



Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Technical Working Group Meeting #2
December 15, 2020



NFWF



OCEAN
PROTECTION
COUNCIL

RECAP TWG MEETING #1

Project Concept and Goals

- ▶ Integrate the natural flood risk reduction properties of salt marsh into the shoreline management strategy for the Eureka-Arcata Highway 101 transportation corridor.
- ▶ Perform site characterization and prepare preliminary design (50%) for a project utilizing tidal benches or similar natural infrastructure techniques.
- ▶ Lay the groundwork for an innovative approach to restore and perpetuate intertidal coastal marsh, increase community resilience to flooding, and demonstrate the use of natural ecological systems for sea level rise adaptation.

Scope of Work

Tasks

Task 1: Grant Administration / Project Management

Task 2: Stakeholder Engagement and Consultation

Task 3: Site Assessment

3.1 – Topographic and bathymetric survey

3.2 – Sediment characterization

3.3 – Habitat evaluation and vegetation mapping

3.4 – Geomorphic evaluation

3.5 – Hydraulic analysis

Task 4: Preliminary Design

4.1 – Goals and objectives

4.2 – Options evaluation

4.3 – Engineering design

4.4 – Re-vegetation plan

4.5 – Access and staging plan

4.6 – Monitoring plan

4.7 – Habitat effects analysis

Task 5: Reporting

Timeline (Updated)

Date	Key Milestones
August – December 2020	<ul style="list-style-type: none">• Initiate site assessment• Technical working group meetings #1 and #2
January-March 2021	<ul style="list-style-type: none">• Continue site assessment• Technical working group meeting #3
April-June 2021	<ul style="list-style-type: none">• 10% design plans• Technical working group meeting #4
July-September 2021	<ul style="list-style-type: none">• 35% design plans• Technical working group meeting #5
October-December 2021	<ul style="list-style-type: none">• 50% design plans, supporting plans, Final Report• Technical working group meeting #6

Role of Technical Working Group

- ▶ Participate in six meetings
- ▶ Provide input on goals and objectives, approach and methods, design concepts and features
- ▶ Help understand context within Humboldt Bay
- ▶ Help identify important studies and reference sites and apply best available science
- ▶ Represent your agency's perspective and mission
- ▶ Technical assistance with site characterization (if possible)

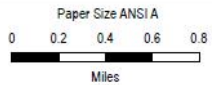
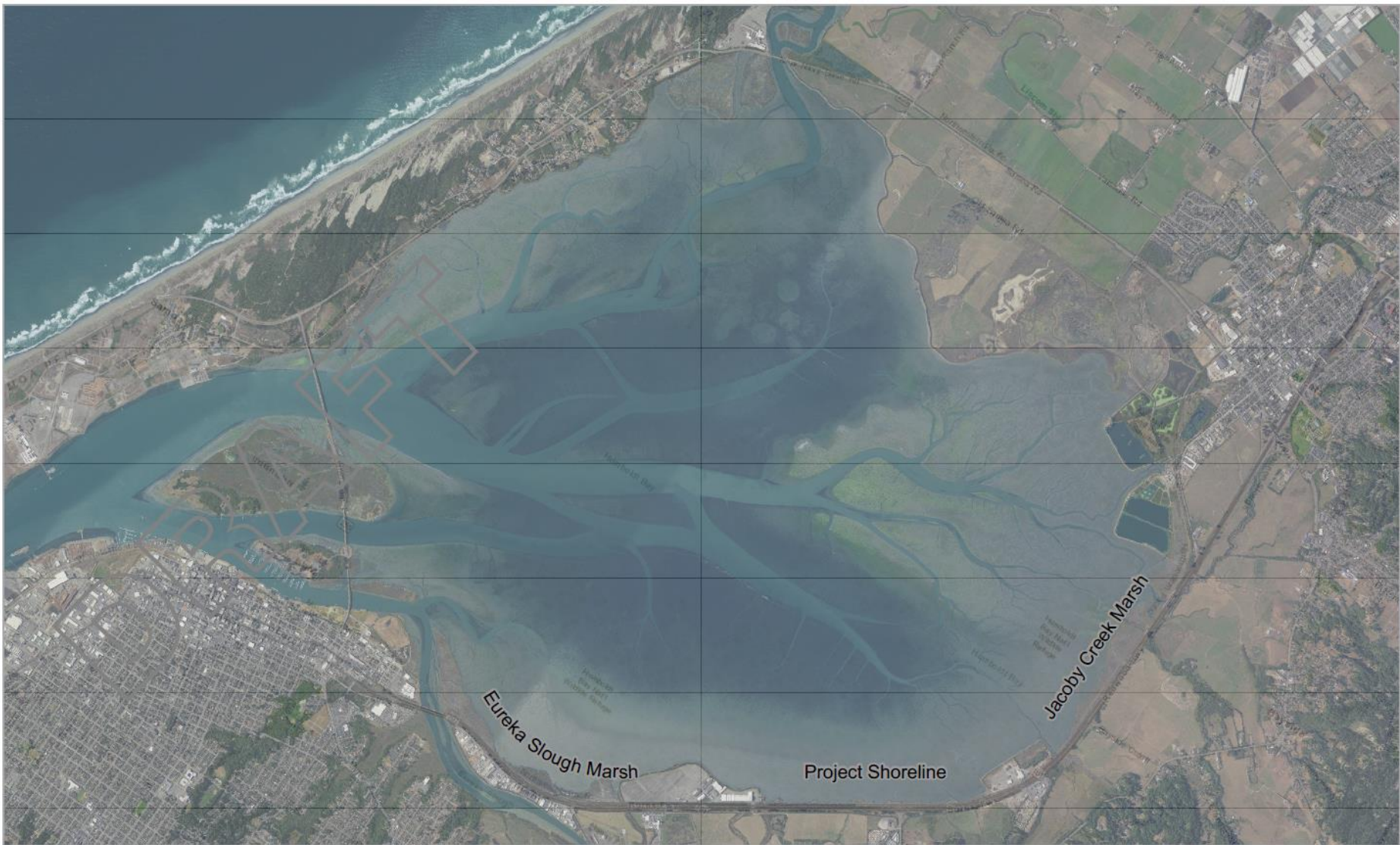
Progress Update:
Task 3 – Site Assessment

Compilation of Available Spatial Data

Preliminary Site Assessment (Task 3)

▶ Primary Goals:

1. Understand the ecological setting, geomorphic context, and historical changes of the study area through comparison with selected reference sites.
2. Initiate the first phase of data collection and analysis. Completion of this initial phase will support more focused scoping of the subsequent analysis.



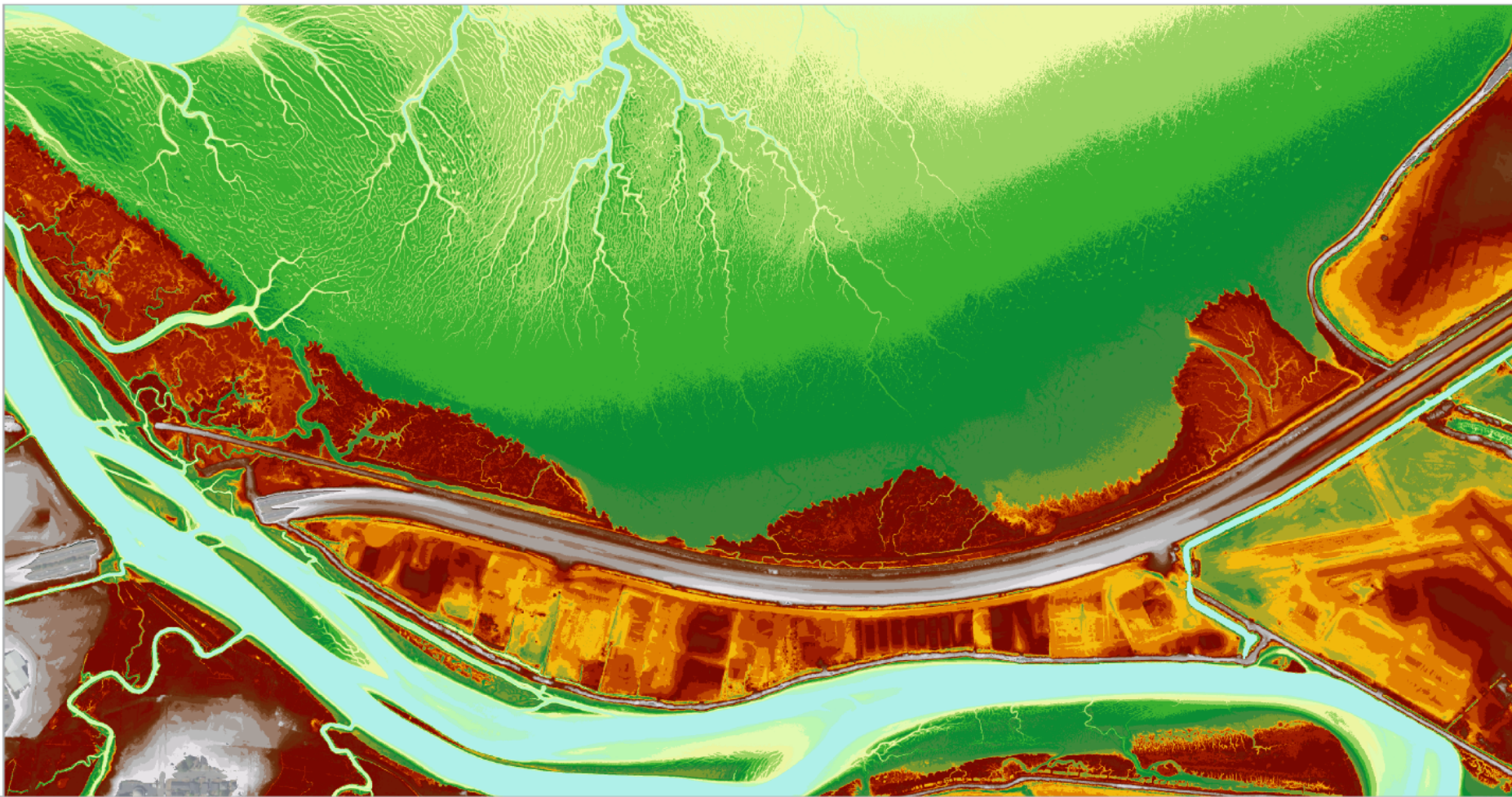
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 Humboldt Bay Natural Shoreline Infrastructure

Project No. 11214987
 Revision No. -
 Date Dec 2020

Project and Reference Areas

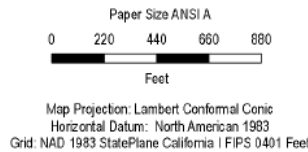
FIGURE X



Legend

Elevation in ft (NAVD88)	1.1 - 1.5	3.1 - 3.5	5.1 - 5.5	7.1 - 7.5	9.1 - 9.5	12 - 13
< 0	1.6 - 2	3.6 - 4	5.6 - 6	7.6 - 8	9.6 - 10	13 - 14
0.01 - 0.5	2.1 - 2.5	4.1 - 4.5	6.1 - 6.5	8.1 - 8.5	10 - 11	14 - 15
0.51 - 1	2.6 - 3	4.6 - 5	6.6 - 7	8.6 - 9	11 - 12	> 15

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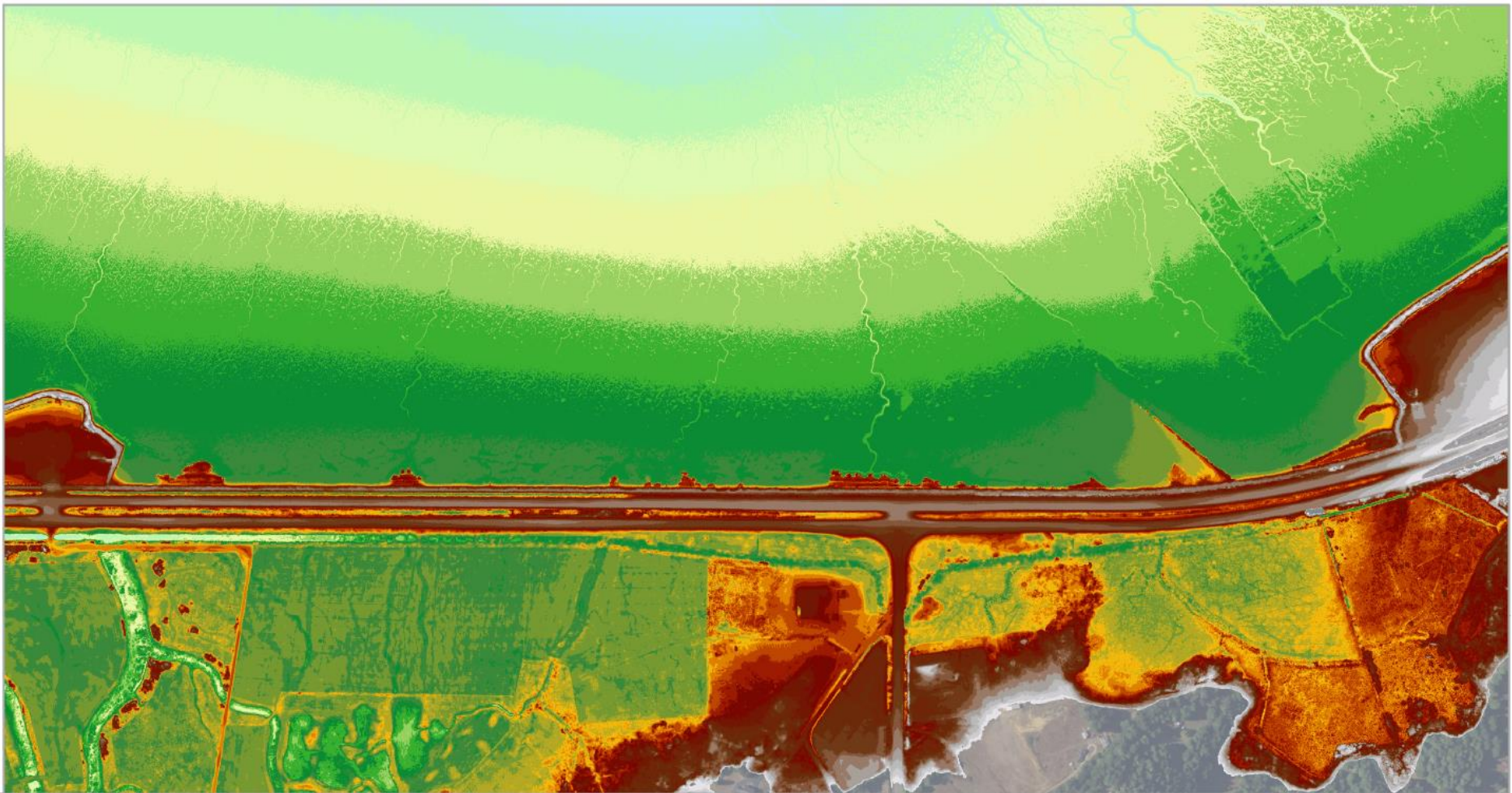


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2019 LiDAR Elevation
Eureka Slough Marsh

Project No. 11214987
Revision No. -
Date Nov 2020

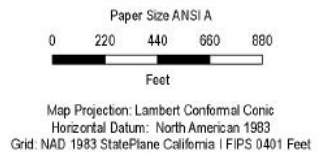
FIGURE X-1



Legend

Elevation in ft (NAVD88)	1.1 - 1.5	3.1 - 3.5	5.1 - 5.5	7.1 - 7.5	9.1 - 9.5	12 - 13
< 0	1.6 - 2	3.6 - 4	5.6 - 6	7.6 - 8	9.6 - 10	13 - 14
0.01 - 0.5	2.1 - 2.5	4.1 - 4.5	6.1 - 6.5	8.1 - 8.5	10 - 11	14 - 15
0.51 - 1	2.6 - 3	4.6 - 5	6.6 - 7	8.6 - 9	11 - 12	> 15

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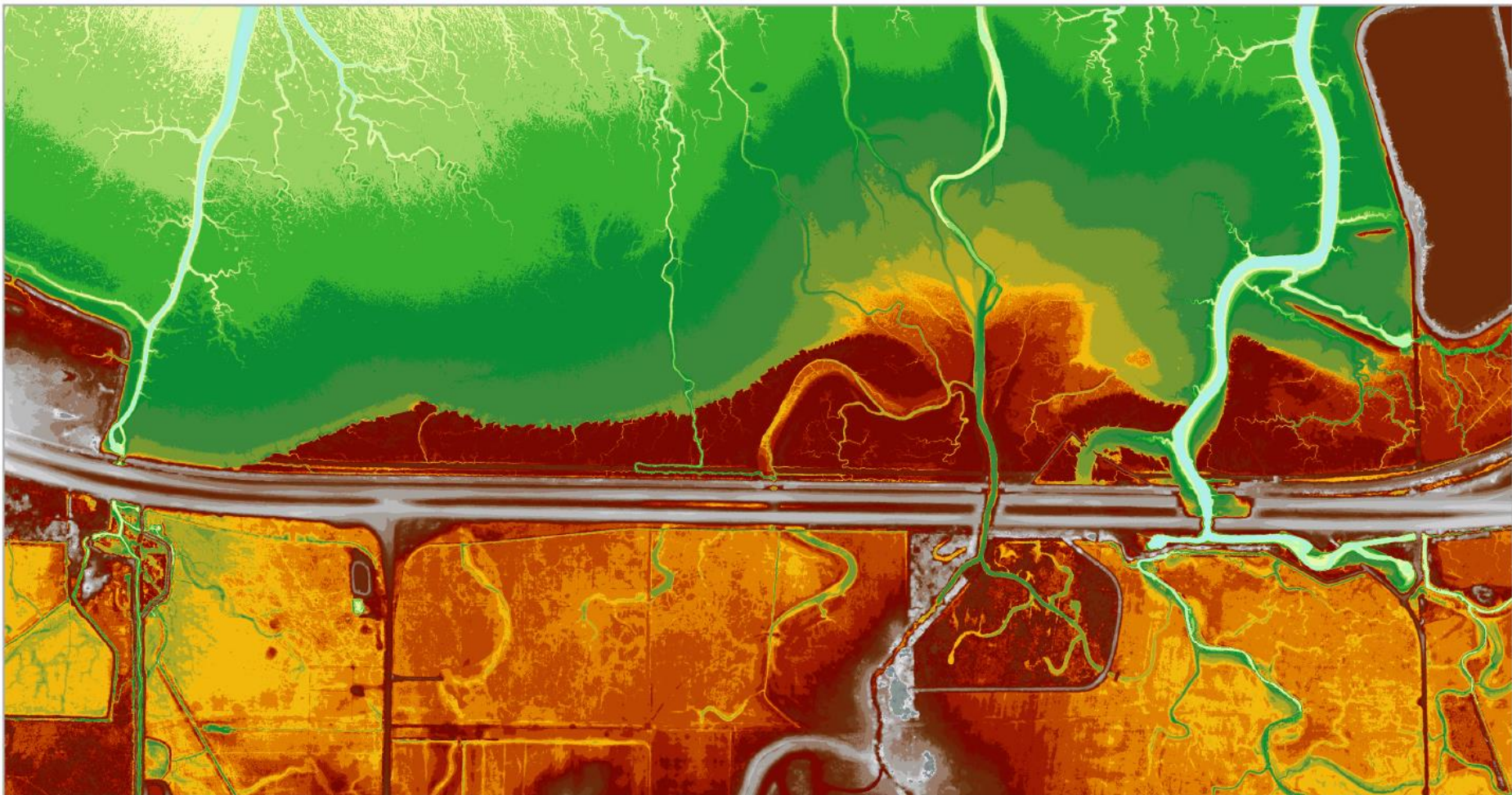


Humboldt County Department of Public Works
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2019 LiDAR Elevation
Project Shoreline

Project No. 11214987
Revision No. -
Date Nov 2020

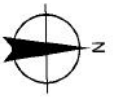
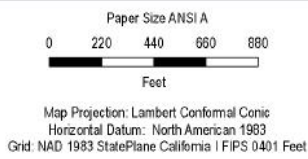
FIGURE X-2



Legend

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0.01 - 0.5	2.1 - 2.5	4.1 - 4.5	6.1 - 6.5	8.1 - 8.5	10 - 11	14 - 15
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2019 LiDAR Elevation
Jacoby Creek Marsh

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FIGURE X-3











Legend





Rare Plant Survey (GHD, 2014)

 *Angelica lucida* (sea watch) (CRPR List 4.2)

ESHA Field Data (GHD, May 2017)

 *Angelica lucida* (sea watch) (CRPR List 4.2)

Sensitive Vegetation Occurrences (May 2020)

-  *Angelica lucida* (Sea watch)
-  *Castilleja ambigua* ssp. *humboldtensis* (Humboldt bay owl's clover)
-  *Chloropyron maritimum* ssp. *palustre* (Point Reyes bird's beak)
-  *Spargularia canadensis* var. *occidentalis* (Northern sand spurrey)

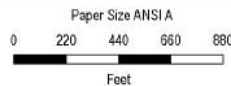
Wetland Delineation (GHD, 2017)

-  Deschampsia Series
-  Estuarine Intertidal Emergent Ditch - with *Spartina densiflora*
-  Estuarine Intertidal Emergent Wetland - Native
-  Estuarine Intertidal Emergent Wetland - with *Spartina densiflora*
-  Estuarine Intertidal Rocky Shore - with *Spartina densiflora*
-  Estuarine Intertidal Unconsolidated Bottom
-  *Juncus* series
-  Palustrine Emergent Ditch
-  Rocky Intertidal Rocky Shore
-  Willow series, dripline

Data Disclaimer

Population density and individual quantities of plants is available but not shown on this map.

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Sensitive Vegetation

FIGURE X



Project Area – 1870 (USCGS)





Legend

Shoreline Position

- 1870
- 1958
- 2020

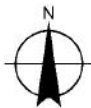
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Paper Size ANSI A

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Feet

Map Projection: Lambert Conformal Conic
 Horizontal Datum: North American 1983
 Grid: NAD 1983 StatePlane California 1 FIPS 0401 Feet



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**Shoreline Position
 Eureka Slough Marsh**

FIGURE X-1

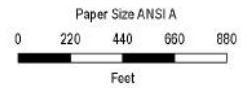


Legend

Shoreline Position

- 1870
- 1958
- 2020

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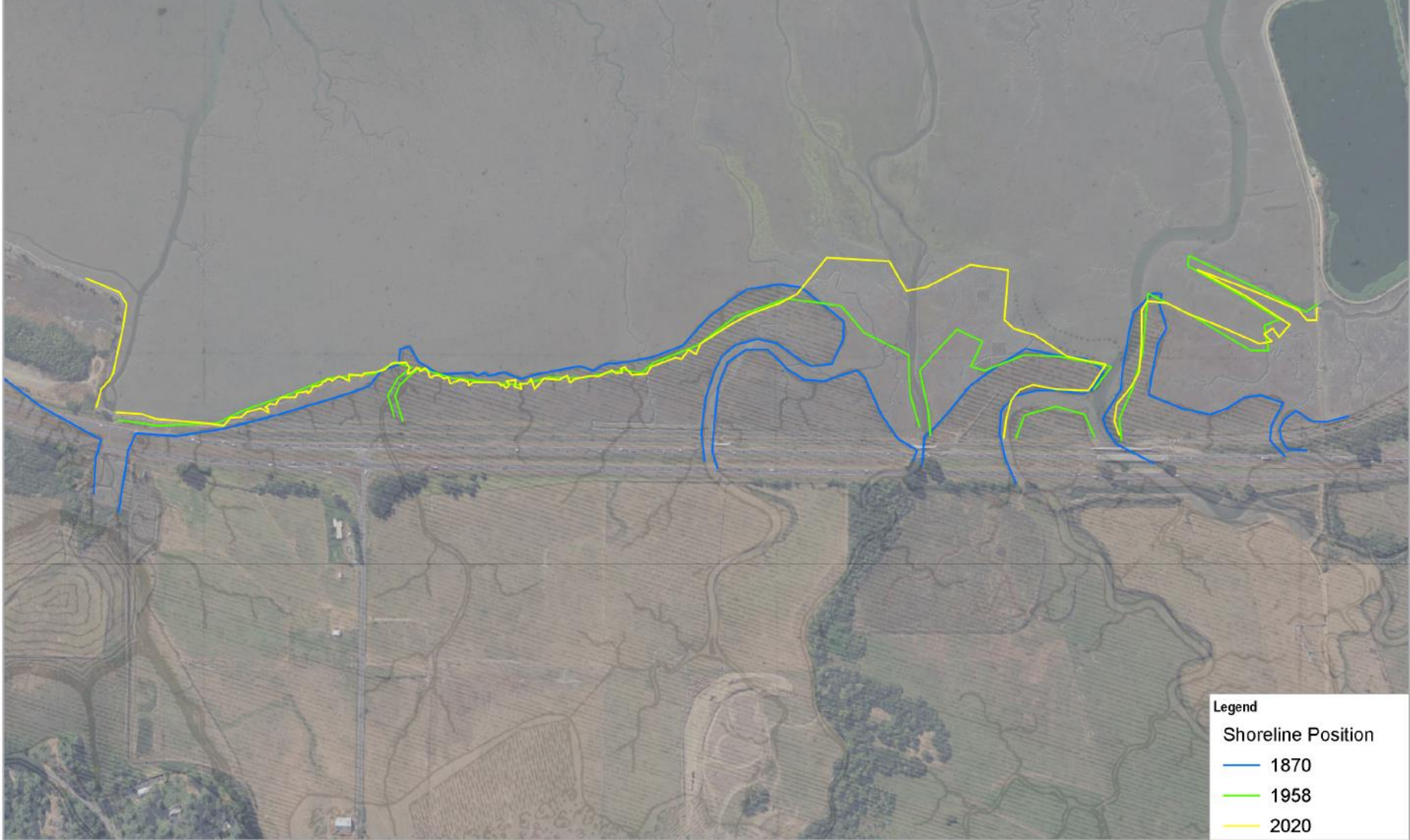
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**Shoreline Position
 Project Shoreline**

FIGURE X-2



Legend

Shoreline Position

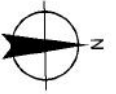
- 1870
- 1958
- 2020

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Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane California I FIPS 0401 Feet



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**Shoreline Position
Jacoby Creek Marsh**

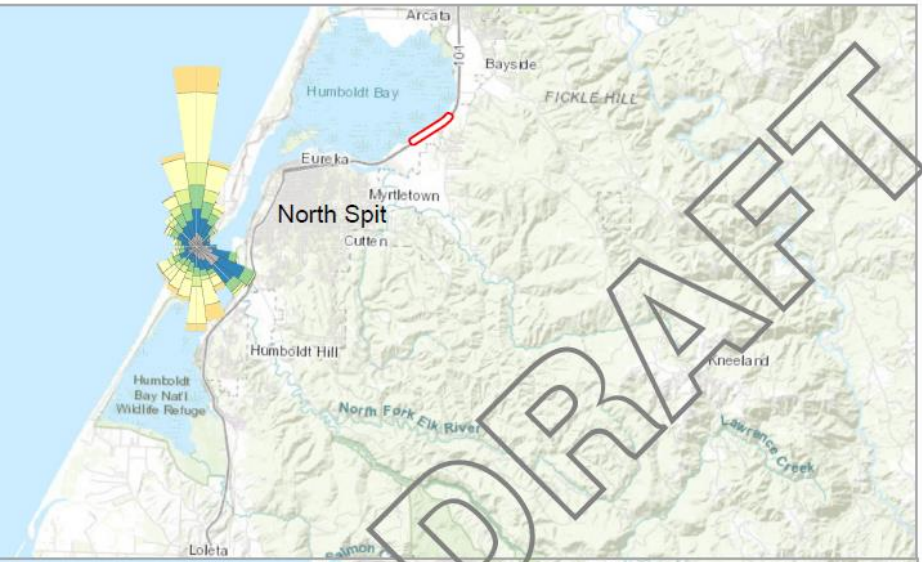
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FIGURE X-3

All Months
 Buoy 22 (1982 - 2015)
 North Spit (2008 - 2019)



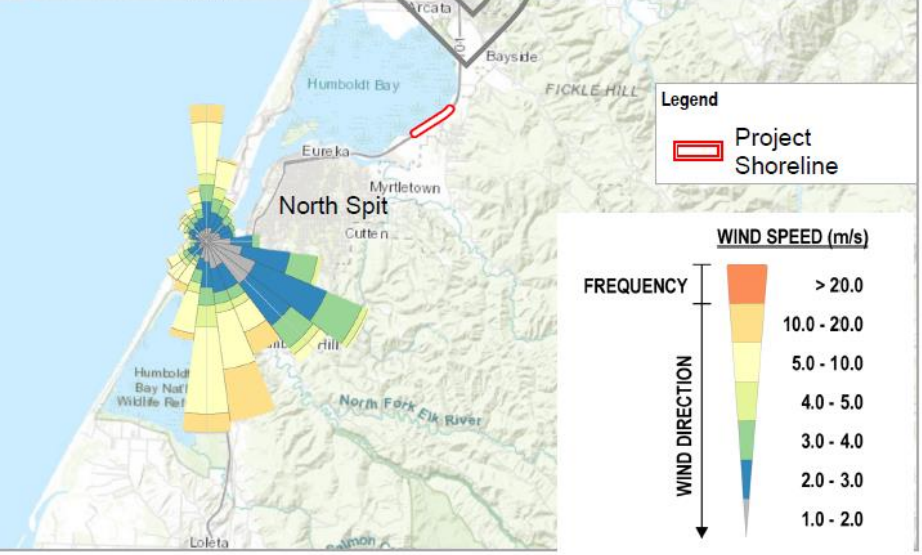
Buoy 22



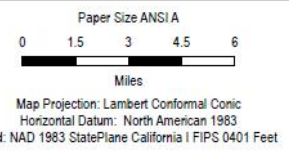
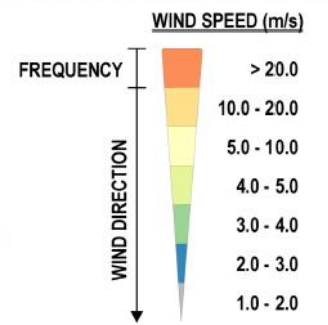
January Only
 Buoy 22 (1982 - 2015)
 North Spit (2008 - 2019)



Buoy 22



Legend
 Project Shoreline

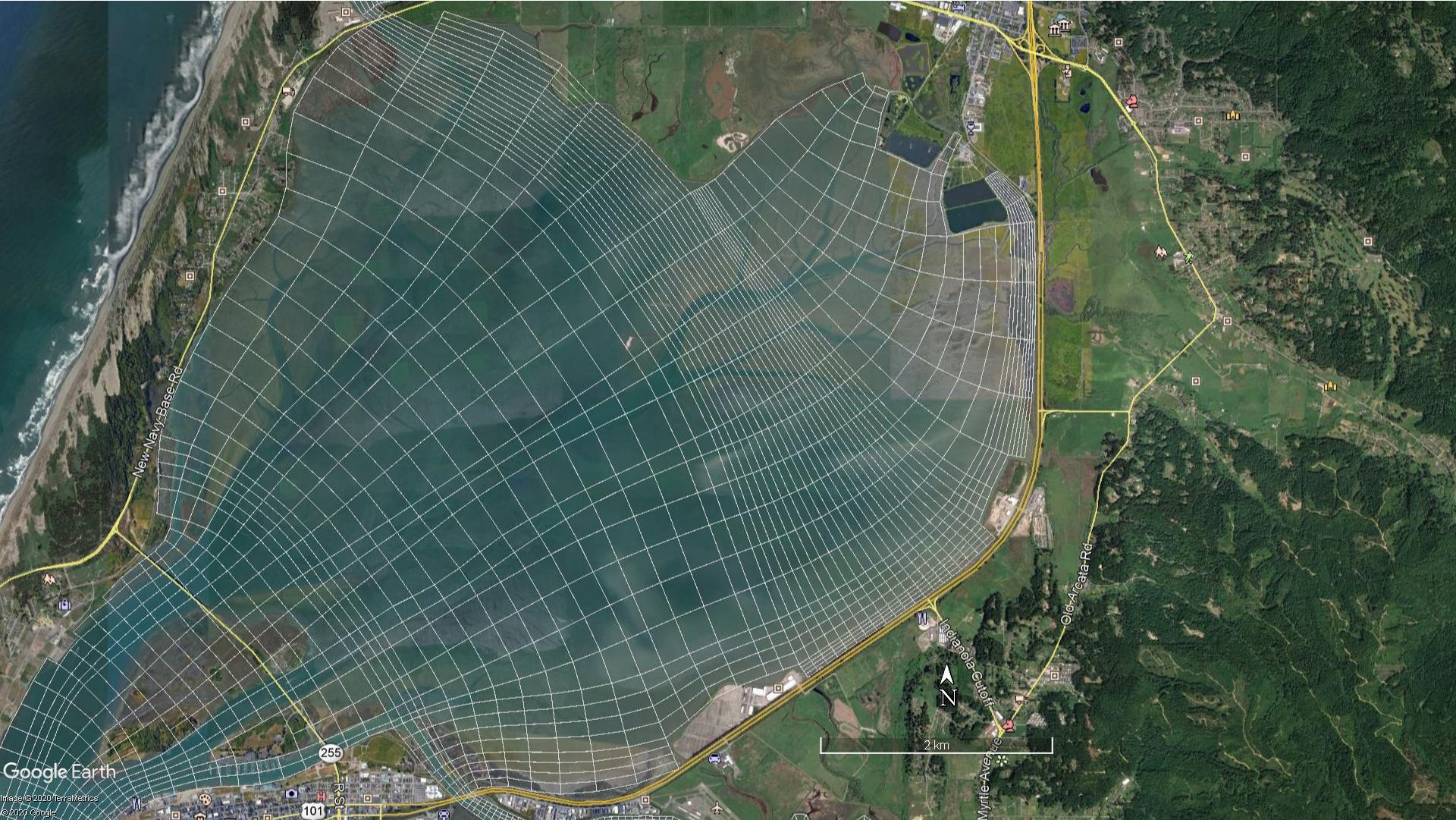


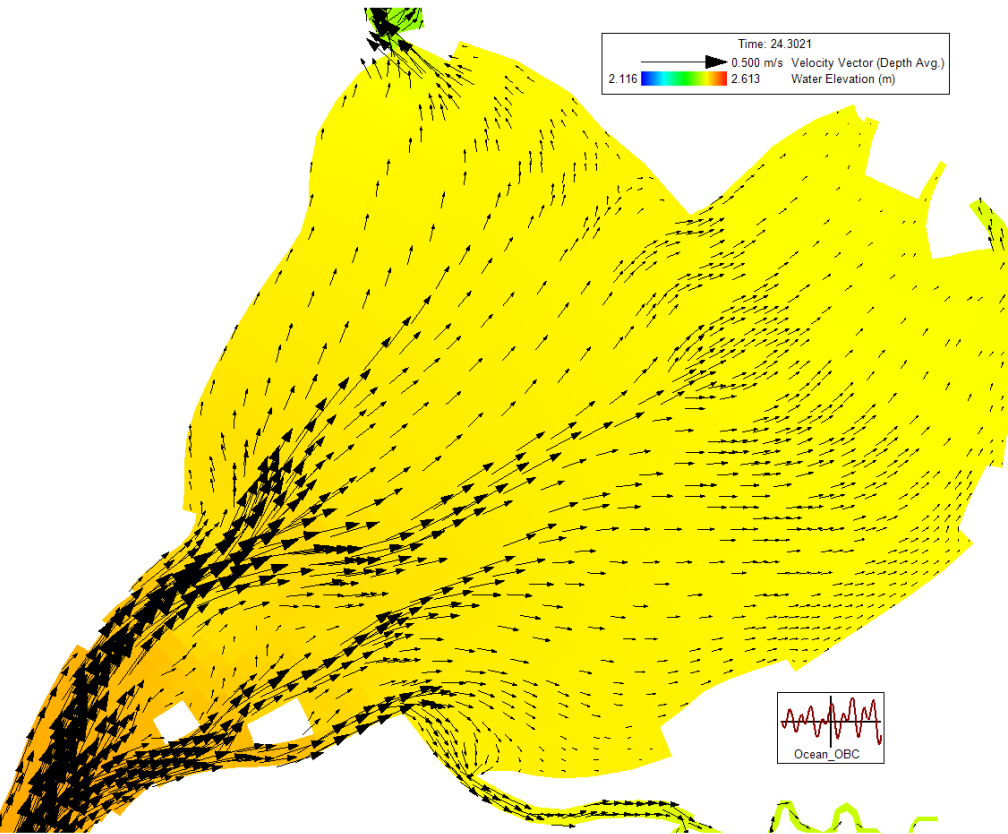
Humboldt County Department of Public Works
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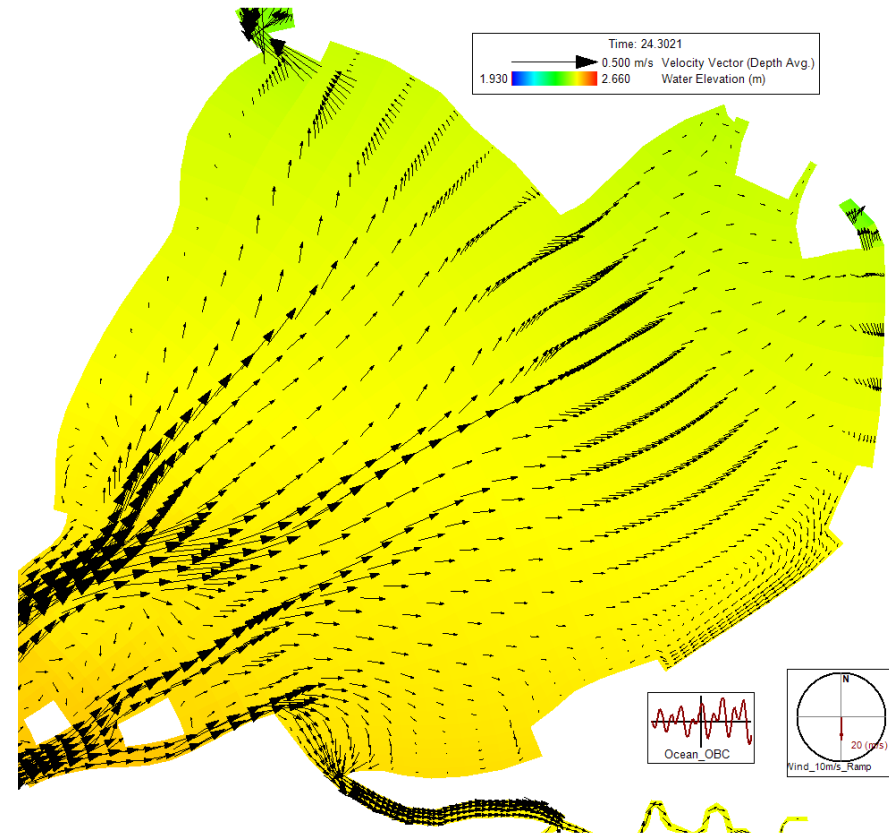
Wind Distribution

FIGURE X

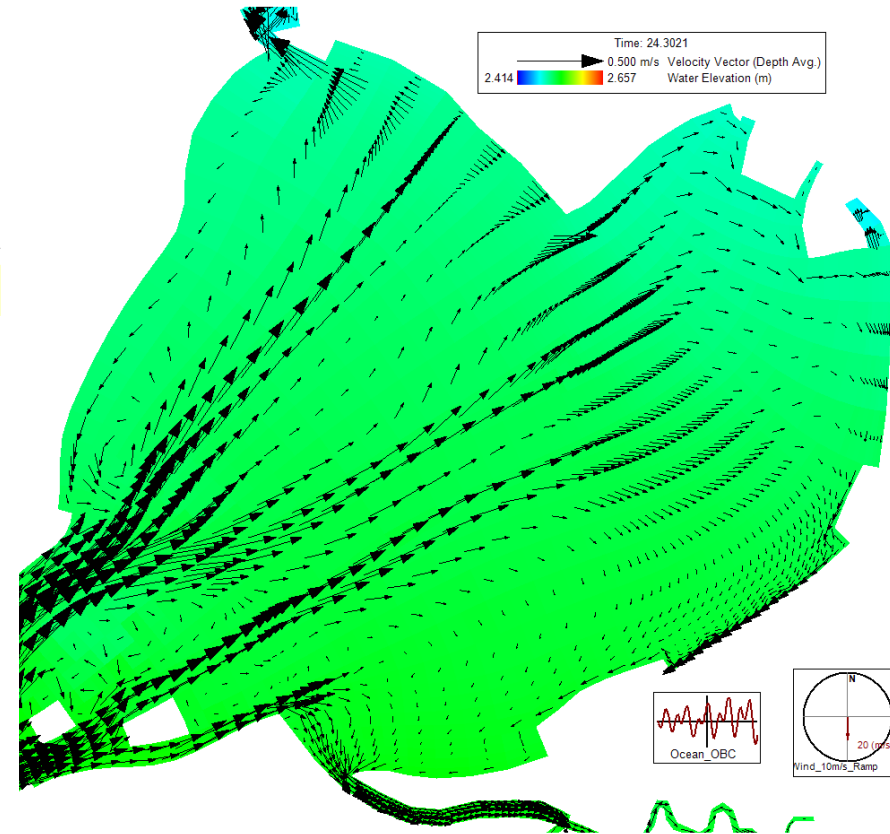
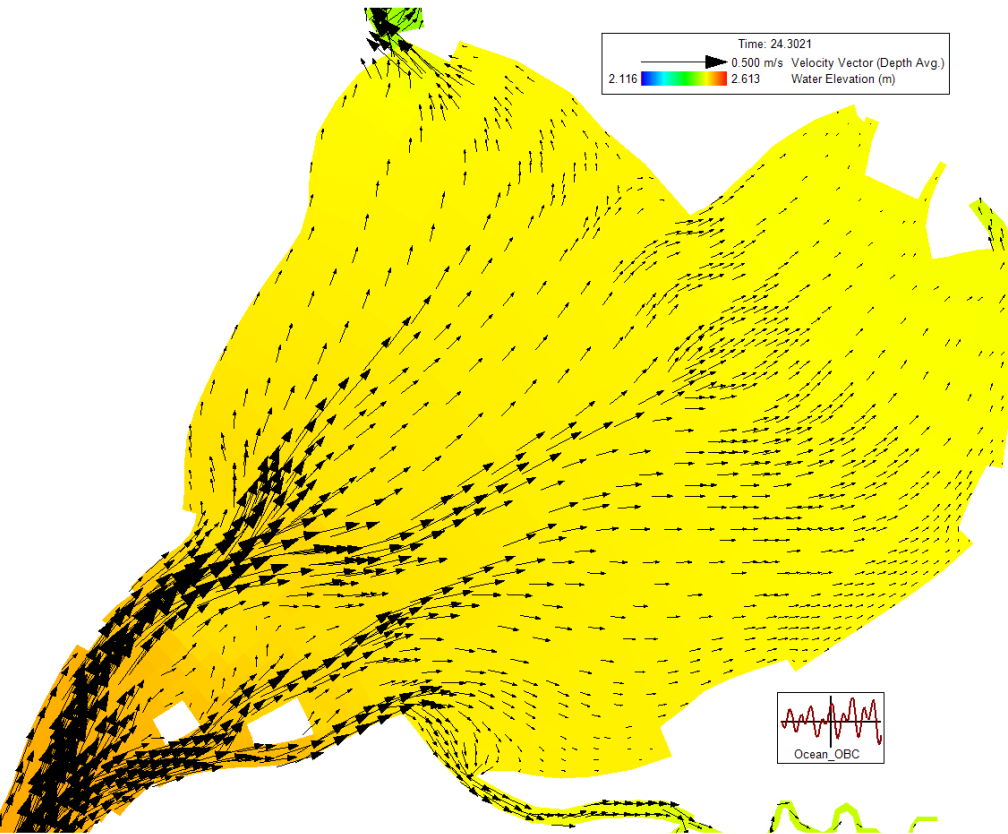




- Mean Annual Max Tide (~2-yr Event)
- No Wind
- No Wind Wave

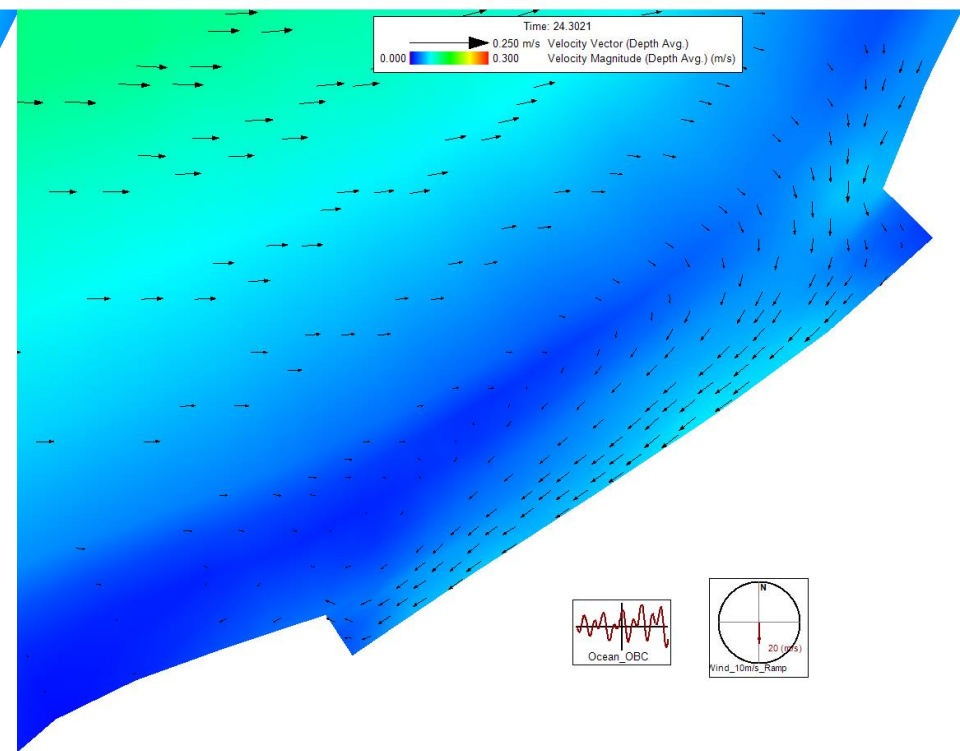
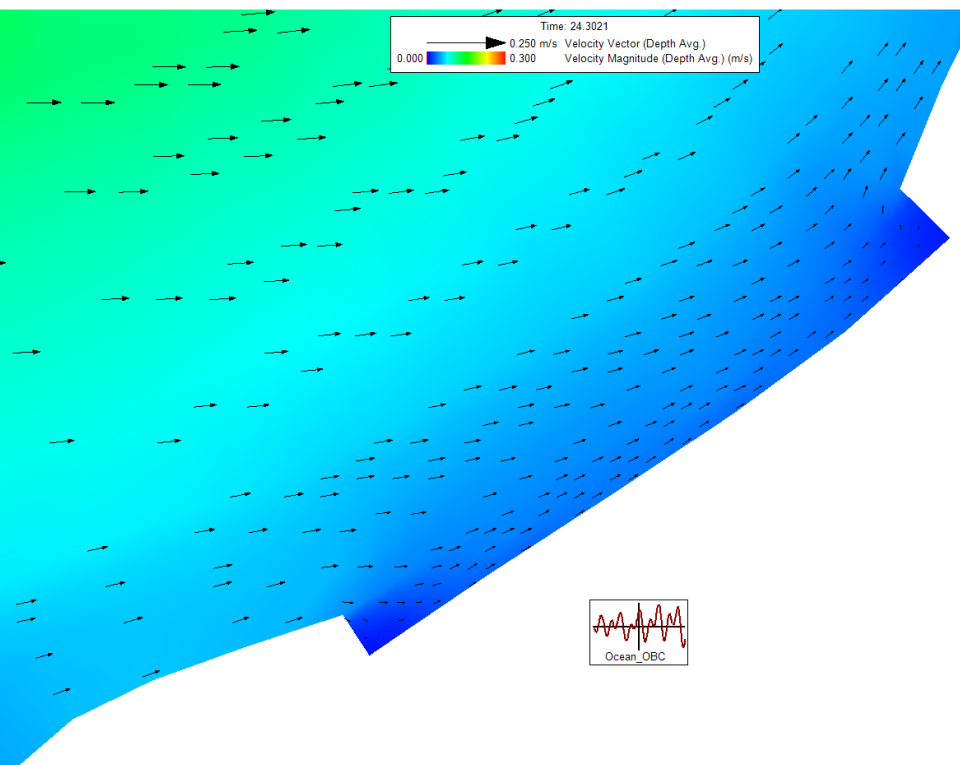


- Mean Annual Max Tide (~2-yr Event)
- 10 m/s (~ 23 mph) North Wind
- No Wind Wave



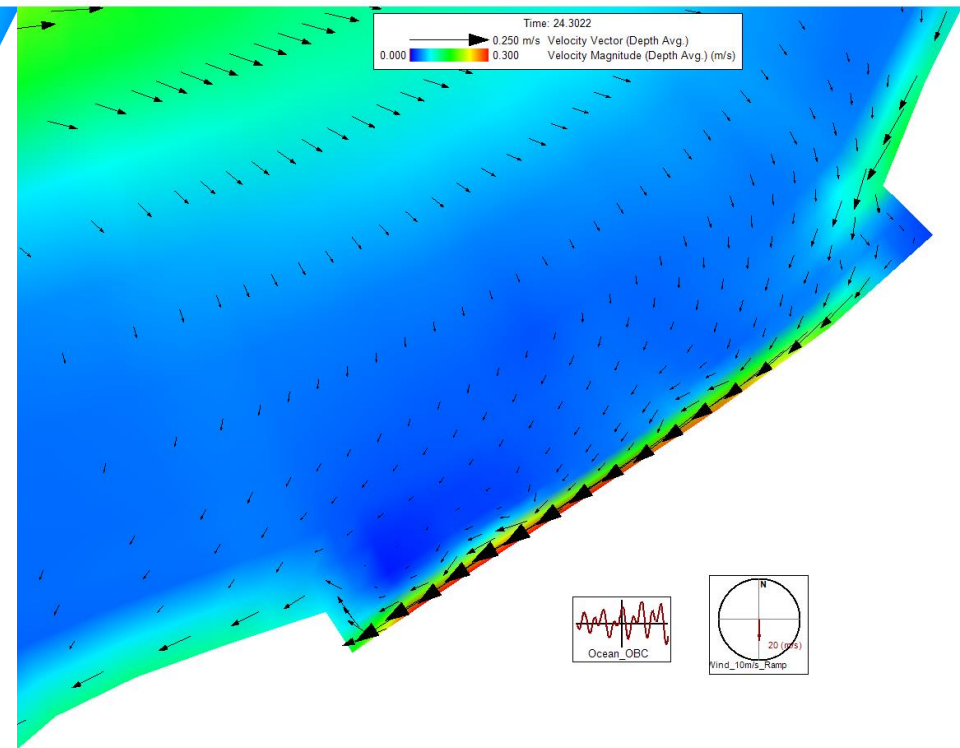
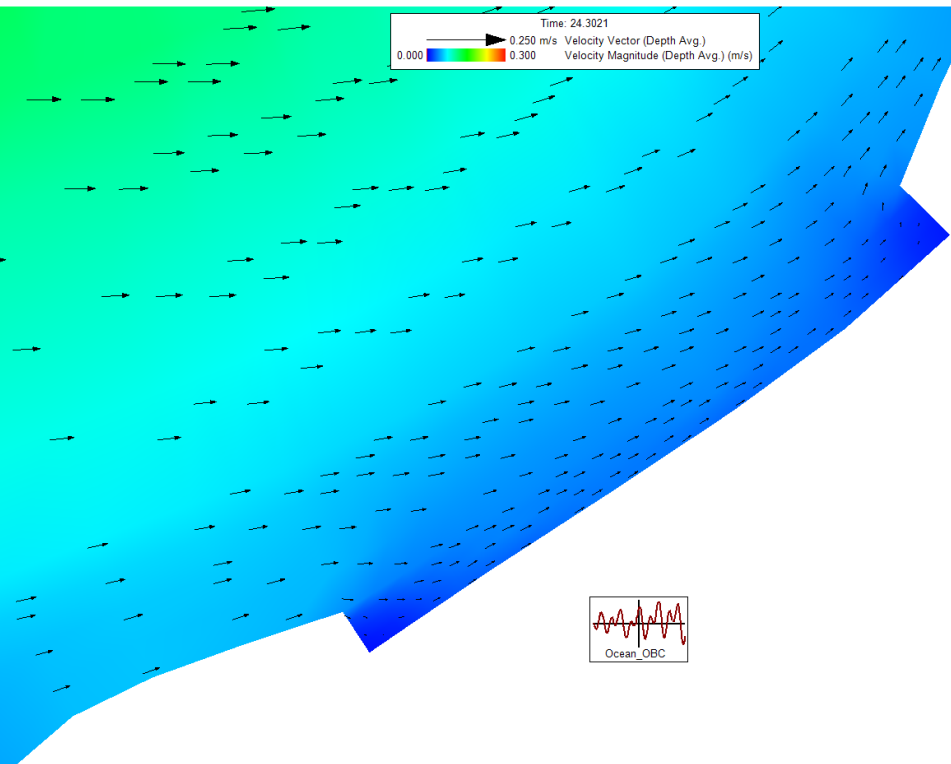
- Mean Annual Max Tide (~2-yr Event)
- No Wind
- No Wind Wave

- Mean Annual Max Tide (~2-yr Event)
- 10 m/s (~ 22.4 mph) North Wind
- Wind Wave with Radiation Stresses



- Mean Annual Max Tide (~2-yr Event)
- No Wind
- No Wind Wave

- Mean Annual Max Tide (~2-yr Event)
- 10 m/s (~ 23 mph) North Wind
- No Wind Wave



- Mean Annual Max Tide (~2-yr Event)
- No Wind
- No Wind Wave

- Mean Annual Max Tide (~2-yr Event)
- 10 m/s (~ 23 mph) North Wind
- Wind Wave with Radiation Stresses

Progress Update:
Task 3 – Site Assessment

Geomorphic Evaluation Scoping

Geomorphic Evaluation Scoping

▶ Key Considerations:

1. Sediment sources and redistribution processes.
2. Hydraulic and meteorological conditions.
3. Human impacts – primarily infrastructure (railroad, highway, levee) and dredging.
4. Vegetation changes – introduction of *Spartina densiflora*.

Geomorphic Evaluation Scoping

▶ Key Questions:

1. How is the study area similar and different from the reference sites?
2. What are the processes that link existing salt marsh with the adjacent mudflats?
3. How will a conceptual model support site-specific predictions for the trajectory of the landforms within the study area under the status quo (no project) scenario and a with-project scenario?
4. Does the study area have too much wave power and not enough sediment supply to create a sustainable tidal marsh?
5. How would an altered landscape respond to future conditions?

Geomorphic Evaluation Scoping

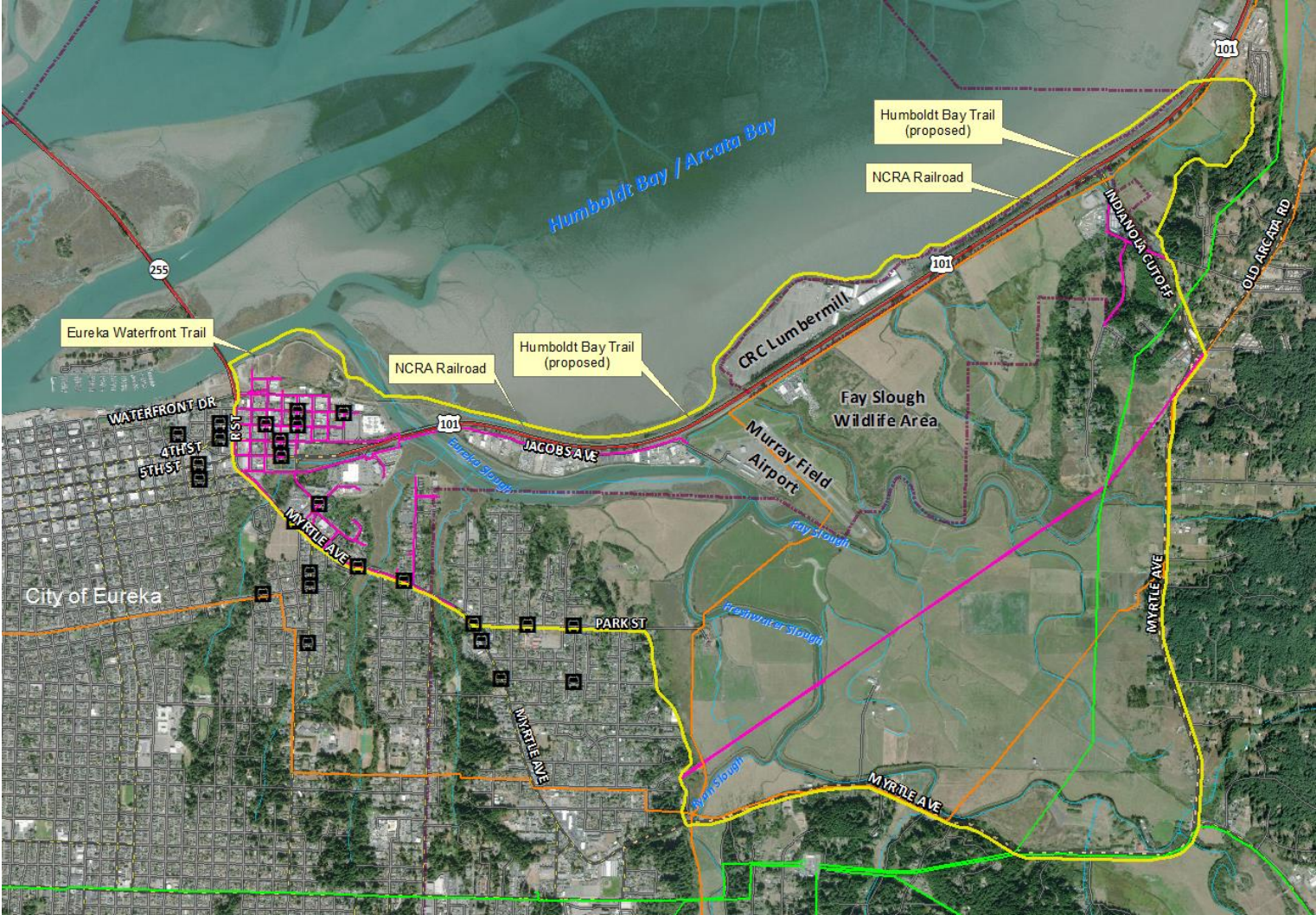
▶ Next Steps:

1. Continued Coordination with Christina Bewley's Masters Thesis Work:
 - a. Vertical and Lateral Shoreline Change
2. Map current salt marsh edge to identify active scarping/ramping
3. Assessment of North Bay Hydraulic Drivers (Depth and Velocity)
 - a. Tidal Circulation
 - b. Wind and wind-wave circulation
4. Develop Conceptual Model of North Bay and Adjacent Tidal Wetlands
 - a. Characterize sediment sources, sinks, pathways on seasonal/annual basis
 - b. Support project alternative actions, *i.e. how will different natural shoreline design techniques function with an excess or deficit of sediment supply?*

Progress Update:

Humboldt Bay / Eureka Slough
SLR Adaptation Plan

Humboldt Bay/Eureka Slough SLR Adaptation Plan – Planning Area



Humboldt Bay/Eureka Slough SLR Adaptation Plan – Adaptation Projects



Sea Level Rise Adaptation Plan for Transportation Infrastructure in the Eureka Slough Hydrographic Area, Humboldt Bay

Working Draft | July 2020

Project Team:

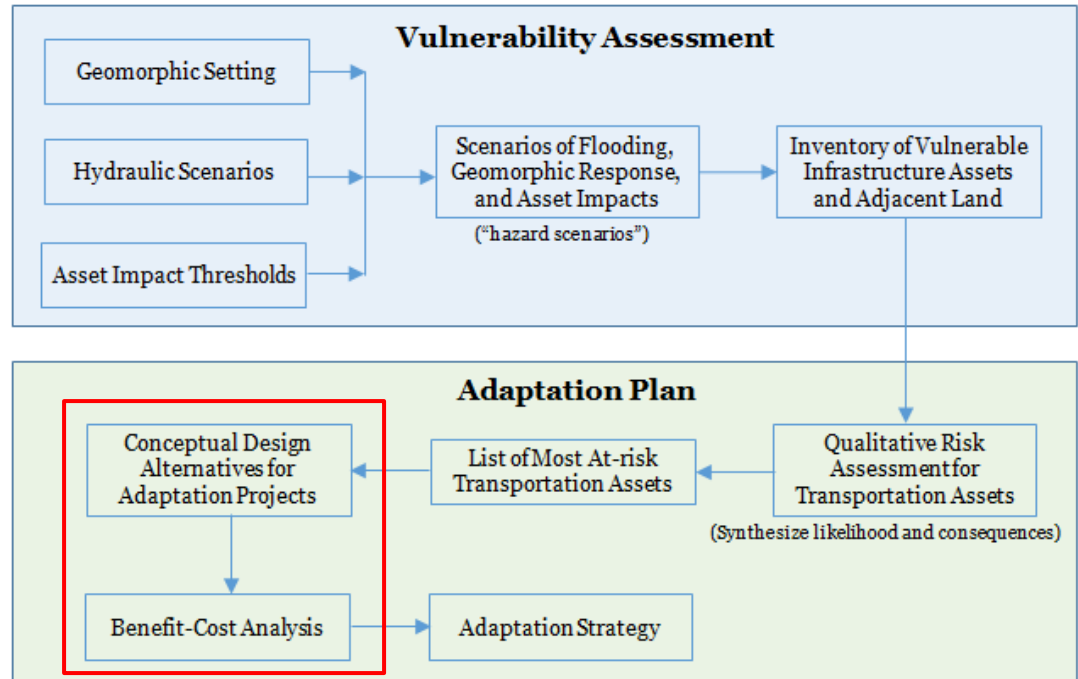
Redwood Community Action Agency (RCAA)
Environmental Science Associates (ESA)
Northern Hydrology & Engineering (NHE)
Trinity Associates
Philip King
GHD



GHD | 718 Third Street, Eureka CA 95501

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Sea Level Rise Adaptation Planning Flow Diagram



Completion date: March 2021

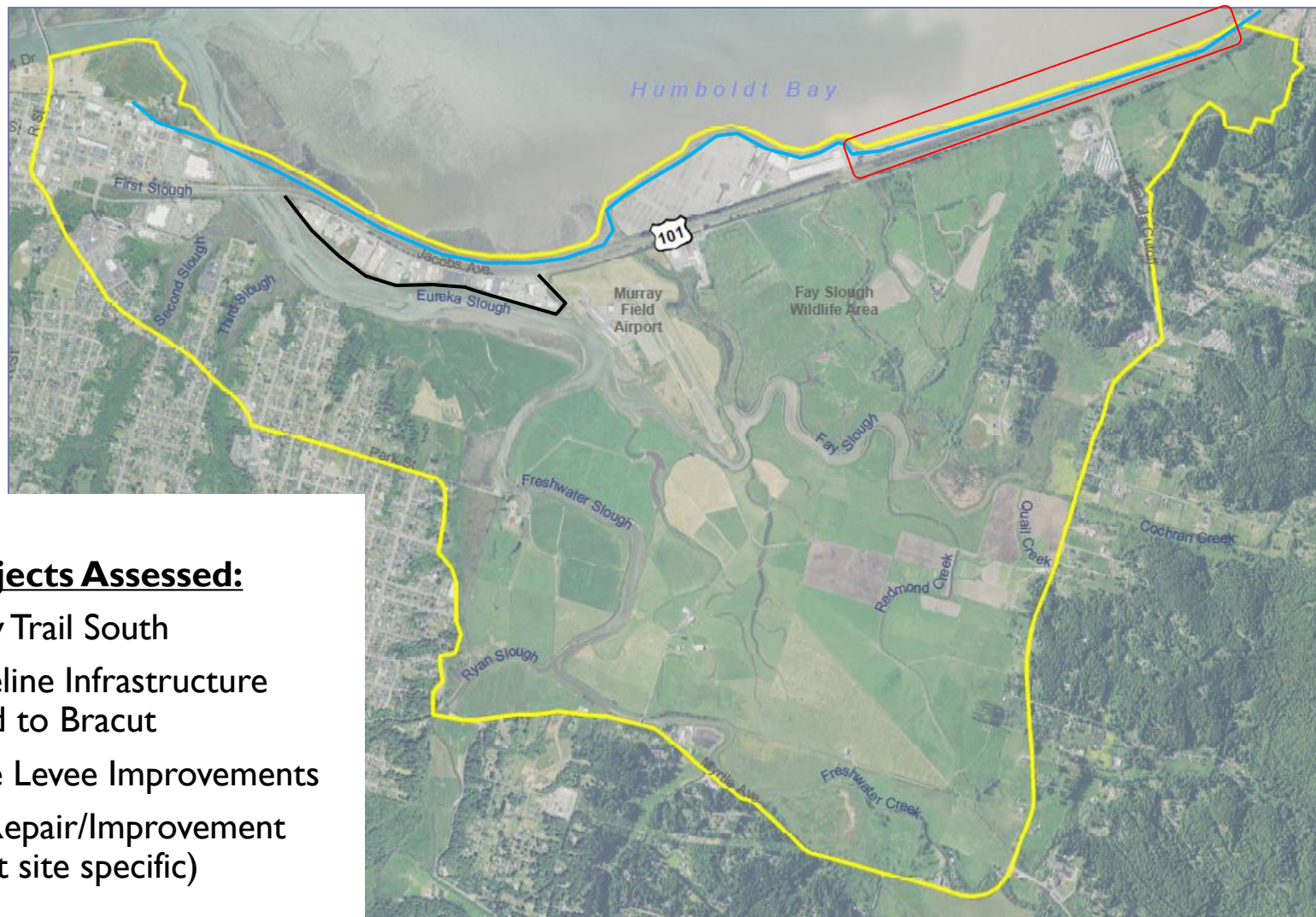
<https://humboldt.gov.org/2487/Sea-Level-Rise>

Humboldt Bay/Eureka Slough SLR Adaptation Plan – Adaptation Projects

Adaptation Project Criteria:

1. Develop conceptual designs four (4) feasible projects that can be implemented within approximately 5-20 years.
2. The four project concepts developed in the plan will provide the basis for future supporting studies and preliminary design phases.
3. Projects will be designed for Likely Low Risk Aversion (66% probability) SLR Projections over estimated project life AND cross-checked for adaptability to Med-High Risk Aversion (0.5% probability) projections
4. Project benefits will assume a completed Humboldt Bay Trail South (HBTS) which is planned to be completed in 2022/2023.
5. Results of the Hazard Scenarios and Qualitative Risk Assessment indicate that impacts to critical resources in Cells A and C pose the greatest risk to the local and regional community. Projects should show benefits to transportation infrastructure.

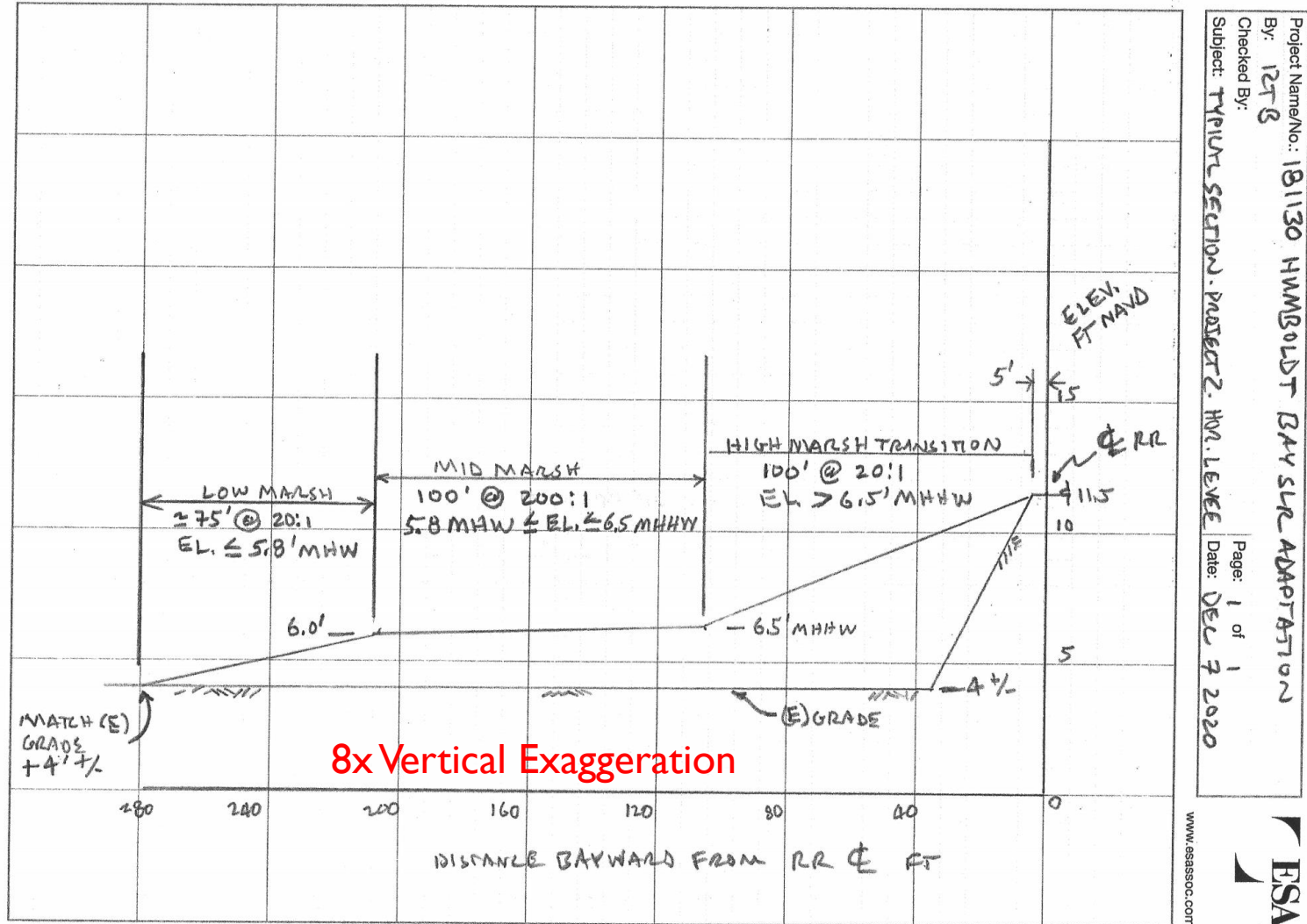
Humboldt Bay/Eureka Slough SLR Adaptation Plan – Adaptation Projects



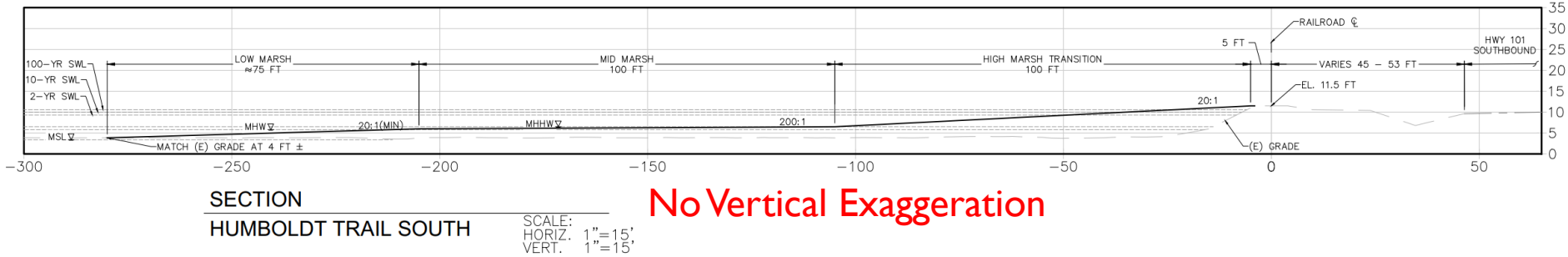
Adaptation Projects Assessed:

1. Humboldt Bay Trail South
2. Natural Shoreline Infrastructure (NSI) Brainard to Bracut
3. Jacobs Avenue Levee Improvements
4. Typical Dike Repair/Improvement Concepts (not site specific)

Humboldt Bay/Eureka Slough SLR Adaptation Plan – Adaptation Projects -#2 Natural Shoreline Infrastructure (NSI)



Humboldt Bay/Eureka Slough SLR Adaptation Plan – Adaptation Projects -#2 Natural Shoreline Infrastructure (NSI)



Progress Update:

Christina Bewley's
HSU Graduate Thesis

Geotechnical Thesis Consists of Four Components

- ▶ Monitoring Groundwater Behind Dikes
 - ▶ Help show groundwater elevation changes with respect to tide changes

- ▶ Conducting High Precision First-Order Land Leveling Survey
 - ▶ Aid in calculating vertical land motion rates and tilt rate

- Producing Coastal and Estuarine Geologic and Geomorphic Maps
 - Show vertical and lateral land elevation changes

- ▶ Creating LiDAR Differencing Maps from 2010 and 2019 LiDAR DEM's
 - ▶ Highlight vertical land elevation changes over past decade

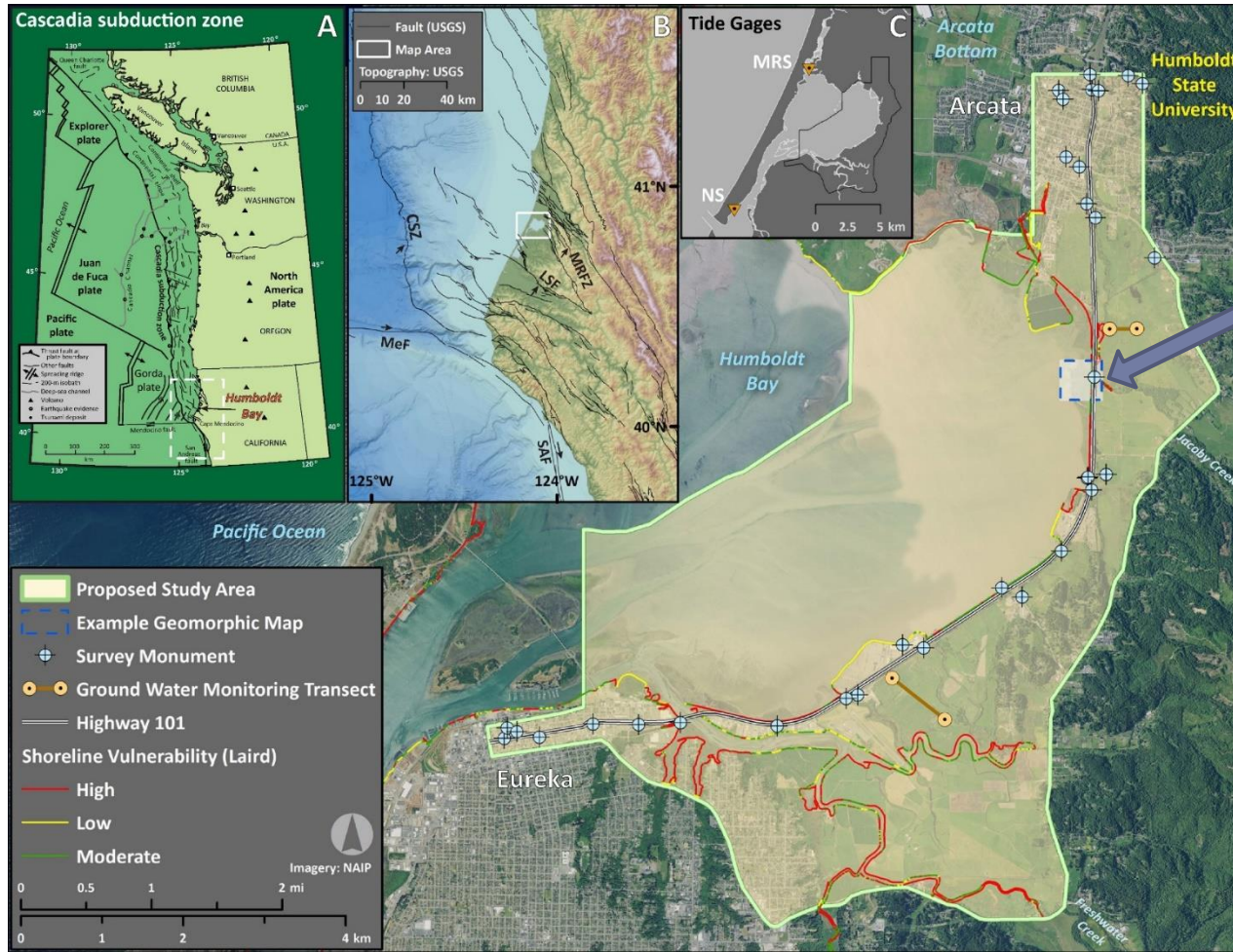
Groundwater and Leveling Surveys

Figure 1. Maps of 101 Eureka-Arcata Corridor, Project area with proposed groundwater and leveling survey locations, and SLR vulnerability ratings from Laird, 2018.

A) Cascadia Subduction Zone with Project area.

B) USGS Fault Map showing Project Area and surrounding faults.

C) Tide gages at Mad River Slough and North Spit.

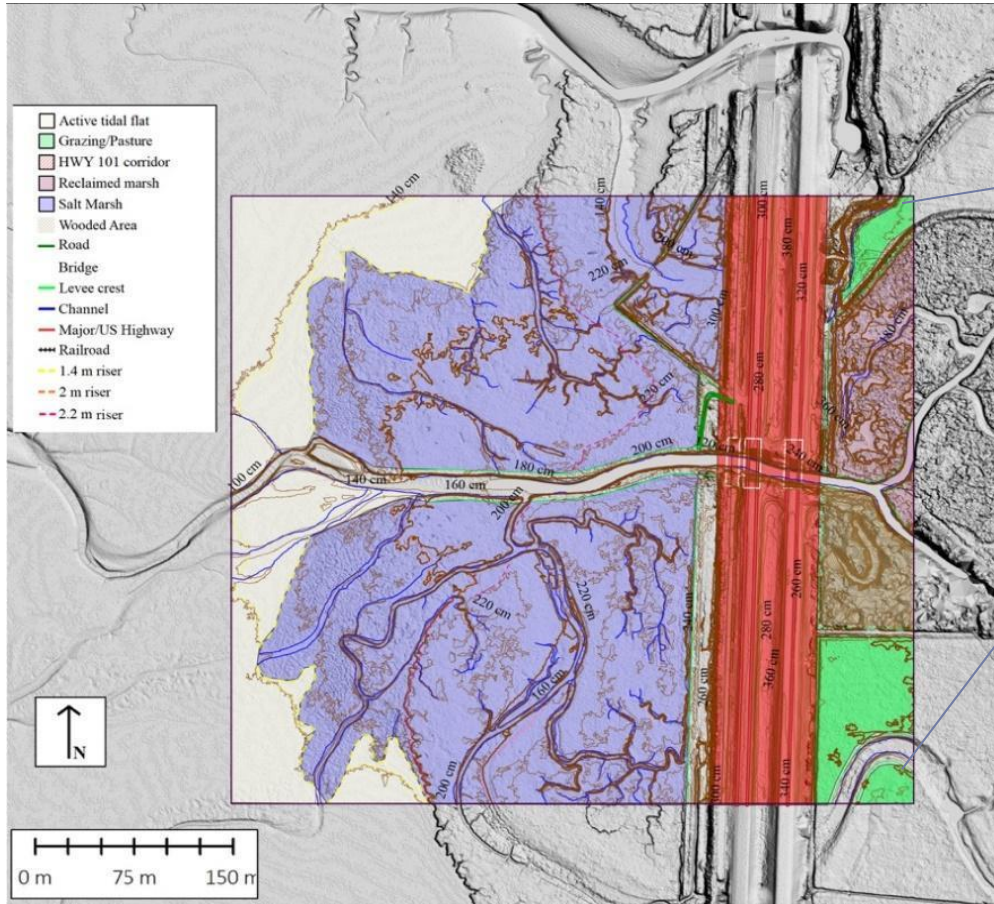


Example Geomorphic Map Area

Figure created by Dr. Jason “Jay” Patton with the CGS, HSU Alumni, Engineering Geologist, long time SLR researcher within Humboldt Bay, and member of my graduate Advising Committee.

Geologic/Geomorphic Mapping and LiDAR Differencing

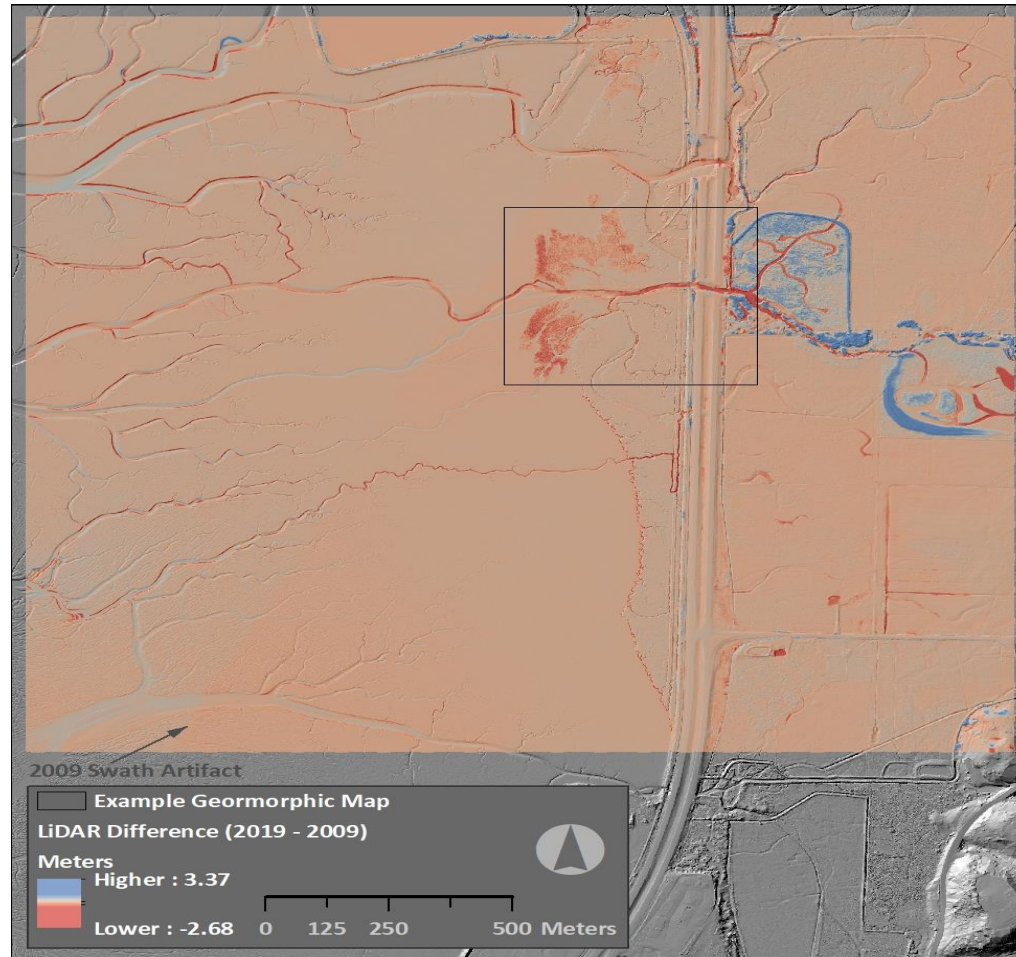
Figure 2. Geomorphic map of mouth of Jacoby Creek using 2019 10cm - res LiDAR hillshade as reference. As the Creek enters the Bay it forms a delta complex that is currently occupied by a salt marsh. Three low terrace risers are formed in the delta complex.



Figures created by Dr. Mark Hemphill-Haley, HSU Alumni and Faculty, Engineering Geologist, Geomorphologist and Paleo-Seismologist, long time SLR researcher within Humboldt Bay, and my Graduate Thesis Advisor.

LiDAR Differencing Map

Figure 3. LiDAR differencing image subtracting the 2010 LiDAR DEM from the 2019 DEM. Red colors suggest a lower surface in the 2019 than 9 years prior. Blue suggests a higher surface relative to 2010. Black box is the boundary indicated in Figures 1 and 2.



Caution should be taken with this interpretation since the 2010 LiDAR resolution was about 1 m and the 2019 LiDAR resolution was about 10cm.

Ultimate Desired Deliverables from Geotechnical Graduate Thesis

- ▶ The four specified data sets; Groundwater Surveys, Land Leveling Surveys, Geologic/Geomorphic Maps, and LiDAR Differencing Maps
- ▶ Series of maps of overall study area with projected impacts of Sea Level Rise over the next 100 years
- ▶ Discuss feasibility of all Potential Adaptation Alternatives for the Highway 101 Eureka-Arcata Corridor
 - ▶ Viaduct/causeway for the total span of the corridor
 - ▶ Viaduct/causeway for portions of the corridor at lower elevations
 - ▶ Dike and levee development
 - ▶ Development of a living shoreline
 - ▶ Relocate 'in place' by building causeway adjacent to the road
 - ▶ Relocating highway to an alternative route on Old Arcata Road
 - ▶ No Action



Wrap Up / Next Steps /
Meeting #3
(Late Feb./Early March 2021)

