenue or start south of Eureka and divert traffic through the Ridgewood area and Cutten to reach an inland alignment. The realignment would likely have direct impacts to Bayside, Indianola, and anyone living anywhere near or off Old Arcata Road/Myrtle Avenue. There would likely also be some indirect impacts to the Freshwater community. These impacts would include relocation, noise, traffic, loss of property value, loss of community cohesiveness, and loss of quality of life for residents.

The combination of these issues makes the realignment alternative less likely a preferred strategy due to environmental impacts, overall cost, community impacts, and public support. In addition, this alternative does not address other at-risk development in the area, including critical infrastructure and prime agricultural land.

Long Range Planning for Sea Level Rise

The District 1 Climate Change Vulnerability Assessment (GHD, 2014) proposed three major on-alignment strategies: viaduct/causeway, raised roads, and protective berm/levee. The most likely scenario would be a combination of these three strategies, with each used at various locations along the alignment. Determining which strategy to use where will be an ongoing discussion about land use with local governments, landowners, and the public.

Future SLR planning would include which lands and facilities to protect in place, and which lands and facilities to cede to the rising sea. The southern/western stretch of the corridor is the most developed with the industrial areas along Jacobs Avenue, Murray Field Airport, Mid-City Motor World, and the former California Redwood Company old mill site. These are also some of the lowest elevation lands, protected by old levees and sandwiched between Freshwater Slough, Eureka Slough, Fay Slough and Arcata Bay. Where sloughs may be more appropriate locations for causeway-type improvements, the developed areas are dependent upon protection.

The drainages of the watersheds inland of the highway would also be addressed. The watersheds south and east of the highway, from Bracut to Eureka, all drain to Eureka Slough where the highway currently acts as a levee for these watersheds, intercepting water before it hits the bay. As the sea level comes up, Eureka Slough will also be higher, causing drainage to back up and higher ground water tables. Both factors lead to generally more water draining through the toe drain along the east/south side of the highway, therefore the capacity of the highway toe ditch would need to be reassessed for the changing hydrologic conditions.

In general, the highway is robust to inundation as SLR approaches one to two feet, with most areas still being above the MAMW, but becomes more susceptible as SLR approaches three feet. At three feet SLR, in about years 2065 to 2095, MAMW will overtop most protective levees and even areas of the highway.

External Coordination on Sea Level Rise

Given the challenges associated with relocating the highway, Caltrans intends on maintaining US 101 on its current alignment between Eureka and Arcata. Caltrans continues to work on addressing projected SLR impacts to the State Highway System. Caltrans completed the **District 1 Climate Change Vulnerability Assessment and Pilot Studies** in December 2014. Humboldt Bay is a vulnerable location in District 1 based on the projected rate of sea level rise, existing roadway elevations, and land subsidence and/or uplift. Caltrans staff recognize the need for a coordinated planning approach. Caltrans staff currently participates in the Humboldt Bay Sea Level Rise

Adaption Planning Working Group meetings. This group includes representatives from local cities as well as public resource agencies.

Caltrans will participate in the Local Coastal Program updates by local agencies and play an active role in the County of Humboldt's **Sea Level Rise Adaptation Plan for Humboldt Bay Transportation Infrastructure - Phase 1.**

District 1 will develop a draft Climate Resilient Corridor Concept for the Eureka-Arcata Corridor. This new corridor level document will be the next step in adaptation planning and will provide a plan for moving forward. District 1 will address sea level rise planning through the identification of segments in Humboldt Bay that could be phased into smaller adaptation projects. These segments will be developed from logical breaks based on roadway elevation, watershed, and changes in the transportation system.

As a District, Caltrans is working on a series of Vulnerability Assessments as one of the first steps in addressing climate change. The Vulnerability Assessment for District 1 is scheduled to be completed in late 2019. The next step after determining vulnerability will be to develop new internal guidance for projects to address sea level rise.

Stakeholders

Caltrans, California Coastal Commission, Humboldt County Association of Governments, County of Humboldt, City of Arcata, City of Eureka, PG&E, North Coast Rail Authority, Department of Fish and Wildlife, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Army Corp of Engineers, Regional Water Board, and adjacent landowners and business owners.

Duration and Timing of Implementation

District 1 will hold a meeting to discuss forming a regional group to focus on sea level rise planning for Humboldt Bay. An initial conversation with the County of Humboldt indicated that a regional group would be best established after the Local Coastal Programs are updated and the County has completed its Adaptation Grant. The goal is to meet with the City of Arcata, City of Eureka, County of Humboldt, and Humboldt County Association of Governments to discuss how to move forward. Engaging the public will be an important step accomplished through the County of Humboldt's Adaptation Grant and through an outreach process shaped by the outcome of this grant. The outcome of the County's Adaptation Grant will also provide recommendations for a regional process to address SLR planning for Humboldt Bay.

References

GHD. 2014. District 1 Climate Change Vulnerability Assessment and Pilot Studies, FHWA Climate Resilience Pilot, Final Report

Northern Hydrology and Engineering. 2015. Humboldt Bay: Sea Level Rise, Hydrodynamic Modeling, and Inundation Vulnerability Mapping Final Report 2015