Sitka Sedge Tidal Wetland Restoration: Alternatives Analysis & Hydraulic Modeling

Sitka Sedge Tidal Wetland Restoration Project – Townhall Meeting

June 17, 2023

OREGON STATE PARKS 100 YEARS EST 1922

TILLAMOOK ESTUARIES PARTNERSHIP

ESA

Town Hall Meeting Agenda

- Introductions (TEP, OPRD, ESA)
- Brief Project Overview for Context
- ESA to Present Results of Alternatives Analysis and 2D Hydraulic Modeling Effort
  - Recap of TDM Drainage System Analysis and Potential Improvements
  - Dike Breach Size/Location and Trail Accommodations
  - Setback Dike Alternative Locations and Hydraulic Performance
  - Setback Dike Feasibility, Constructability, and Long-Term Maintenance Considerations
- Questions and Discussion

OPRD Soliciting comments on project webpage (open for 2 weeks):

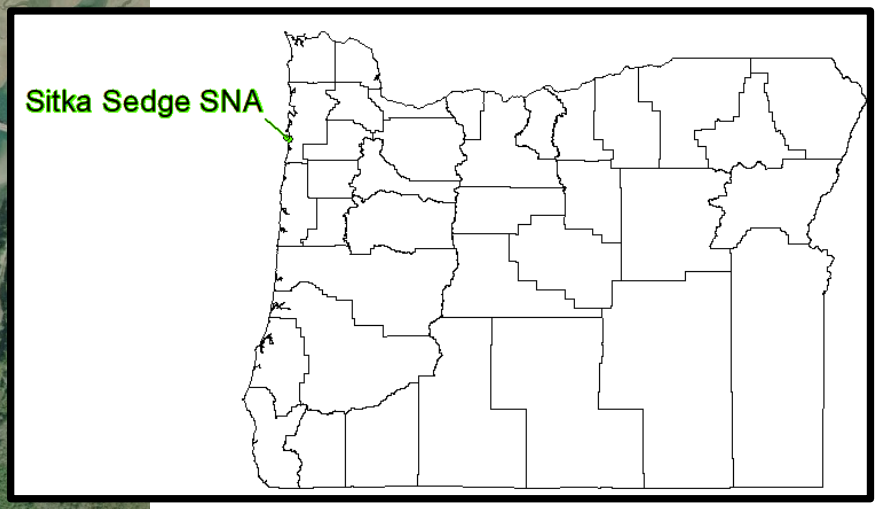
https://www.oregon.gov/oprd/prp/pages/pla-sitka-sedge-hydro.aspx

Or search for “Sitka Sedge Hydrology” to find OPRD project webpage

Key Staff Involved

- **Oregon Parks & Recreation Department (OPRD)**
  - Noel Bacheller – Ecologist/Natural Resource Coordinator
  - Jason Elkins – Cape Lookout Park Manager
  - Chris Parkins – Coastal Region Park Resource Program Manager
  - Justin Parker – North Coast District Manager
  - Trevor Griffith – North Coast Natural Resource Specialist
- **Tillamook Estuaries Partnership (TEP)**
  - Kristi Foster – Executive Director
  - Conrad Ely – Habitat Restoration Project Manager
  - Christer LaBrecque – Habitat Restoration Project Manager
- **Environmental Science Associated (ESA)**
  - Hunter White, PE – Principal Civil and Water Resources Engineer
- **Nestucca Neskowin Sand Lake Watershed Council (NNSLWC)**
  - Dave Shively – Executive Director
- **Tillamook County Public Works (TCPW)**
  - Chris Laity, PE – Director
- **Technical Advisory Team**
  - Comprised of +15 engineering, science, planning, and design professionals including representatives from TEP, OPRD, NNSLWC, USFS, ODF, DLCD, USFW, ODFW, CTWS, and DEQ

Location and Setting



Project Purpose –

- **Current tide gate is failing**
  - Boards on the flap are missing
  - The dike is eroded around the box culvert and wing walls
  - The box culvert itself appears to be compromised
  - The amount of work that would need to be done to repair and stabilize the existing gate would trigger fish passage regulations that would not allow the use of the current old-model structure

- **Current tide gate is undersized**
  - The opening is too small to efficiently drain - backs up water and acts like an hourglass
  - "firehose" water velocity

- **Current tide gate restricts fish passage to Reneke, Beltz, and No-name Creeks as well as to the marsh behind the dike**

- **The current dike is only barely above current king tides and will soon be at risk of overtopping from sea-level rise**

Conceptual Alternatives Studied and Compared in 2019 Phase

No action/ existing condition – reference condition

Dike breach – 40' bottom width, 80' top width, or larger

Replace existing tide gate with modern muted tidal regulator– two 10' wide by 8ft' tall gates with 7 or 8' closure valve… Reneke inside or outside… location…

Setback dike- construct new dike closer to TDM that includes a modern tide gate, then breach the old dike… tide gate style/sizing/closure settings… location…

Brief Summary of the Pros and Cons of the Alternatives

1. No-action (leaving the dike and tide gate exactly how they are)

- Pros: Existing dike provides limited reduction of peak tide levels
- Cons: Least benefit and highest risk; dike will fail; existing dike is undersized and not to long term sustainable standards for sea level rise

2. Dike breach

- Pro: Highest estuary restoration value and fish passage improvement
- Cons: more frequent tidal effects to private properties than the other action-alternatives; Potentially lower protection from storm surge with sea level rise; Local public concern; Increased frequency of flooding on Sand Lake Road; Recreational access impacts.

3. Modern tide gate in existing dike

- Pros: limits tide on private properties; lets stormwater out efficiently, allows fish passage
- Cons:

  7’ tide gate closure: Water stays within tidal channels… limited value for fish habitat and water quality; worst option for juvenile salmon rearing due to water staying within tidal channels; existing dike is undersized and not to long term sustainable standards for sea level rise

  8’ tide gate closure: relatively low estuarine restoration and salmon benefits relative to breach and setback dike; existing dike is undersized and not to long term sustainable standards for sea level rise

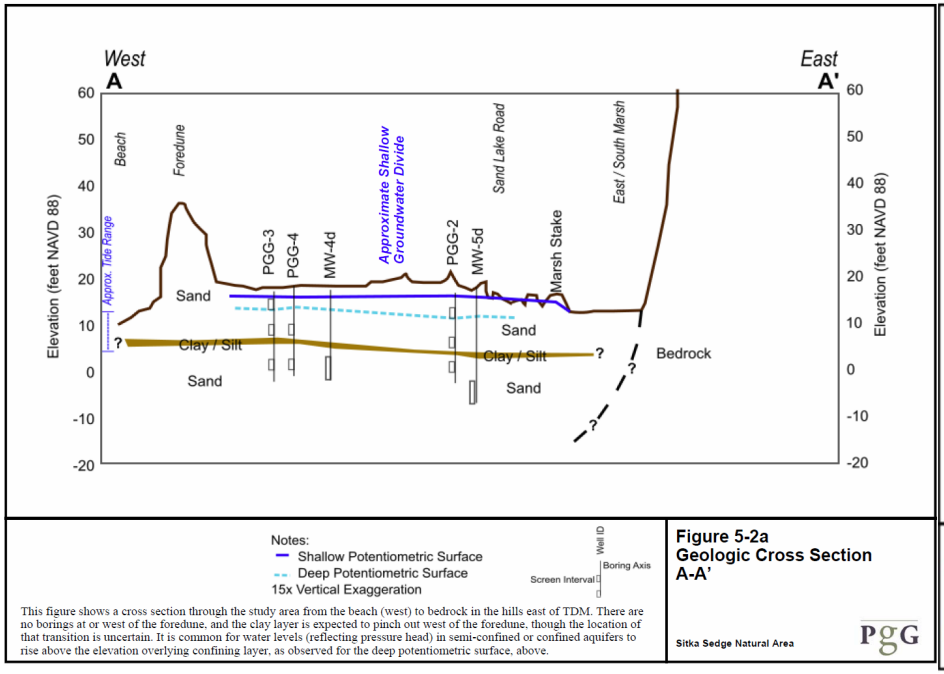
  Significant repairs would be needed to bring dike up to modern flood protection standards

4. Setback dike

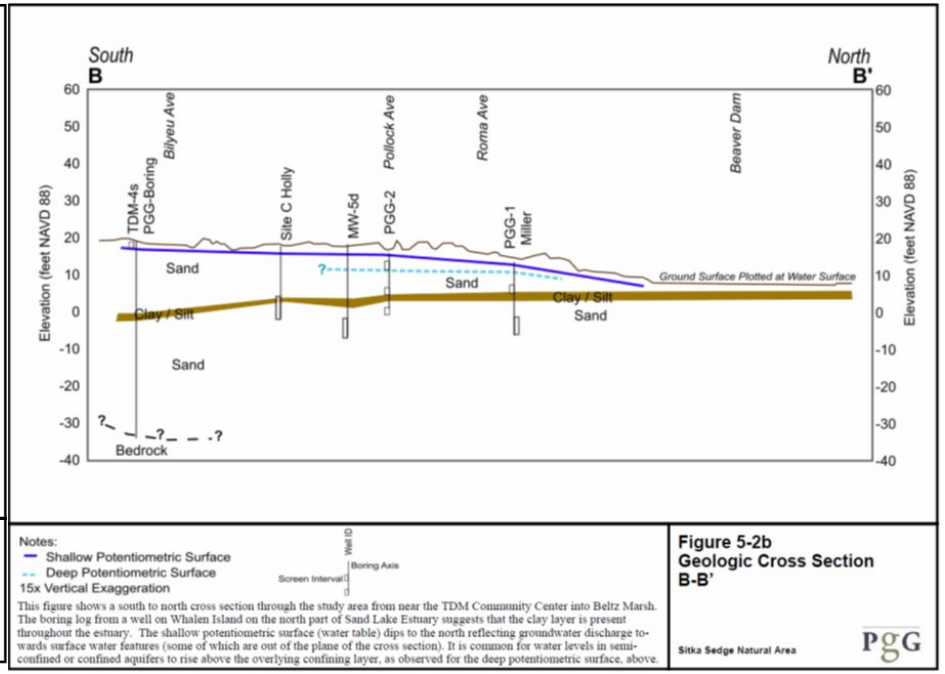
- Pros: Fish passage and rearing habitat benefits second only to those of the breach scenario. Higher protection to TDM than the existing dike. Resilient to sea level rise. Stormwater drainage from TDM comparable to Modern Tide Gate Scenarios. Requires much smaller tide gate.
- Cons: Would be constructed through high value wetland habitat. Includes an expensive mechanical tide gate structure. Recreation impacts. Most expensive option (in terms of construction costs only). Feasibility/Constructability/Maintenance considerations

Findings: Ground Water

- 2 aquifers separated by a clay layer
- The surface aquifer is the primary interest due to its effect on septic systems and stormwater issues



East-west cross section



North-south cross section

Findings: Ground Water

- The groundwater interacts with surface water, but slowly.

Effects of tidal water in Beltz Marsh on groundwater in TDM

<u>During average tides</u>

- BREACH: a breach might result in up to ¼ inch increase in water table elevation relative to the existing condition
- MODERN TIDE GATE OR SETBACK DIKE: likely a small decrease in water table elevation relative to the existing condition

<u>During a major storm and tide event</u>

- BREACH: a breach might result in up to a 2-inch decrease in water table elevation relative to the existing tide gate due to the existing tide gate's effect of backing up water for days
- MODERN TIDE GATE OR SETBACK DIKE: A modern tide gate or setback dike with a modern tide gate would similarly result in a decreased water table elevation relative to the existing tide gate

Selection of the Setback Dike as the Alternative to Pursue

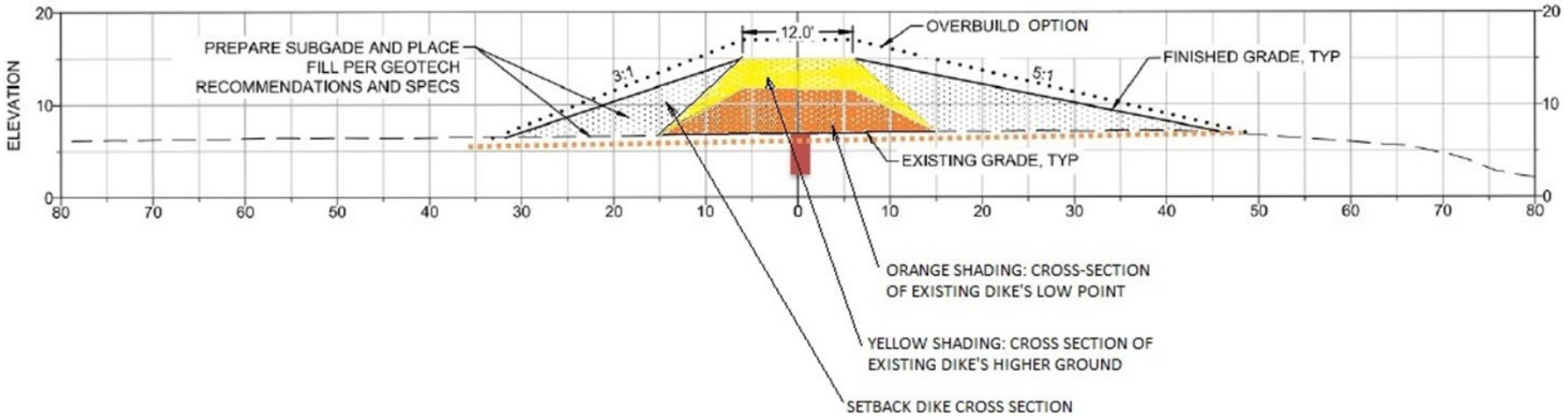
- In March 2020 - after the assessments and comparative ranking of alternatives by the Technical Team, public hearing with the Tillamook County Commission, and review by the Oregon Parks and Recreation Commission – OPRD leadership selected the setback dike alternative as the option to pursue for more detailed study and design.
- OPRD released a decision memorandum and a FAQ shortly thereafter
- OPRD received a letter of support for the setback dike alternative from the TDM neighborhood association in June 2020 to be used for the purposes of pursuing grants to continue the process

1. No-action

2. Dike breach

3. Modern tide gate in existing dike

4. New setback dike



Sitka Sedge Tidal Wetland Restoration Project - Phase Work Plan

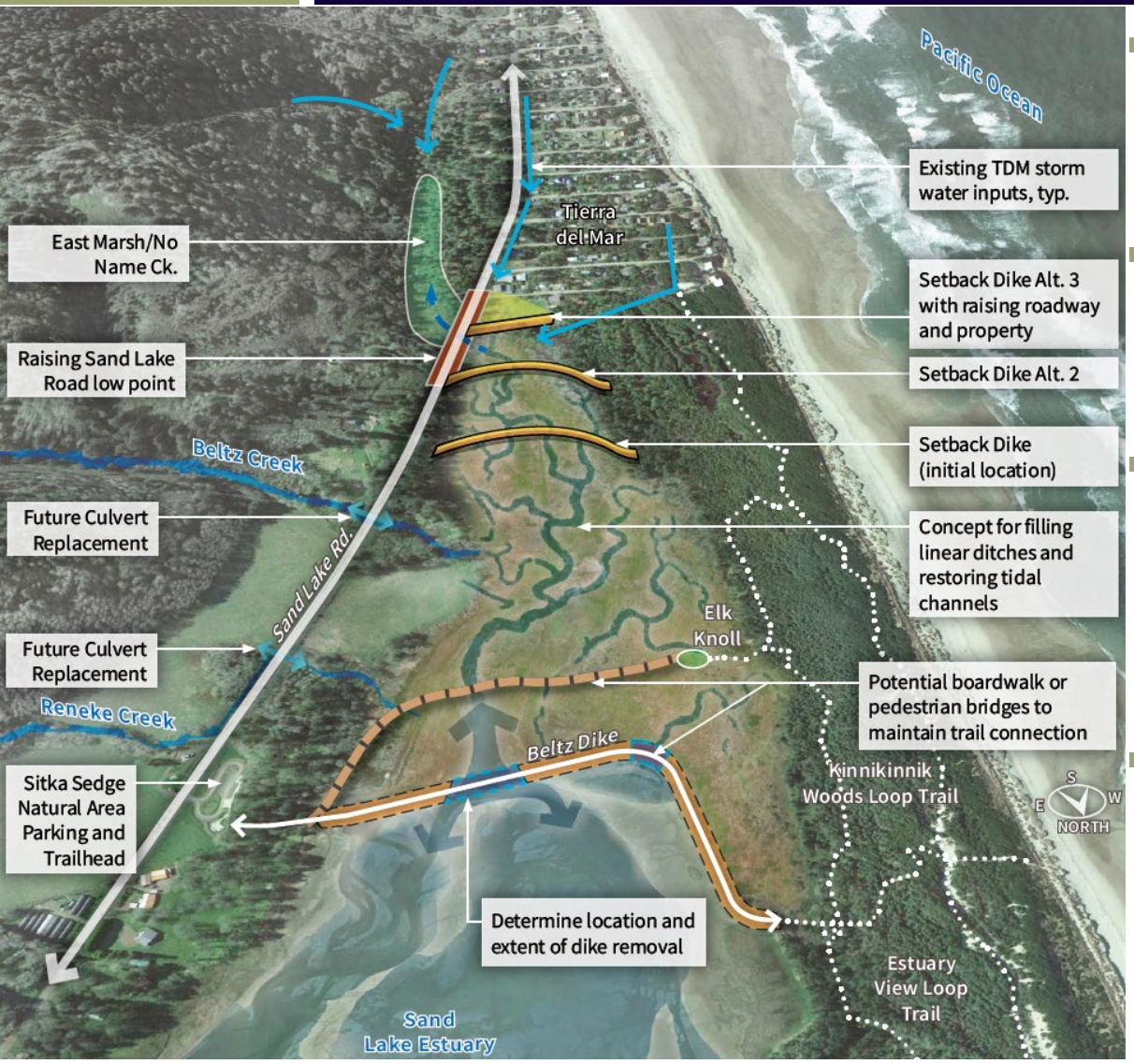
- **Goal of this project phase:** Refine elements of preferred alternative through 2D modeling and detailed alternatives analysis

- 2-D Hydrodynamic Modeling using HEC-RAS
  - Additional topographic and bathymetric survey
  - Additional water level monitoring
  - Evaluate alternative configurations under range of storms/tidal scenarios

- Refine Key Alternative Elements (Dike Breach, Setback Dike, Interior habitat enhancements)

- Assess TDM stormwater drainage system, inputs to Beltz Marsh, and potential improvements

SSTW – Conceptual Alternatives



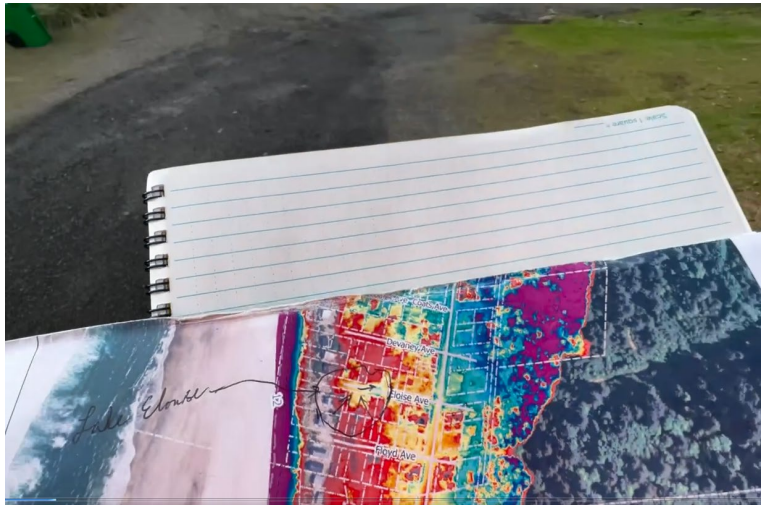
- Dike Breach Location and Dimensions
- Setback Dike Configuration/Location
- Interior Enhancements
  - Tidal channels, ditch filling, vegetation/habitat enhancements
- Sand Lake Rd Culvert Replacements at Reneke, Beltz, and No Name Creeks (separate project)

Tierra Del Mar Stormwater/Drainage System Assessment

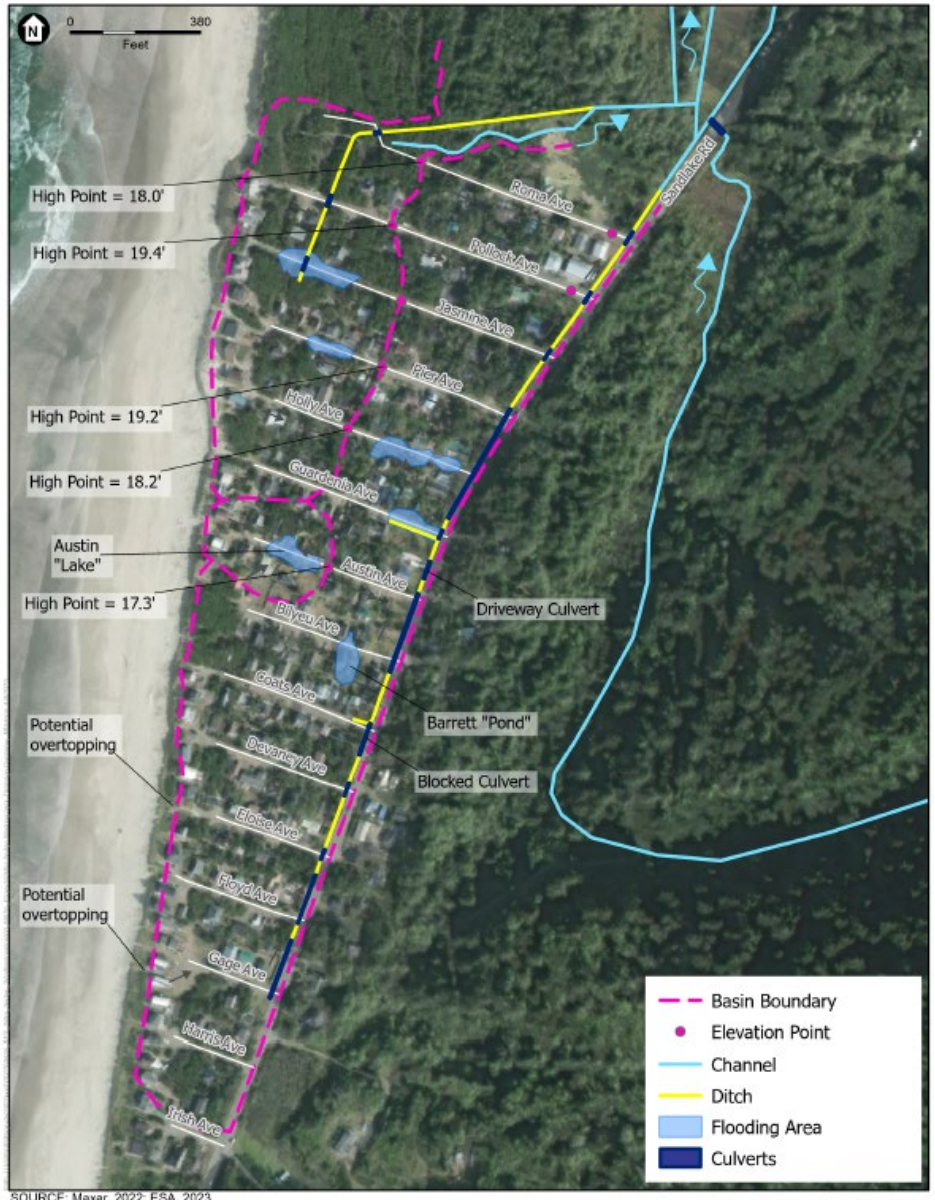
- At a minimum to understand drainage patterns, hydrologic inputs for 2D HEC-RAS Model
- Also identify system deficiencies and potential improvements that could be implemented as part of this project or future County/Community projects

Tierra Del Mar Stormwater/Drainage System Assessment

- OPRD received reports and photo data sets from residents from 2015-2017
- October 2022 to January 2023 we received additional input from TDM residents on known flooding or drainage issues
  - Areas that hold water/ponding
  - Blocked drainage pipes/ditches
  - Damage or functional deficiencies, septic system
  - Desired drainage/stormwater management improvements
- Drainage Observations in October, December, January
- January 2023 - ESA performed drainage system assessment and met with several TDM residents to discuss specific locations of concern



Tierra Del Mar Drainage System

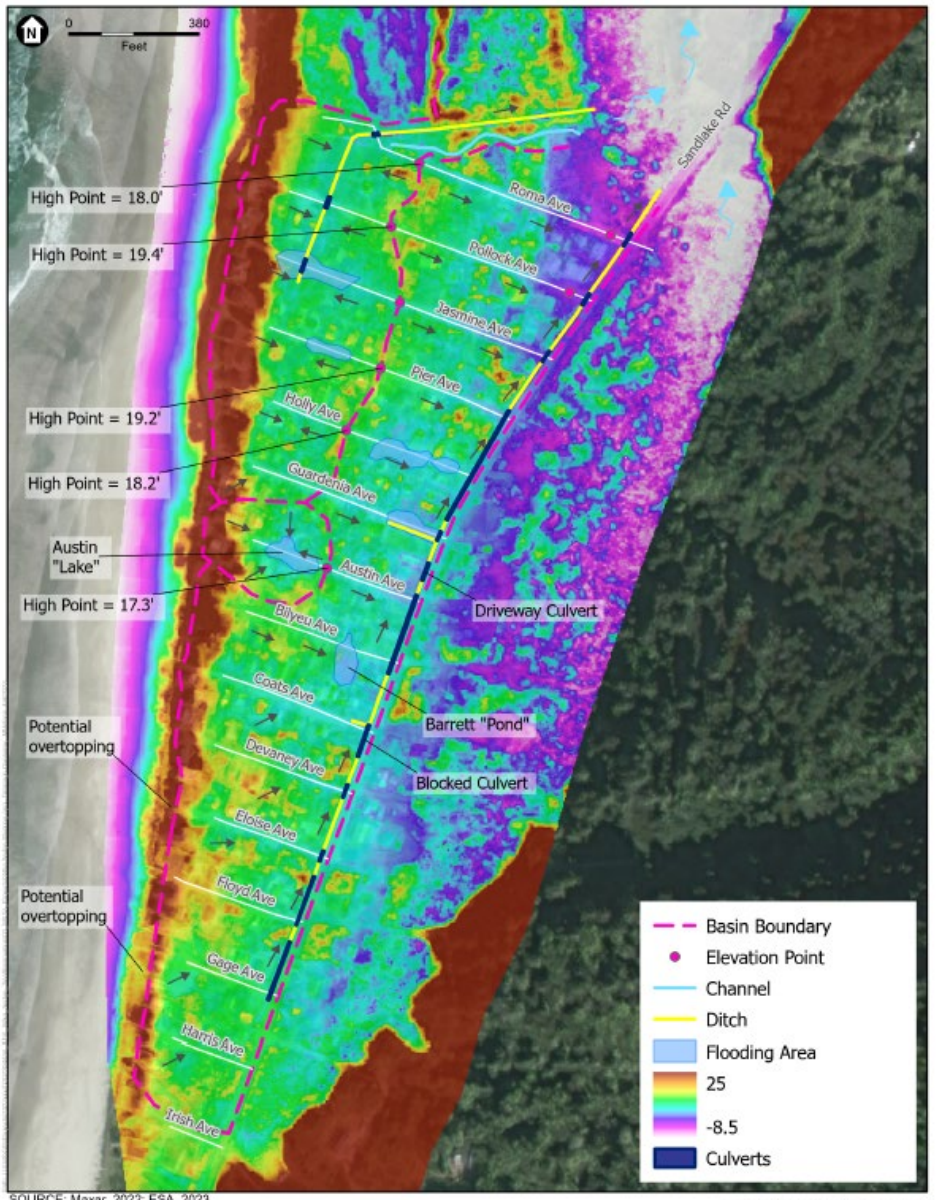


SOURCE: Maxar, 2022; ESA, 2023

TEP Sitka Sedge Tidal Wetland

ESA

Figure 1
Tierra Del Mar Drainage Overview



SOURCE: Maxar, 2022; ESA, 2023

TEP Sitka Sedge Tidal Wetland

ESA

Figure 1
Tierra Del Mar Drainage Overview

Surface-Water Flooding – Characterized as Depressional Ponding and Poor Drainage Efficiency

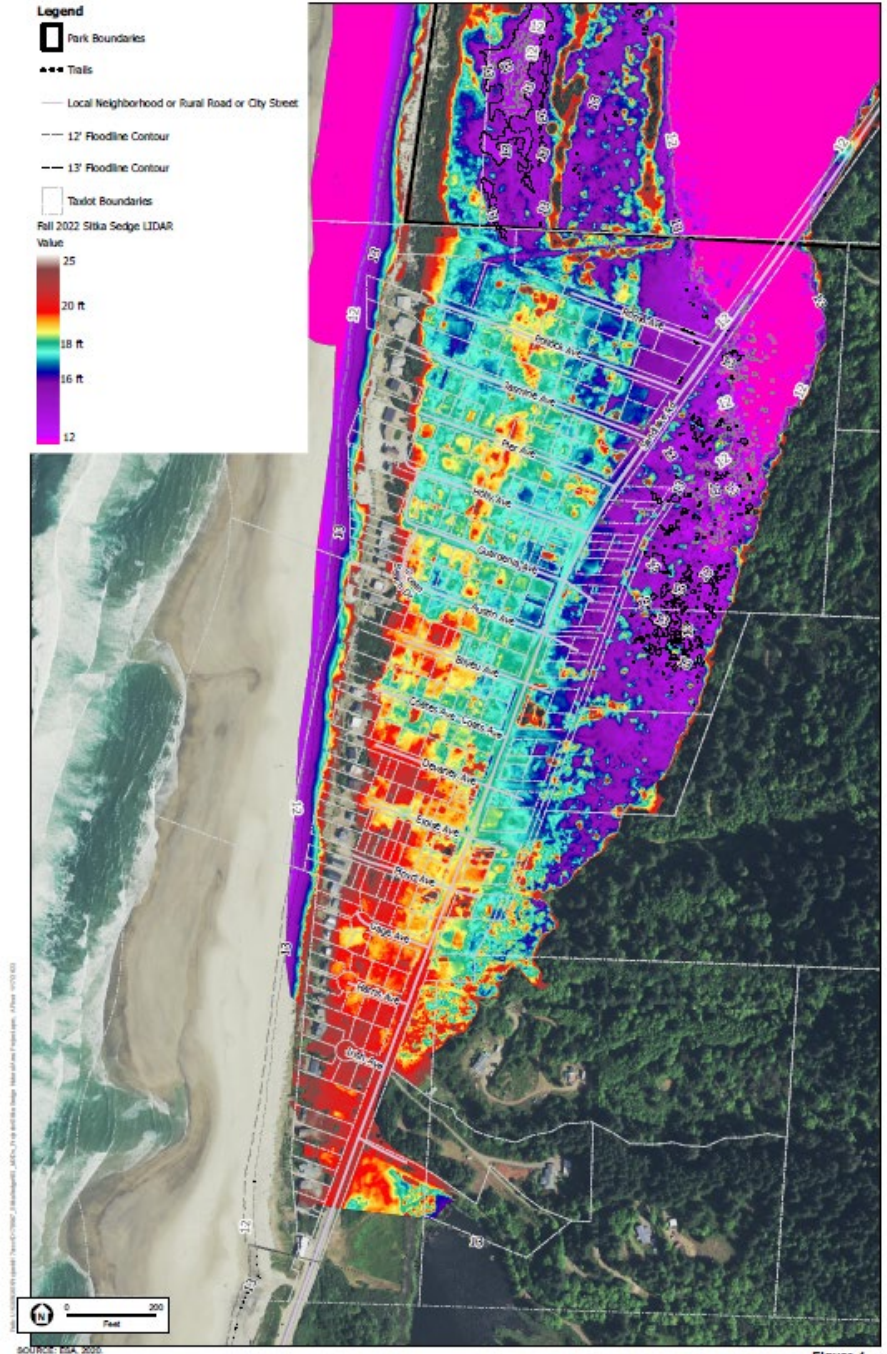


Figure 4
Sitka Sedge Natural Area Project
LIDAR Elevation Mapping and Taxlot Boundaries For Tierra Del Mar

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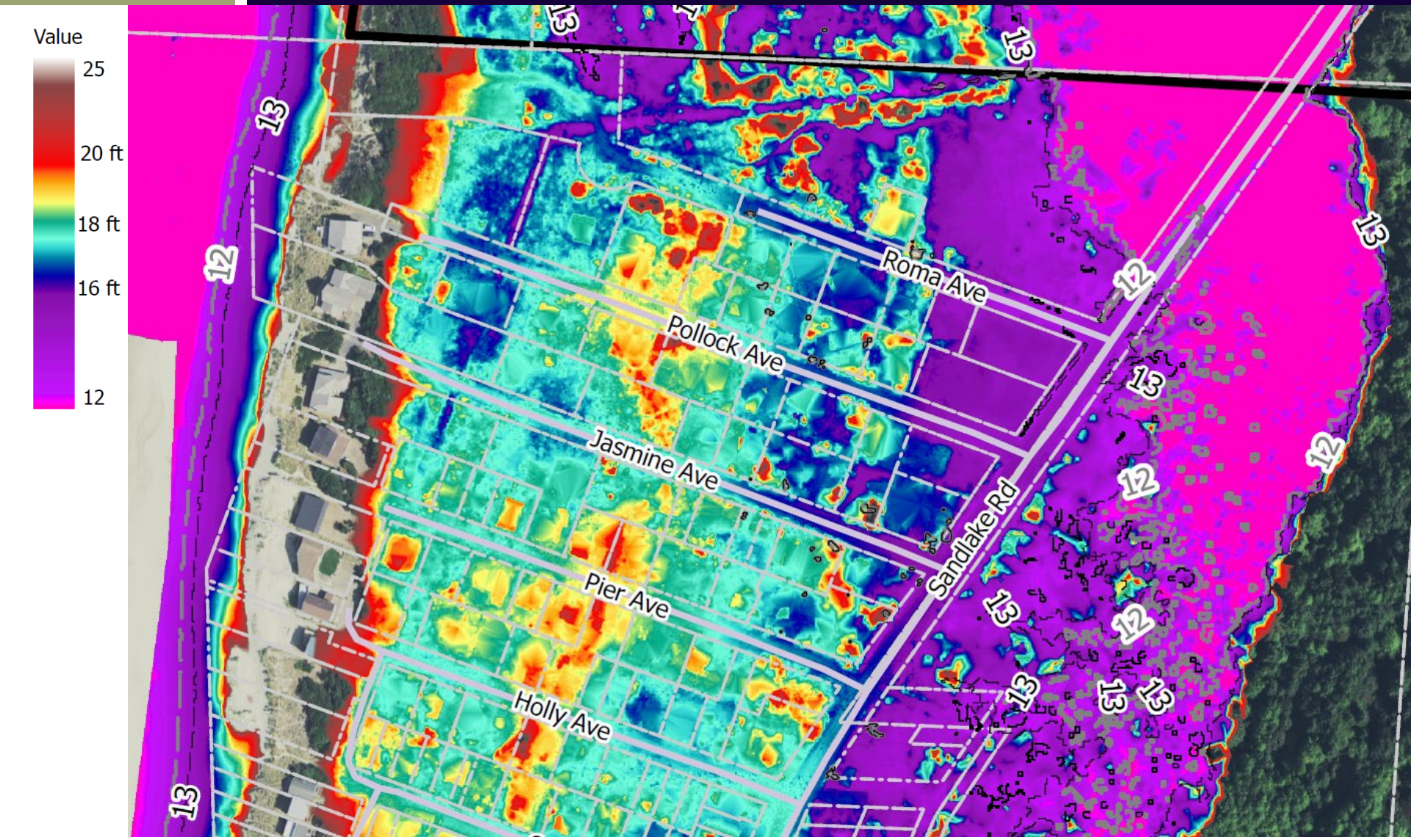
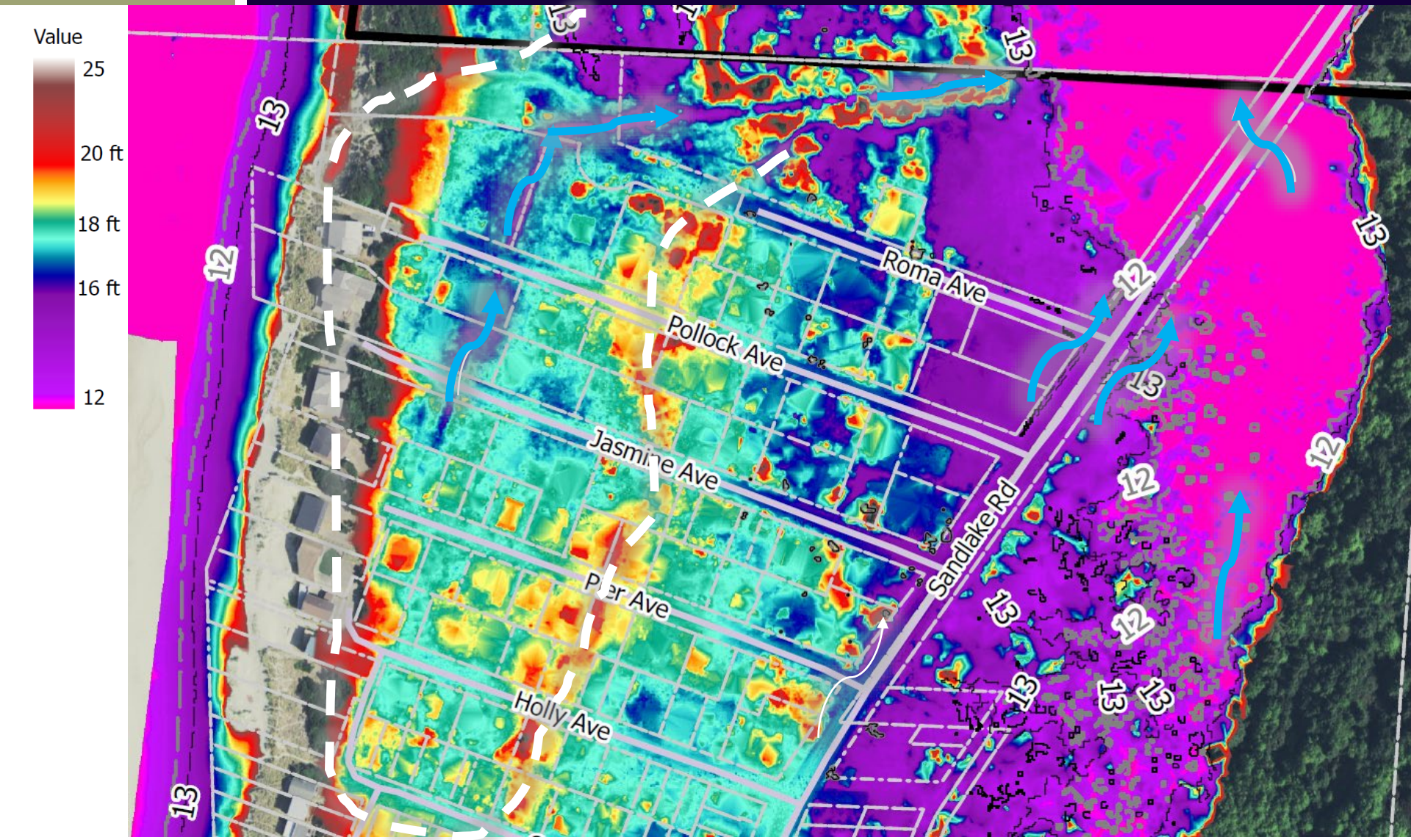
Recorded Storm Events	48-Hr Rainfall (inches)
Dec. 18, 2015	4.1
Nov. 24, 2016	3.3
Dec. 20, 2016	2.3
Feb. 9, 2017	3.1
Feb. 16-19, 2017	2.4 + 1.6
Mar. 7, 2017	1.3
Mar. 15, 2017	2.9

Tierra Del Mar Drainage System Assessment



Tierra Del Mar Drainage System Assessment



Roma Ave Culvert Inlet and Outlet

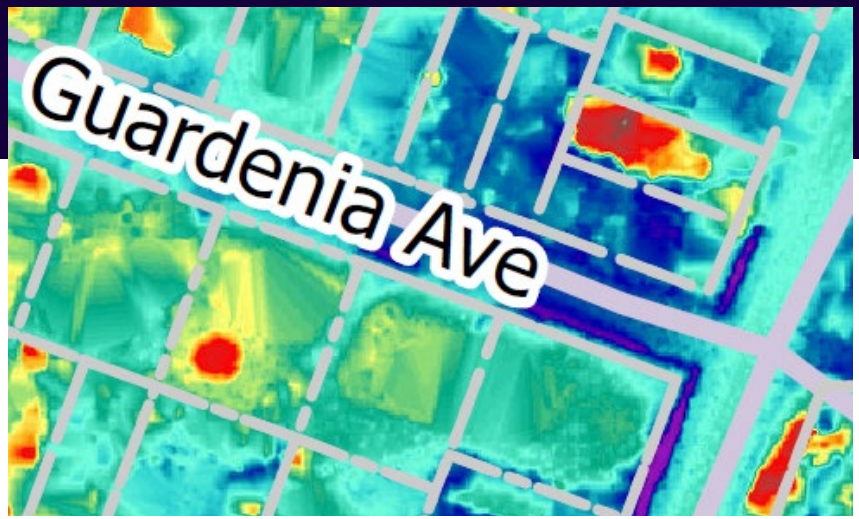
Roma Ave

Surface-Water Flooding Events

TDM Drainage System Assessment
Jasmine Ave SLR culvert blockage

Tierra Del Mar Drainage System Assessment

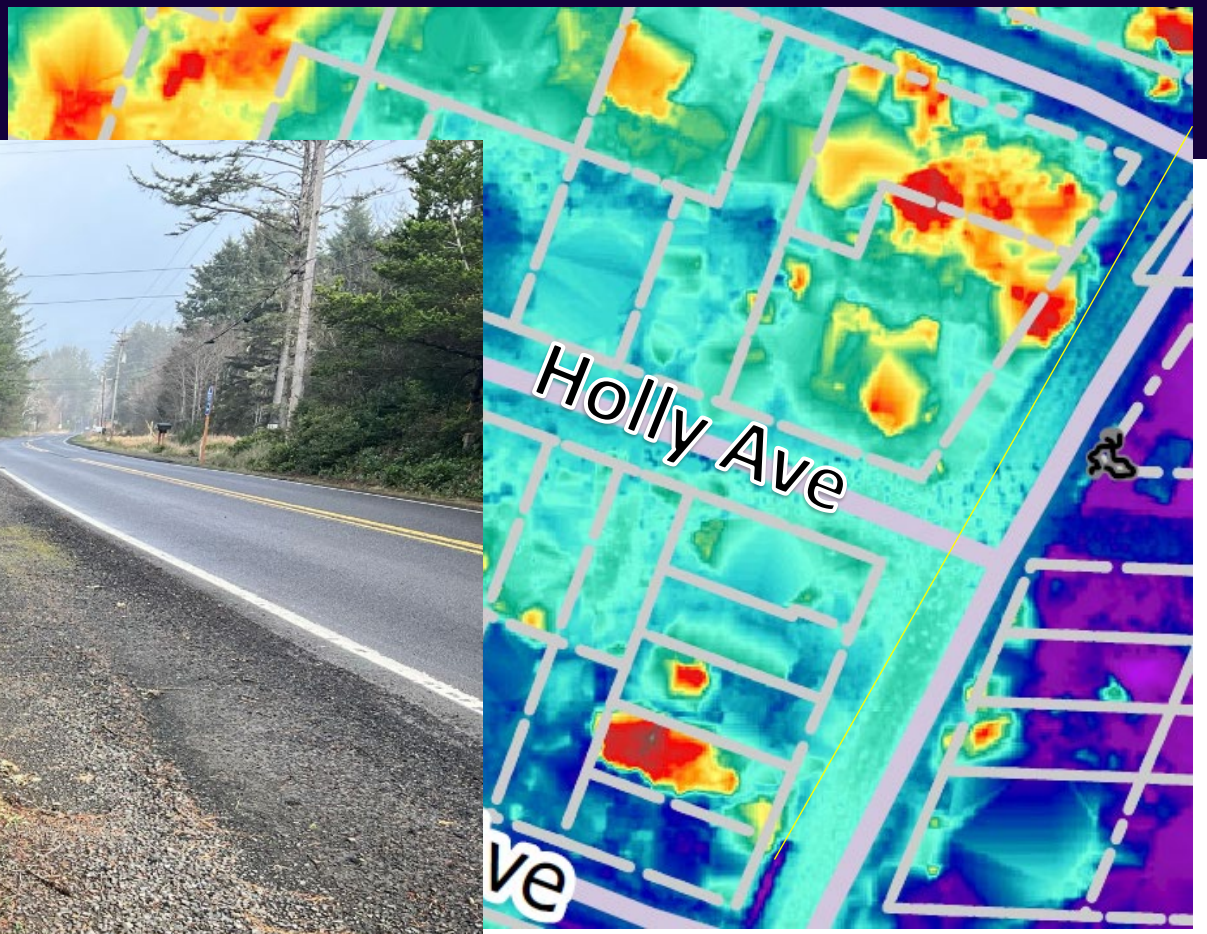
TDM - Drainage System Assessment



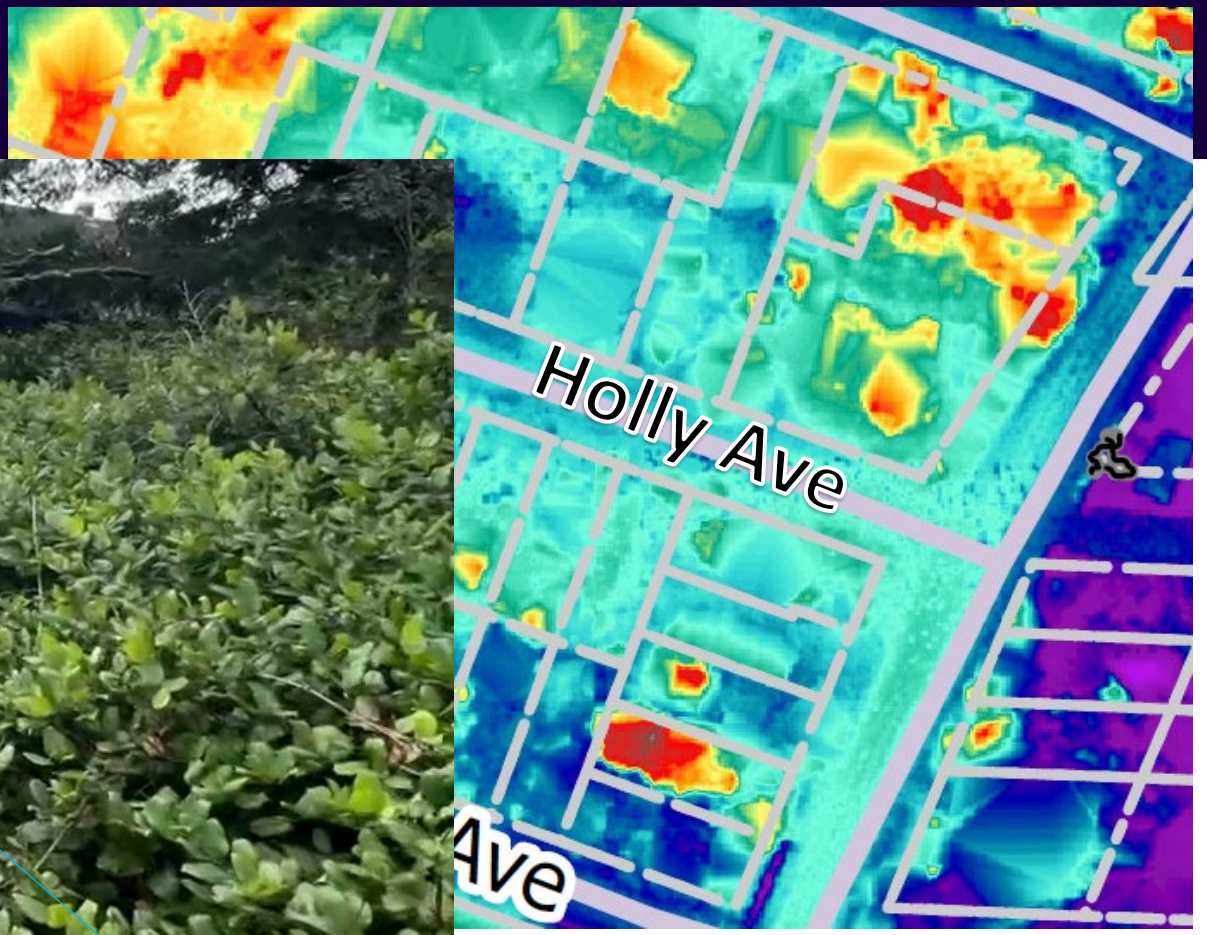
Guardenia Ave/Sand Lake Rd

- Example of side street ditch/swale connections to SLR Ditch
- Raised driveway over culvert

TDM - Drainage System Assessment



TDM - Drainage System Assessment



Long culvert prone to blockage

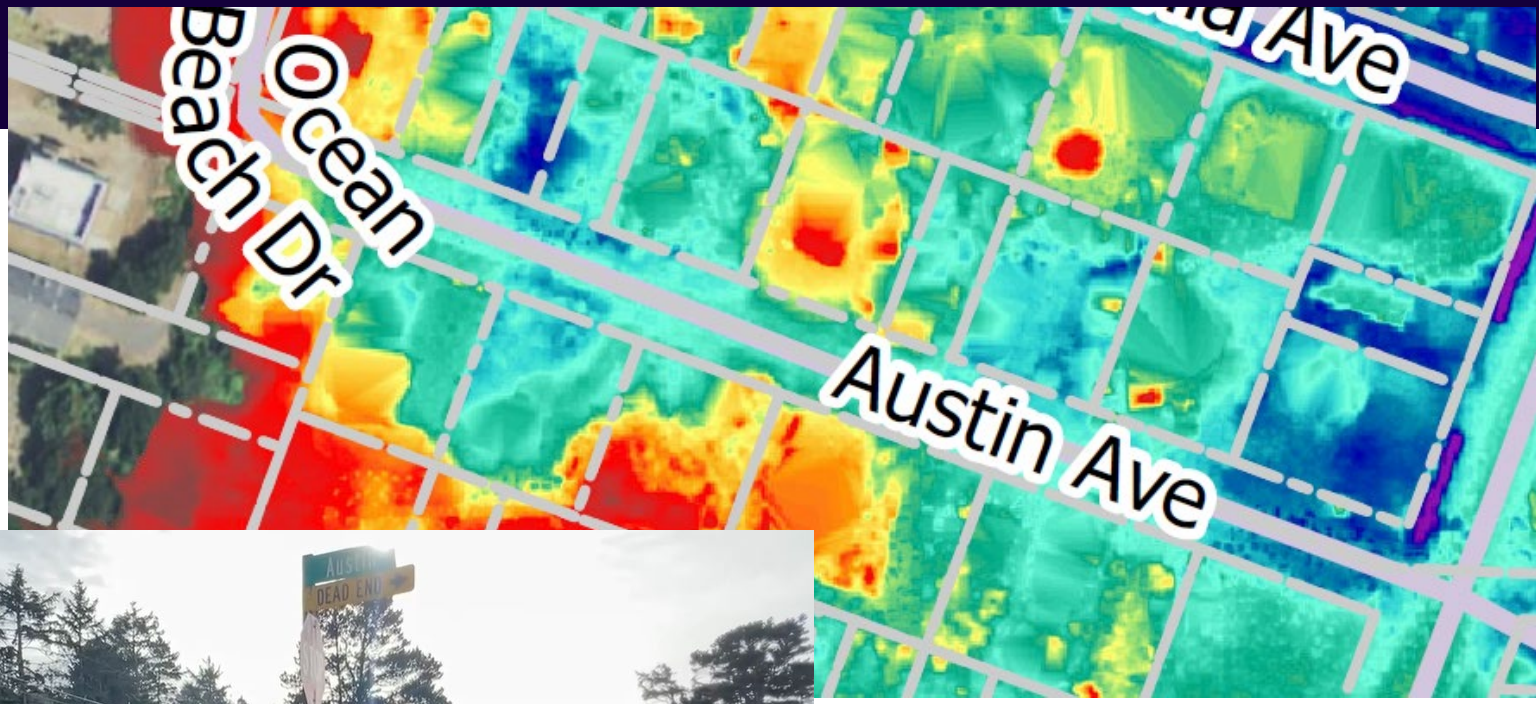
Surface-Water Flooding Events

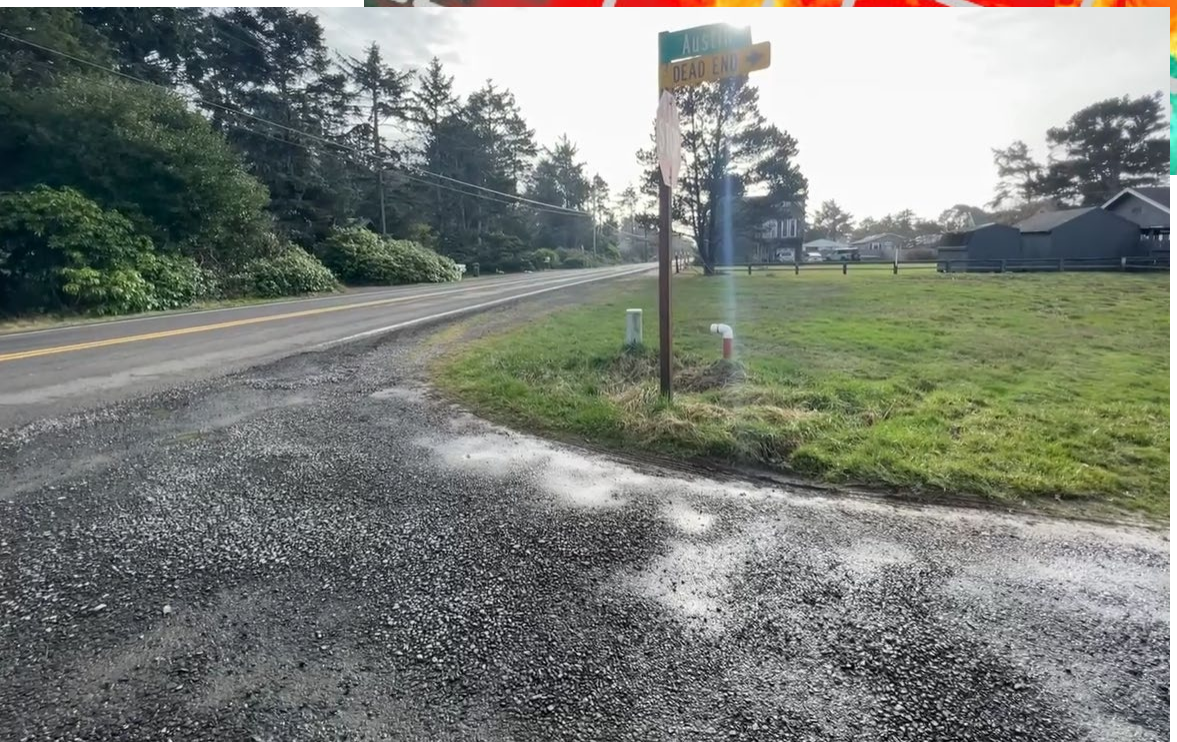
Austin Ave - “Lake Austin”

Surface-Water Flooding Events

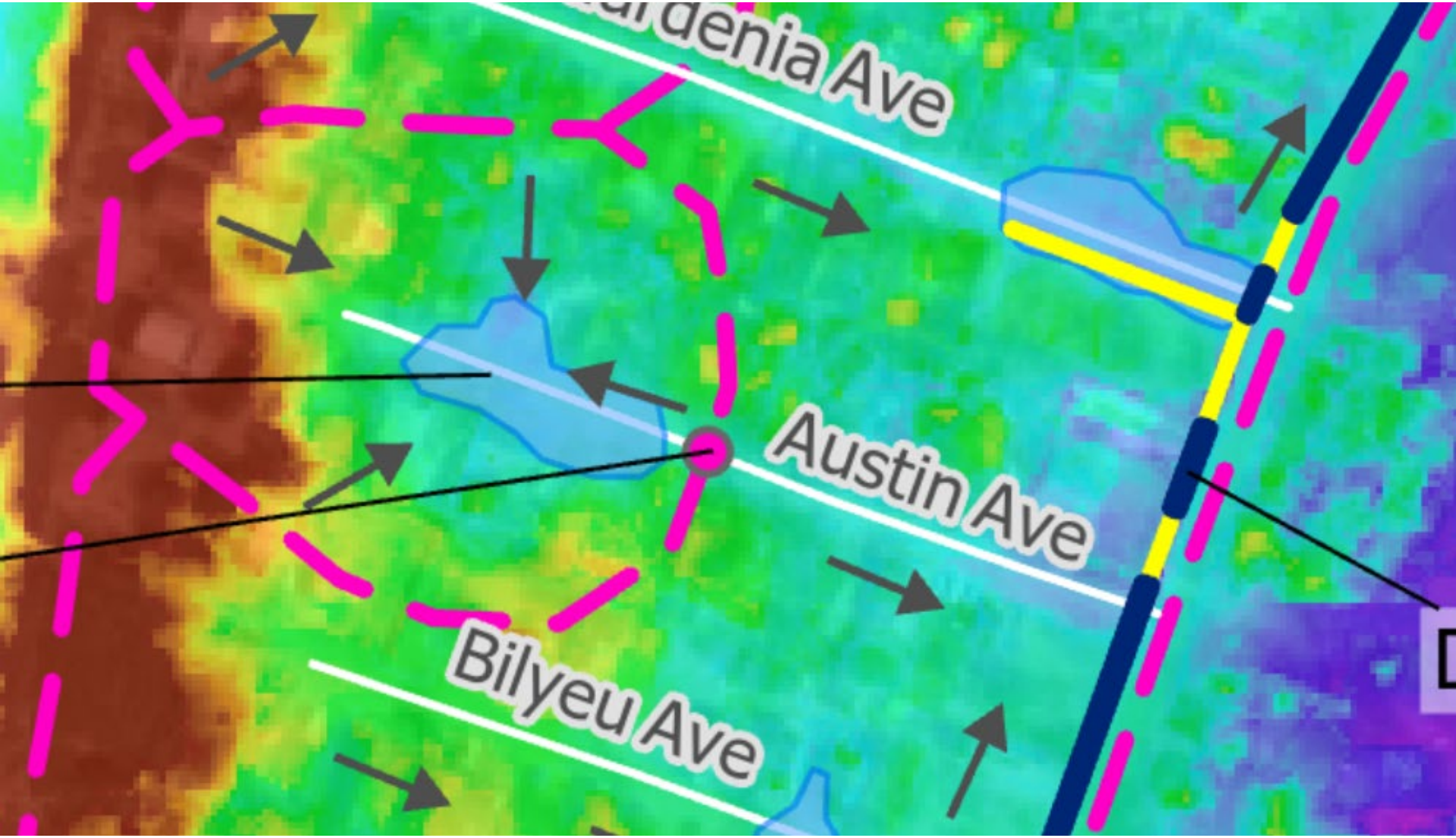
Austin Ave - “Lake Austin”

TDM - Drainage System Assessment

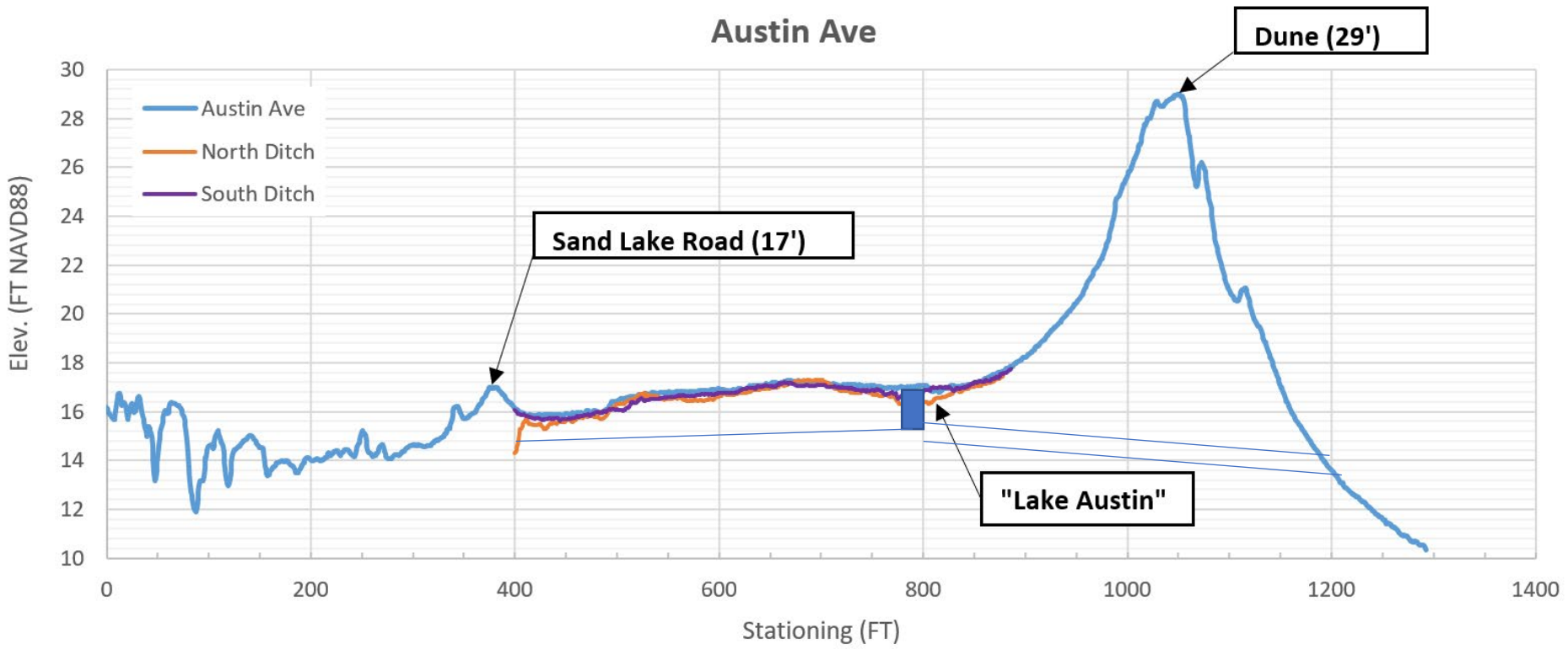




Surface-Water Flooding Events



Tierra Del Mar Drainage System Assessment – Side Street Centerline Profiles



Relief drainage outfall to beach - concept

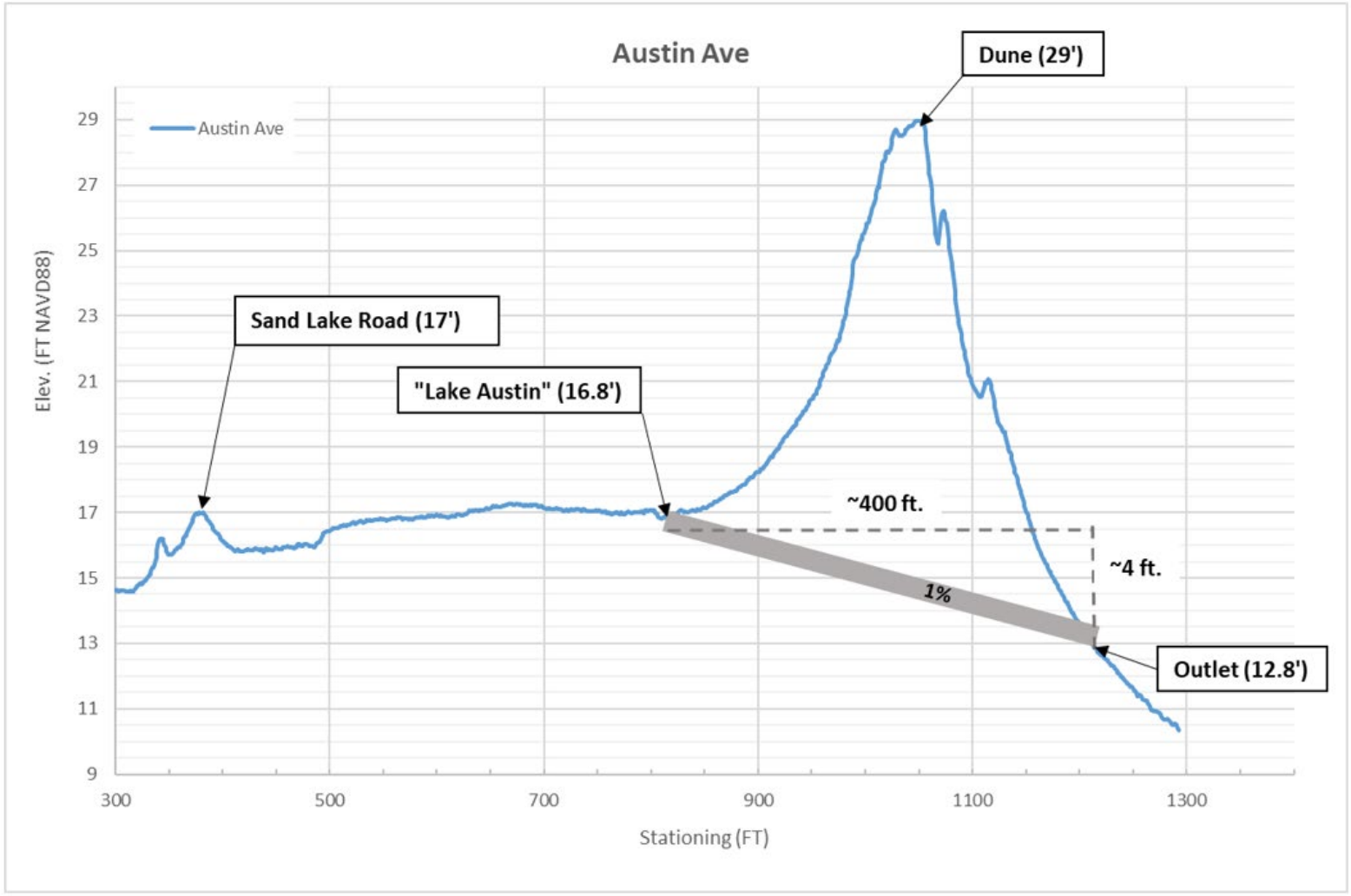
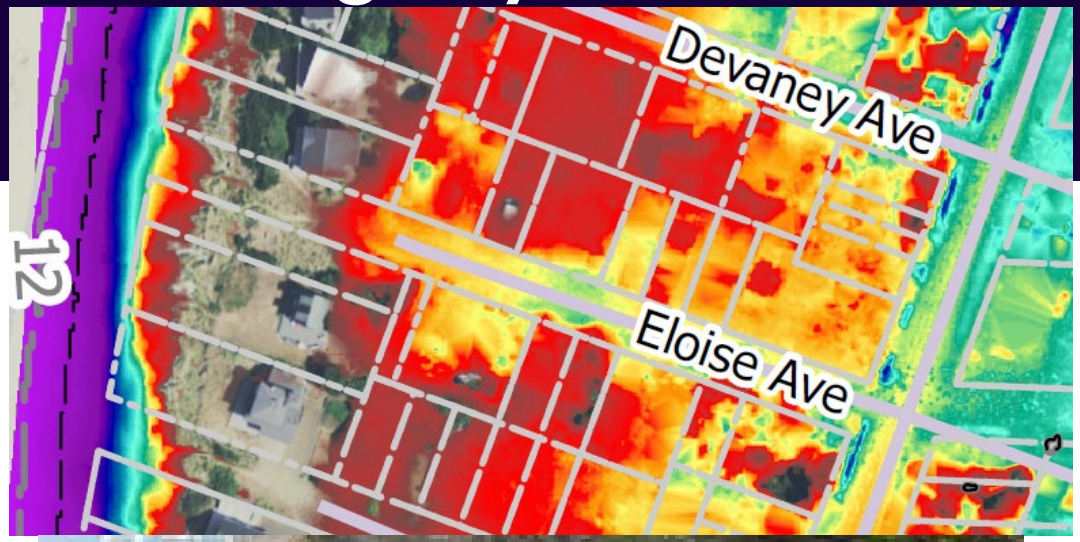


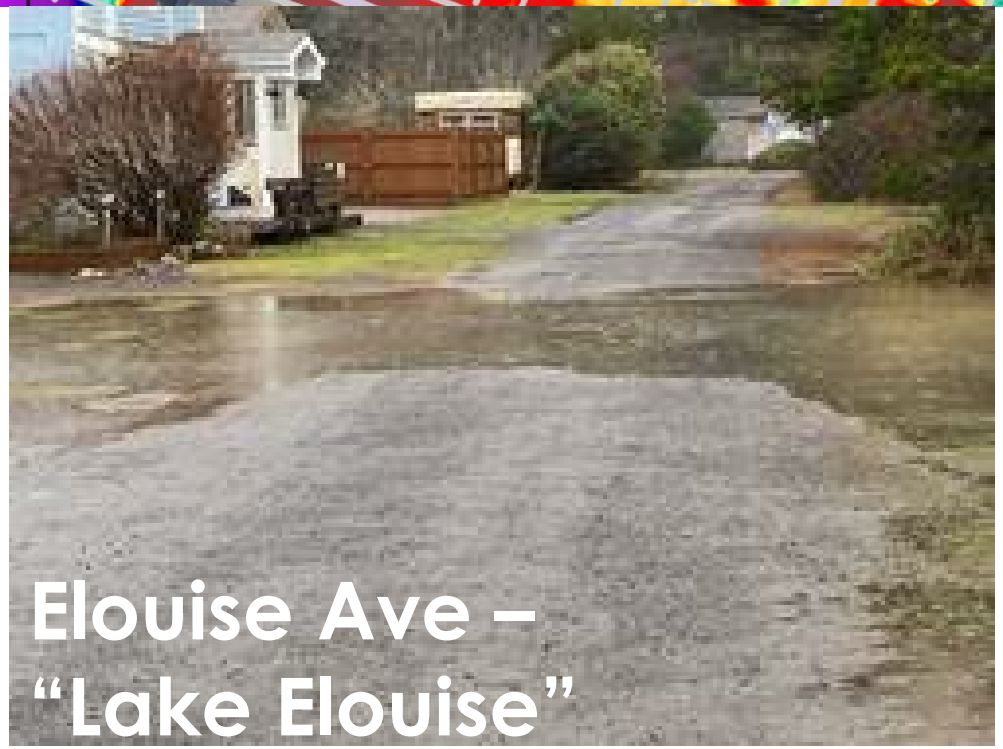
Figure 7. Proposed Beach Outfall Concept

TDM Drainage System Assessment
Coats Ave – example of recent ditch improvement

TDM Drainage System Assessment
Coats Ave – example of recent ditch improvement

Tierra Del Mar Drainage System Assessment





Elouise Ave –
“Lake Elouise”

Drainage Improvement Constraints – Competing goals (conveyance vs. water quality treatment)

Septic System – elevated drain field/sand filter

Septic System – Advanced Treatment System

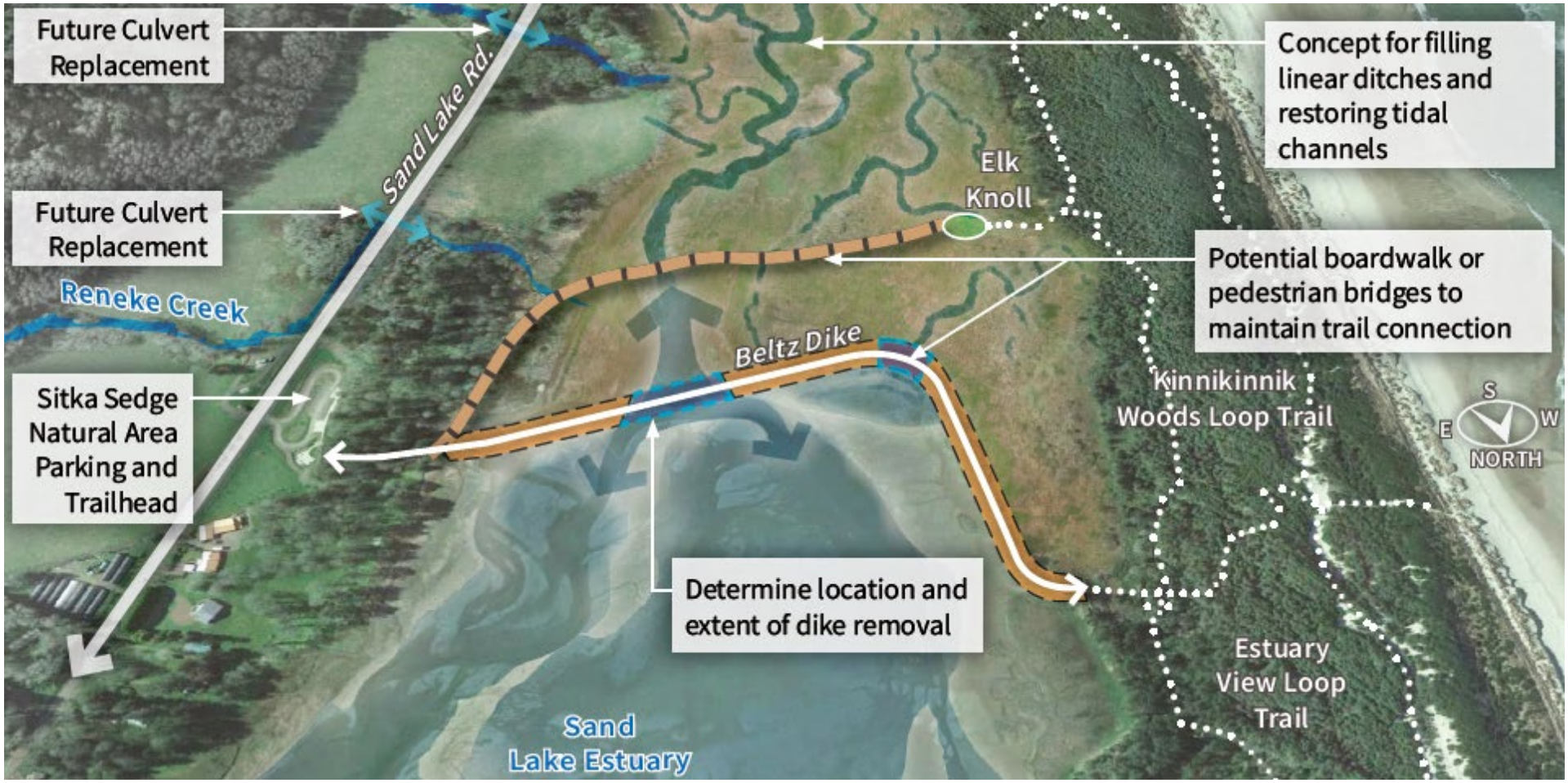
Potential TDM Drainage System Improvements – Sandlake Road Ditch

- Frequently maintain culverts and ditches to clear blockages
- Upsize culverts along Sandlake Rd ditch for increased drainage capacity (especially at Roma Ave)
- Excavate swales/ditches along side streets to drain to Sandlake Rd ditch (similar to recent improvements at Guardenia/Coats)
  - Range from subtle grading/hand excavation to more extensive/deeper ditching
  - Requires driveway culverts/raising driveways in some locations
  - Consider/manage conflicts with existing utilities (water, telecom, OH poles) – adjust/deepen/protect lines
  - Catch basins/Inlets and storm pipes to collect and convey water from low points
  - Perforated pipe underdrain/'French Drains' option to intercept groundwater
- Daylight sections of Sandlake Rd ditch where long culverts prevent side street drainage (Holly Ave). Longer culverts also susceptible to plugging

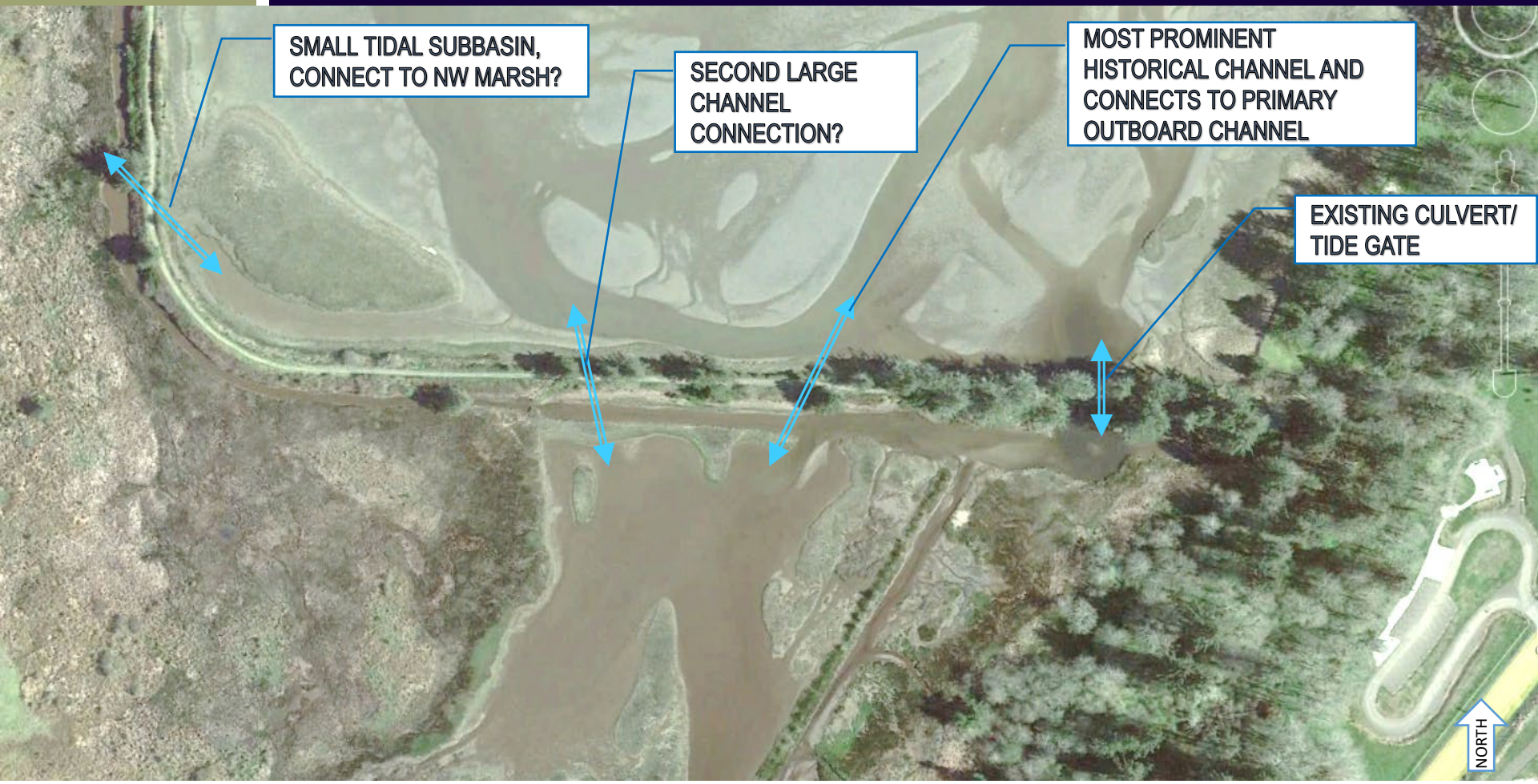
Potential TDM Drainage System Improvements – NW Ditch/Subbasin

- Replace/Upsize Culverts at Pollock and Jasmine Ave/NW Ditch to increase conveyance (also deteriorating)
- Enlarge ditch/swale in select locations, remove fill and blockages in specific locations
- Consider catch basins and new outfall pipes to beach to drain areas that are not feasible to connect to Sandlake Rd Ditch (such as Austin Ave)
- Enhance flow paths that have been lost due to infill developments, potentially with subsurface drain system

Dike Breach Locations and Dimensions - Maintain Beltz Dike Trail Connection

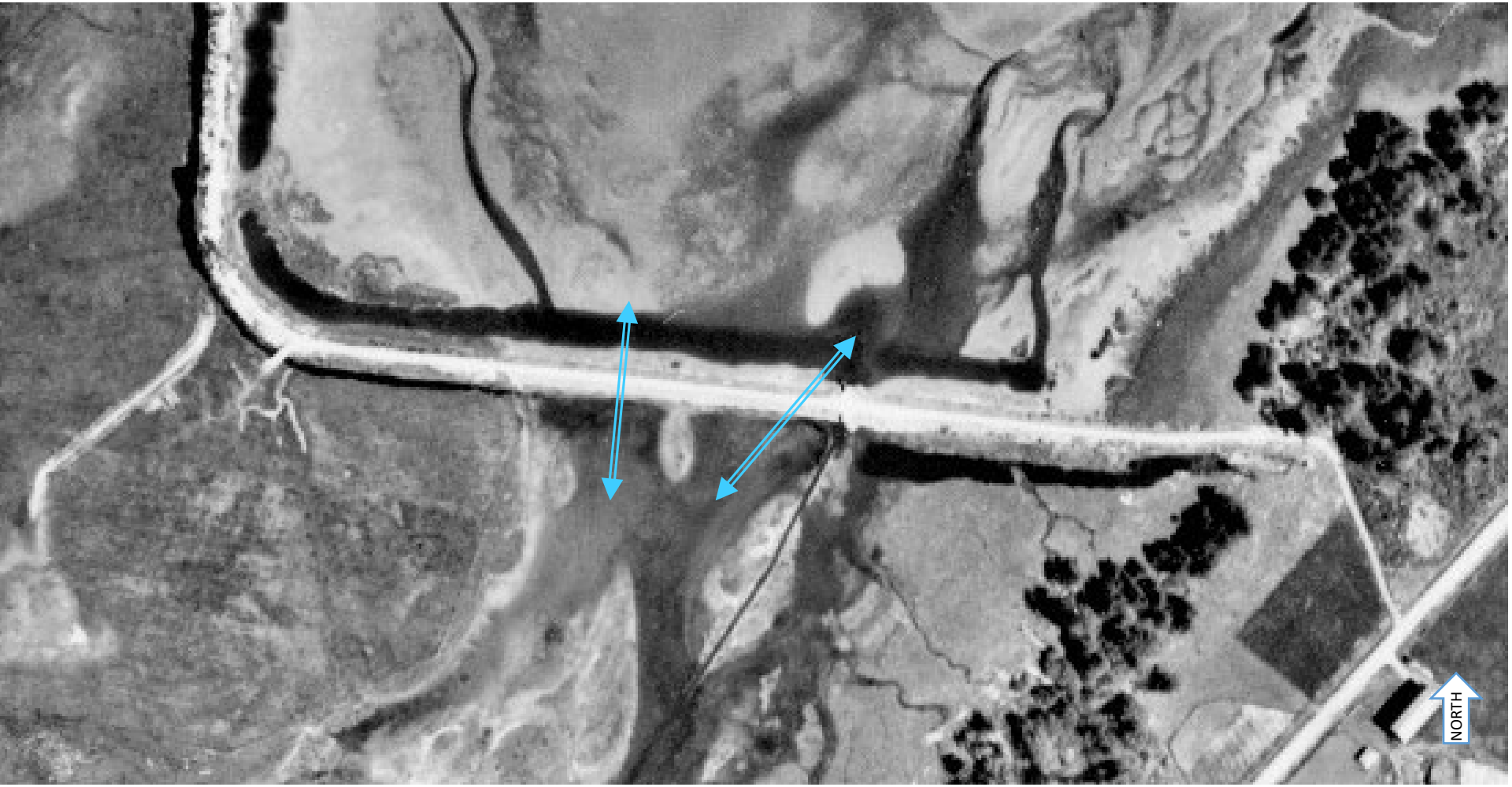


Determining Dike Breach Location(s) and Dimensions



Historical aerial photo - 1939

Historical aerial photo - 1939

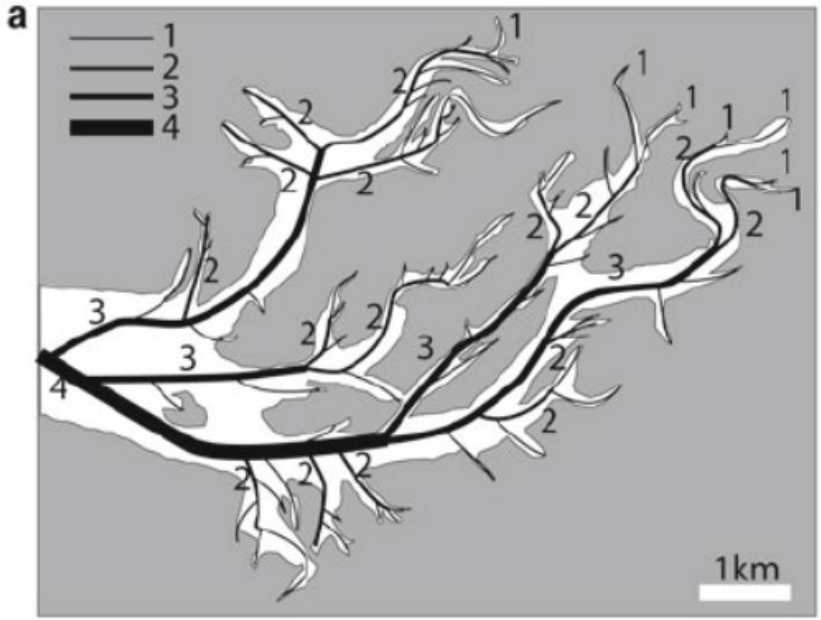


Consider Two or More Breaches aligned with prominent historical channels?

- Would two breaches be beneficial?
  - If allowed for less expensive bridges
- Would two breaches be risky/less predictable?
  - Two equally sized breaches?
  - **One could dominate as preferential primary channel and adjust/scour**
- Cost of additional breach/bridge if sized to allow either to dominate

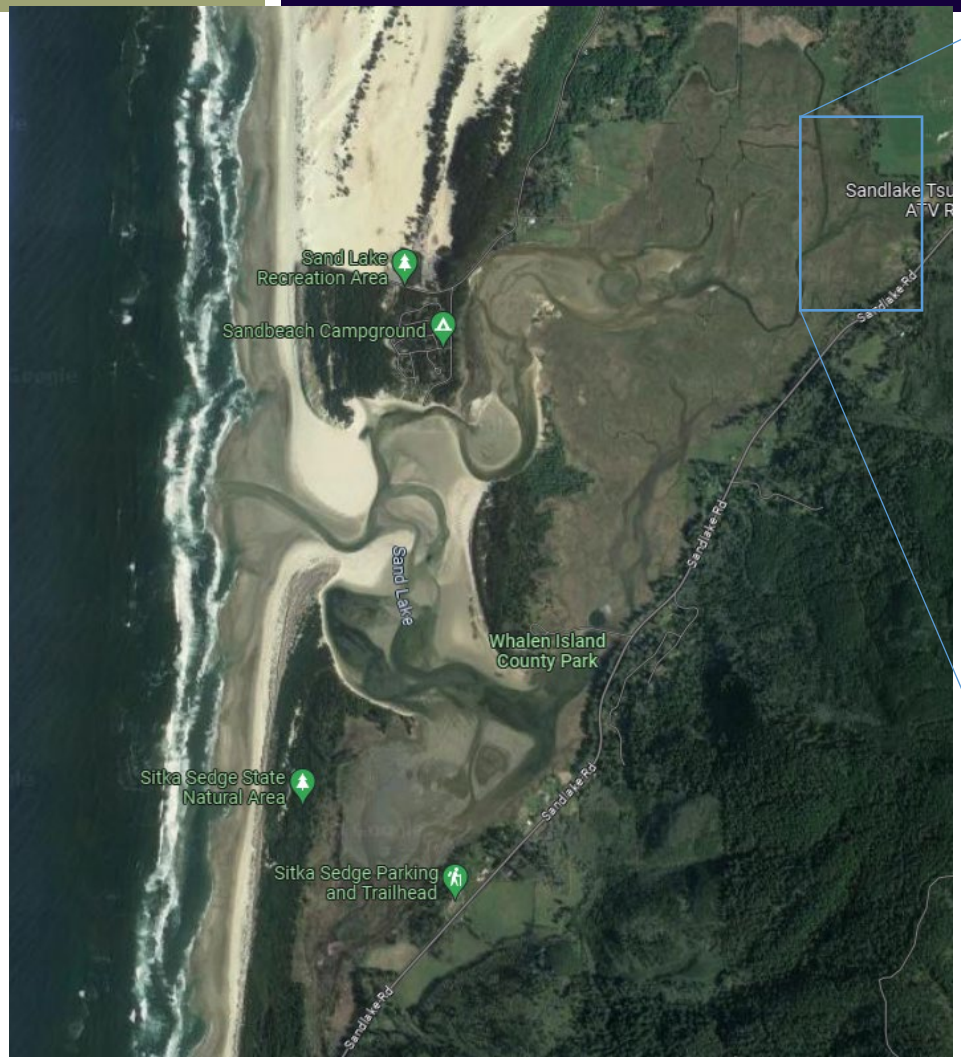
Justification for focusing on a single breach

- Many natural tidal channel networks exhibit a fractal dendritic channel planform (tree trunk with branches)



Example network in NE end of Sand Lake

Justification for focusing on a single breach



Example network in NE end of Sand Lake

Justification for focusing on a single breach

Example network in NE end of Sand Lake

Sizing of a Single Dike Breach

- Appropriate Breach/Inlet size based on tidal channel design guidelines
  - Analyzed Marsh Area, Tidal Prism Volume vs. Inlet Size
    - Hydraulic Geometry
  - 40’ bottom width (80’ top width) minimum

- Minimum size for fish passage – review model velocities

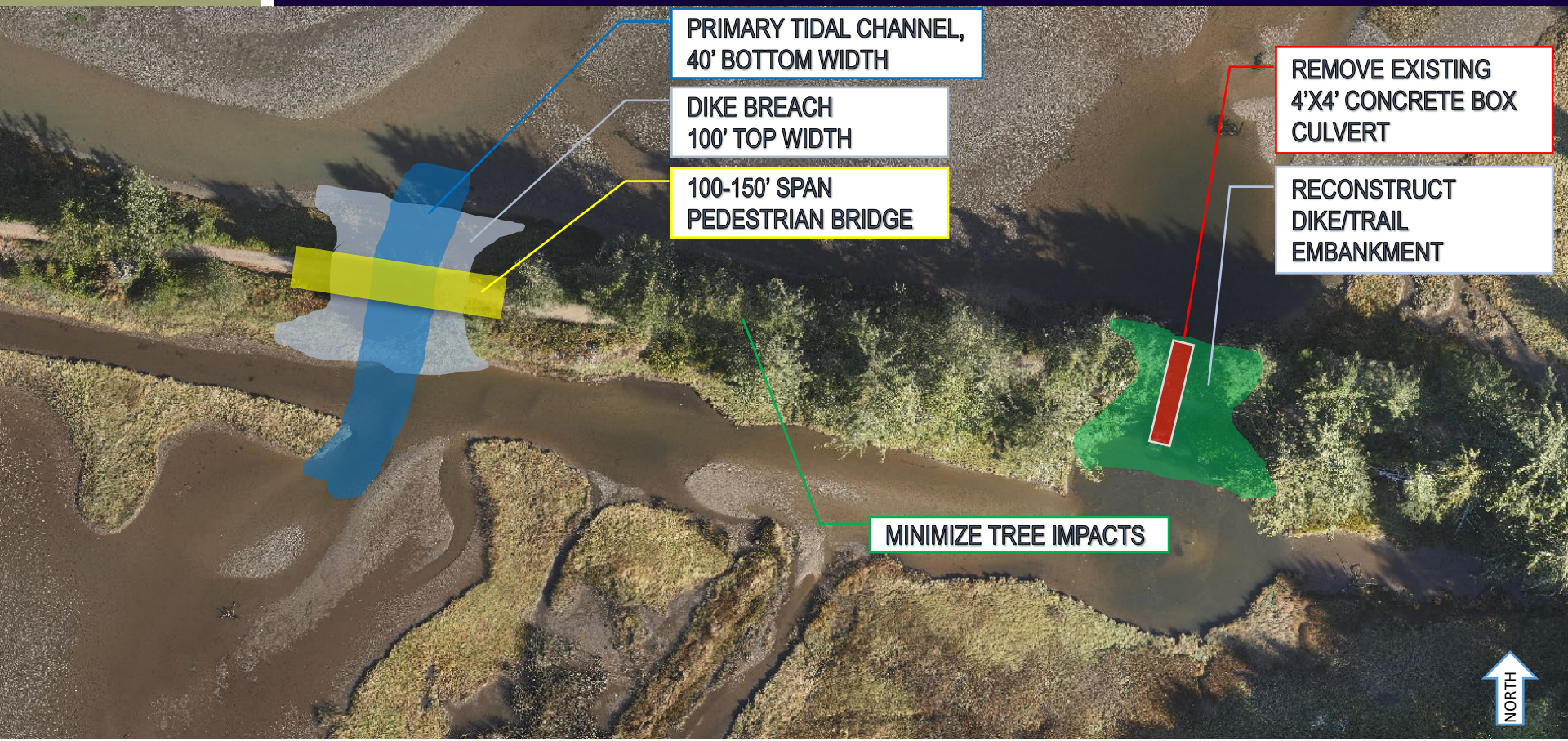
  2 ft/sec threshold for fishways (ODFW criteria)

  - Maximum reasonable bridge span?
    - 150-foot-span is reasonable. Larger spans become more expensive and higher profile (deeper substructure)

  - Minimize Constriction for scour/erosion

100’ DIKE BREACH, SPANNED BY 100-150’ PEDESTRIAN BRIDGE

SINGLE 100’ DIKE BREACH, SPANNED BY 100-150’ PEDESTRIAN BRIDGE

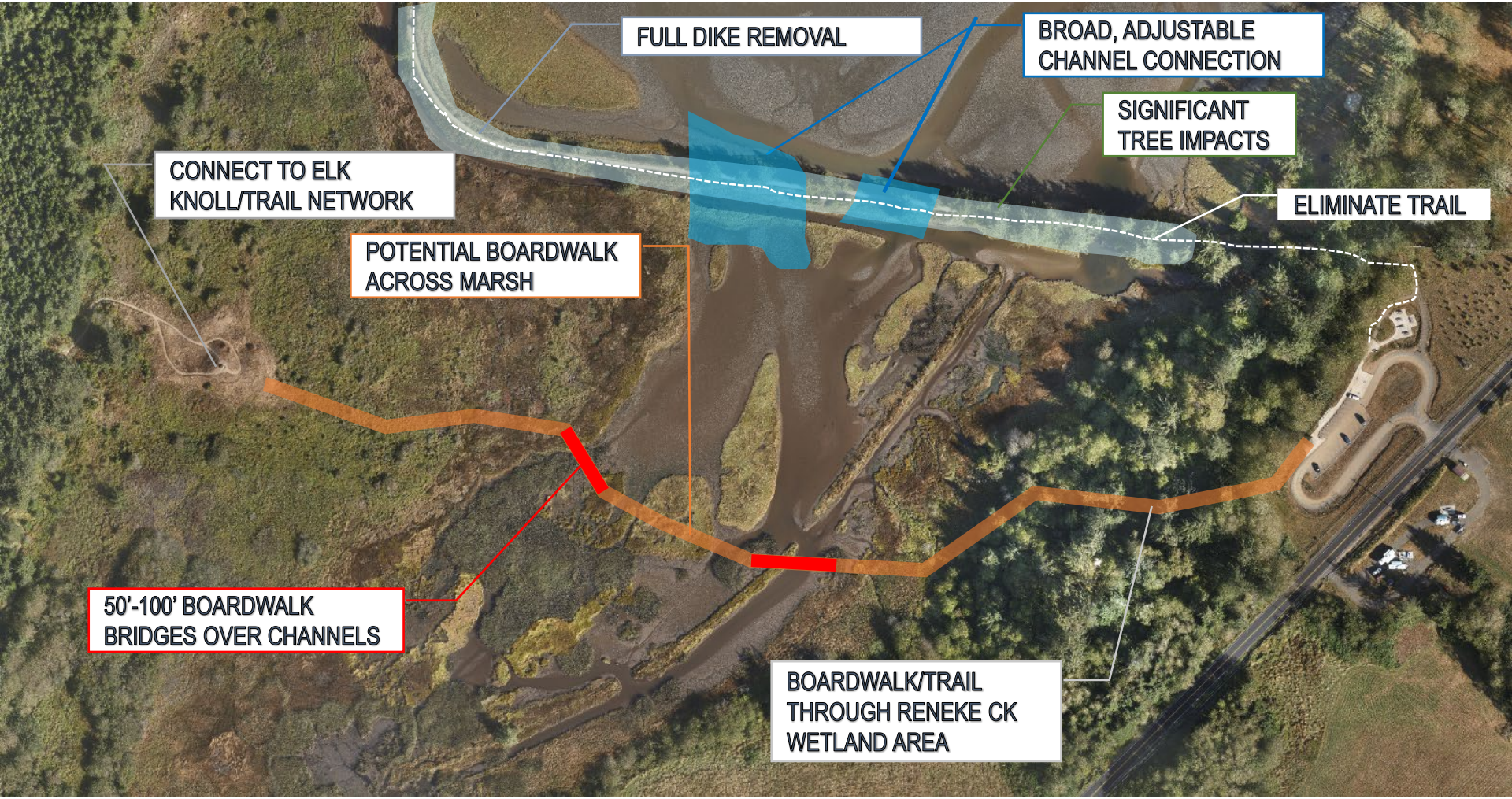


Pedestrian Bridge Examples

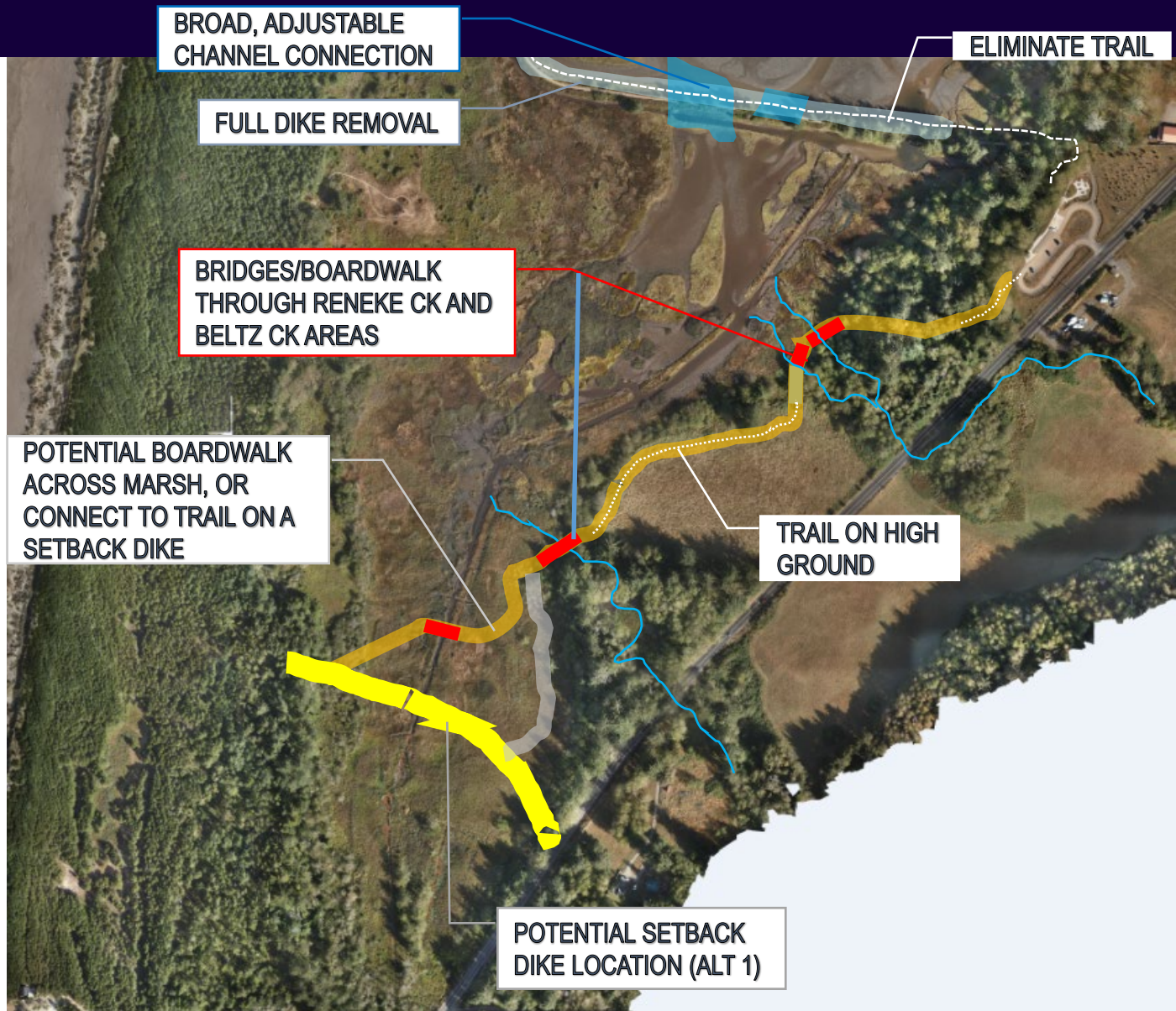
Continental Connector®

Big Sky, MT

Boardwalk Option under larger breach or full dike removal

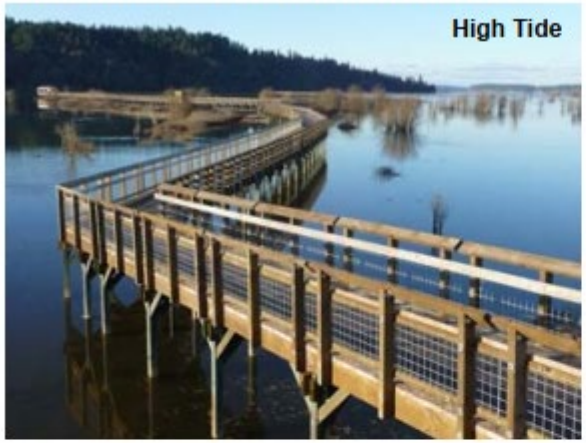


Reroute trail to the south along eastern edge of marsh



Boardwalk Example – Nisqually NWR

Nisqually Estuary Boardwalk Trail, USFWS



Nisqually NWR, WA

- 8’ wide
- 8-13’ height
- Pressure Treated structural members
- Laminate decking
- Diamod Pier Foundations
- $68/SF (1 mile)
- $2.8 Million
- Built in 2010

Boardwalk/Bridge Example – Nisqually National Wildlife Refuge

Boardwalk/Bridge Example – Nisqually NWR lesson learned

Concrete Boardwalk option (less maintenance, higher cost)

- PermaTrak – precast concrete boardwalk system

PermaTrak®
The Concrete Boardwalk Company

Concrete Boardwalk option (less maintenance, higher cost)

Consider Full Dike Removal: Potential Benefits?

- Maximum Restoration/Reconnection by removing artificial fill that bisects marsh/Sand Lake
- Would full removal provide more/better connectivity than 100-foot breach?
  - Any Difference in Water Levels in Beltz Marsh? – No
  - Difference in circulation patterns? –Yes, at higher water levels
  - Influence on sediment dynamics/accretion? – Unclear
- Restore wetland area within footprint of existing dike
- Use dike fill for setback dike (logistically challenging)

Consider Full Dike Removal: Disadvantages/Risks?

- **Impact to Beltz Dike Trail** (trailhead connection to network)
  - Require 2,000 feet of boardwalk across marsh, plus 'bridges' over channels
  - Re-route trail through Reneke Creek area (wetland, braided channel, dynamic due to sediment)

- **Significant cost** for dike removal and trail modification
  - Boardwalk Cost Estimated: $3M - $5Million+
    - Similar to Nisqually (low end). Long term maintenance/replacement
    - Precast Concrete Boardwalk (PermaTrak) (high end)
  - Earthwork and off hauling 25,000 CY ~$1.25M
  - Compared to 100-150' ped bridge = $500,000-$1M depending on type/foundation

- Impacts to trees on existing dike

- Potential for increase wind-wave erosion by increasing fetch distance at high water levels? Remaining dike may act as wave break

Dike Breach/Removal Cost Comparison

A - 100-150' dike breach with Pedestrian Bridge

	Low Est	High Est
Dike Breach	$250,000	$450,000
Pedestrian Bridge	$400,000	$1,000,000
Dike Repairs for Trail	$50,000	$150,000
TOTAL (range)	**$700,000**	**$1,600,000**

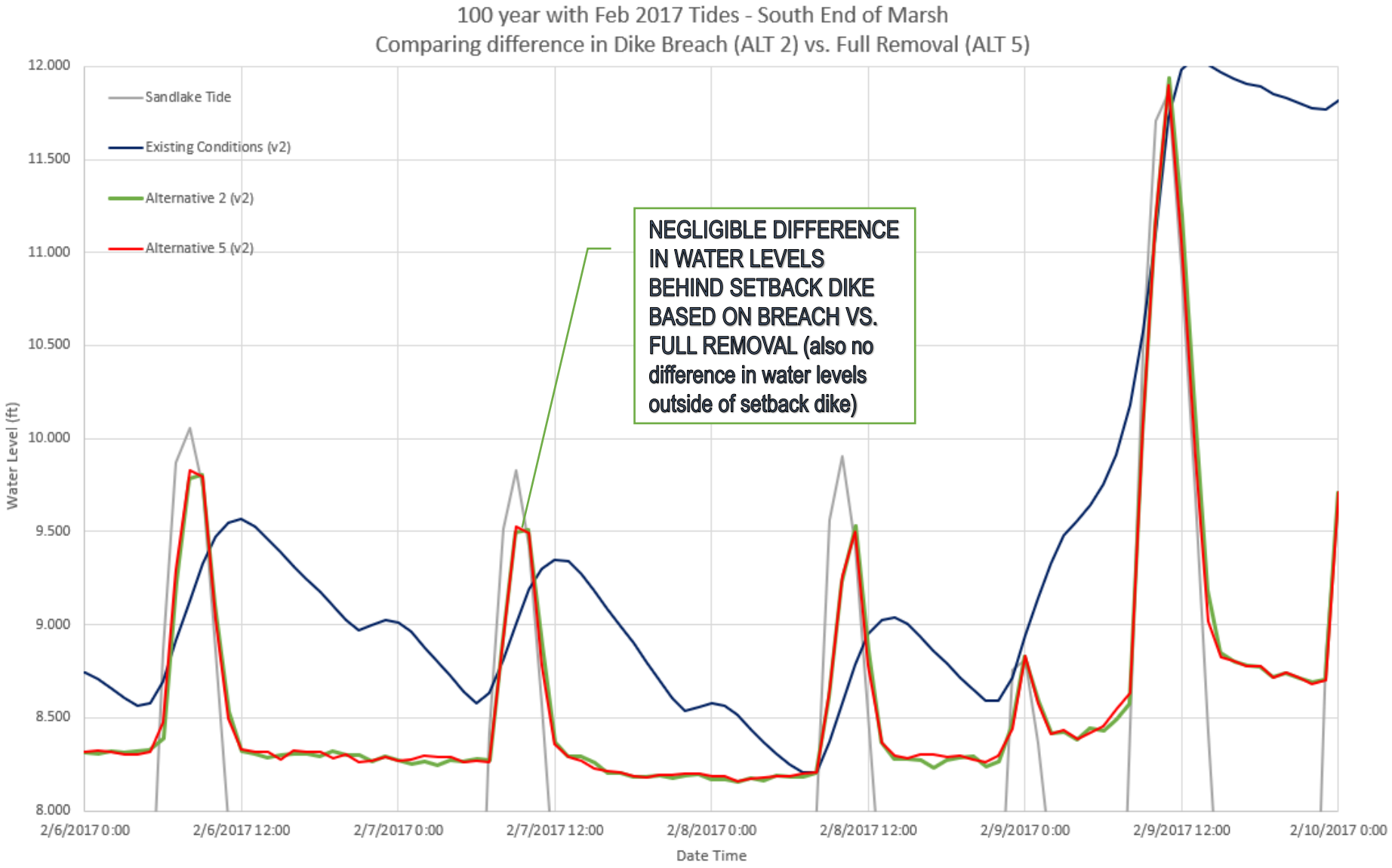
B - 200-250' dike breach with Pedestrian Bridge

	Low Est	High Est
Dike Breach	$300,000	$550,000
Pedestrian Bridge	$1,000,000	$1,600,000
Dike Repairs for Trail	$50,000	$150,000
TOTAL (range)	**$1,350,000**	**$2,300,000**

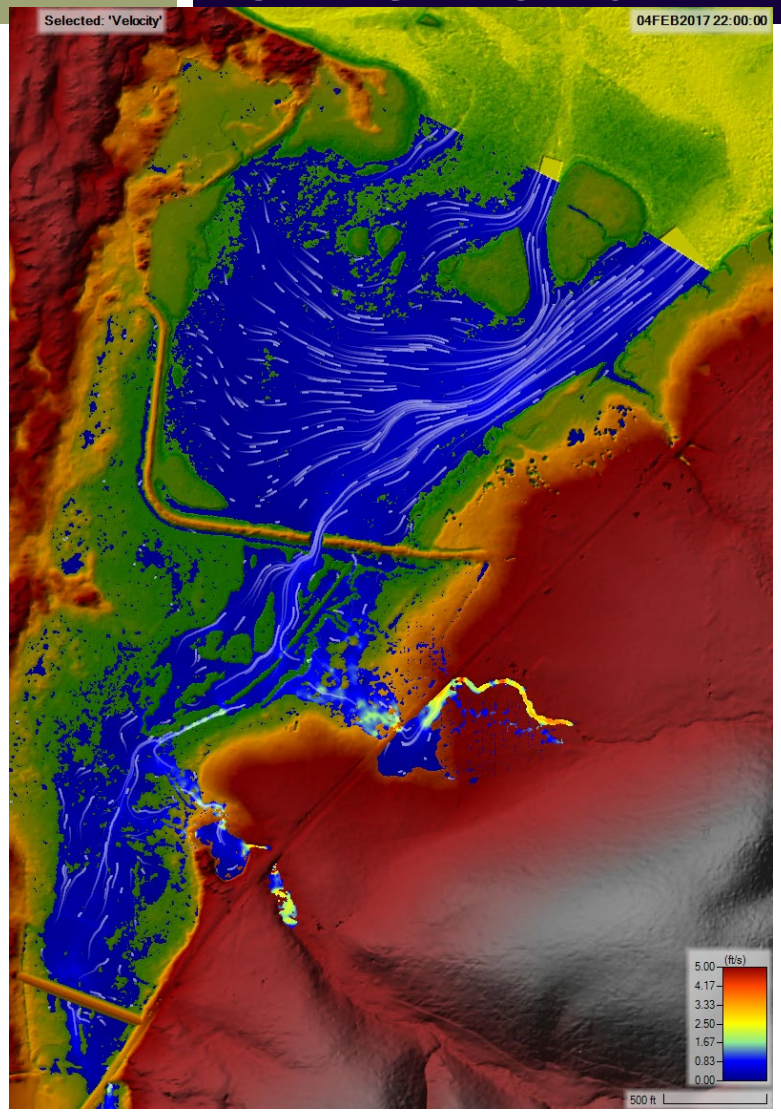
C - Full Dike Removal with Boardwalk across Marsh

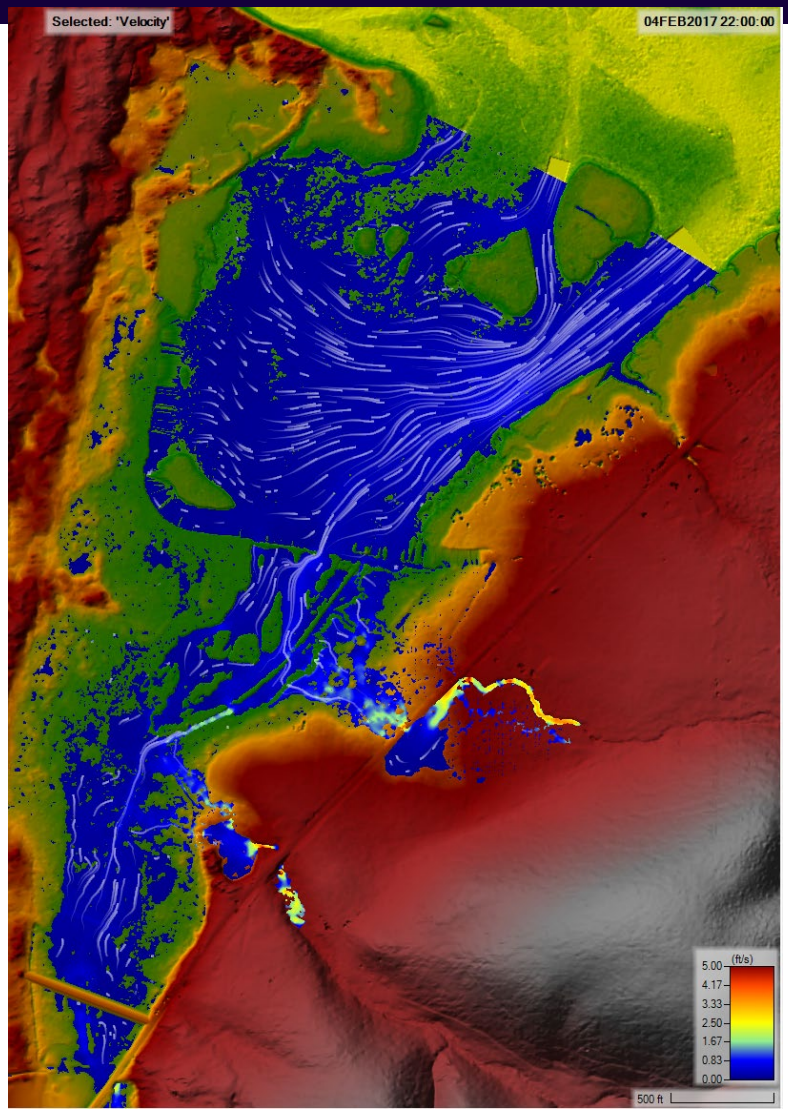
	Low Est	High Est
Dike Removal	$1,000,000	$1,500,000
Boardwalk	$3,000,000	$5,000,000
Trail Improvements	$150,000	$250,000
TOTAL (range)	**$4,150,000**	**$6,750,000**

Comparing Marsh Water Levels Under Dike Breach vs. Full Removal

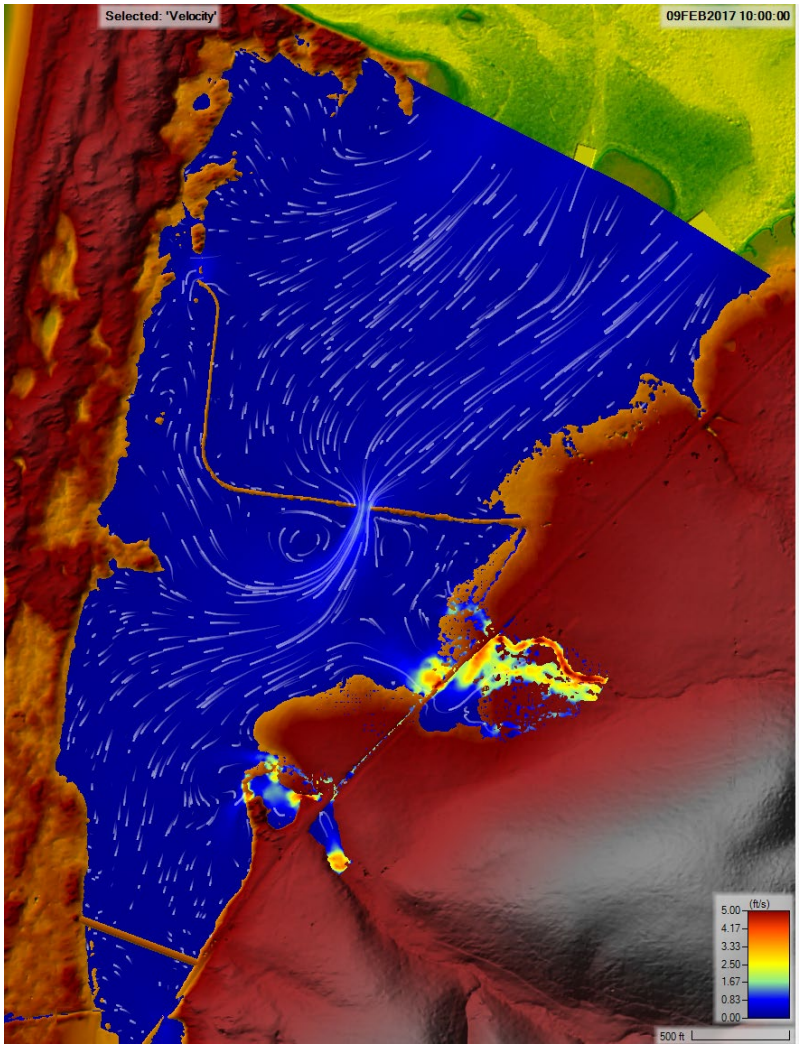


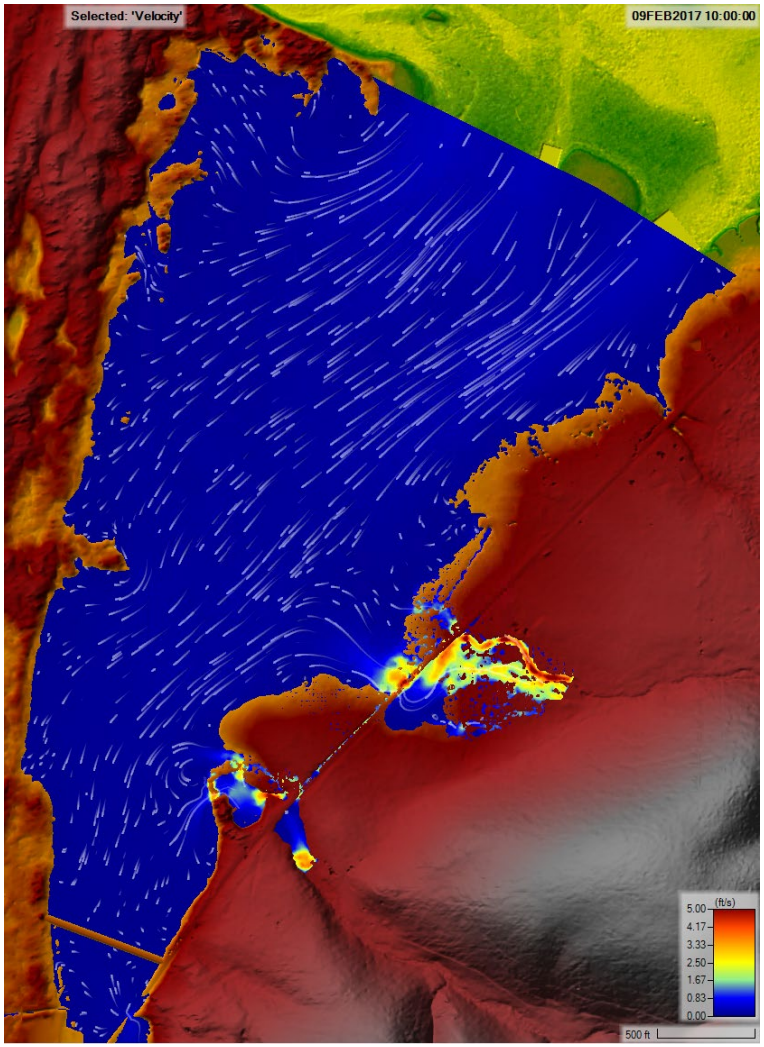
2D Modeling Results – Comparing circulation under 100’ dike breach vs. full removal





2D Modeling Results – Comparing circulation under 100’ dike breach vs. full removal

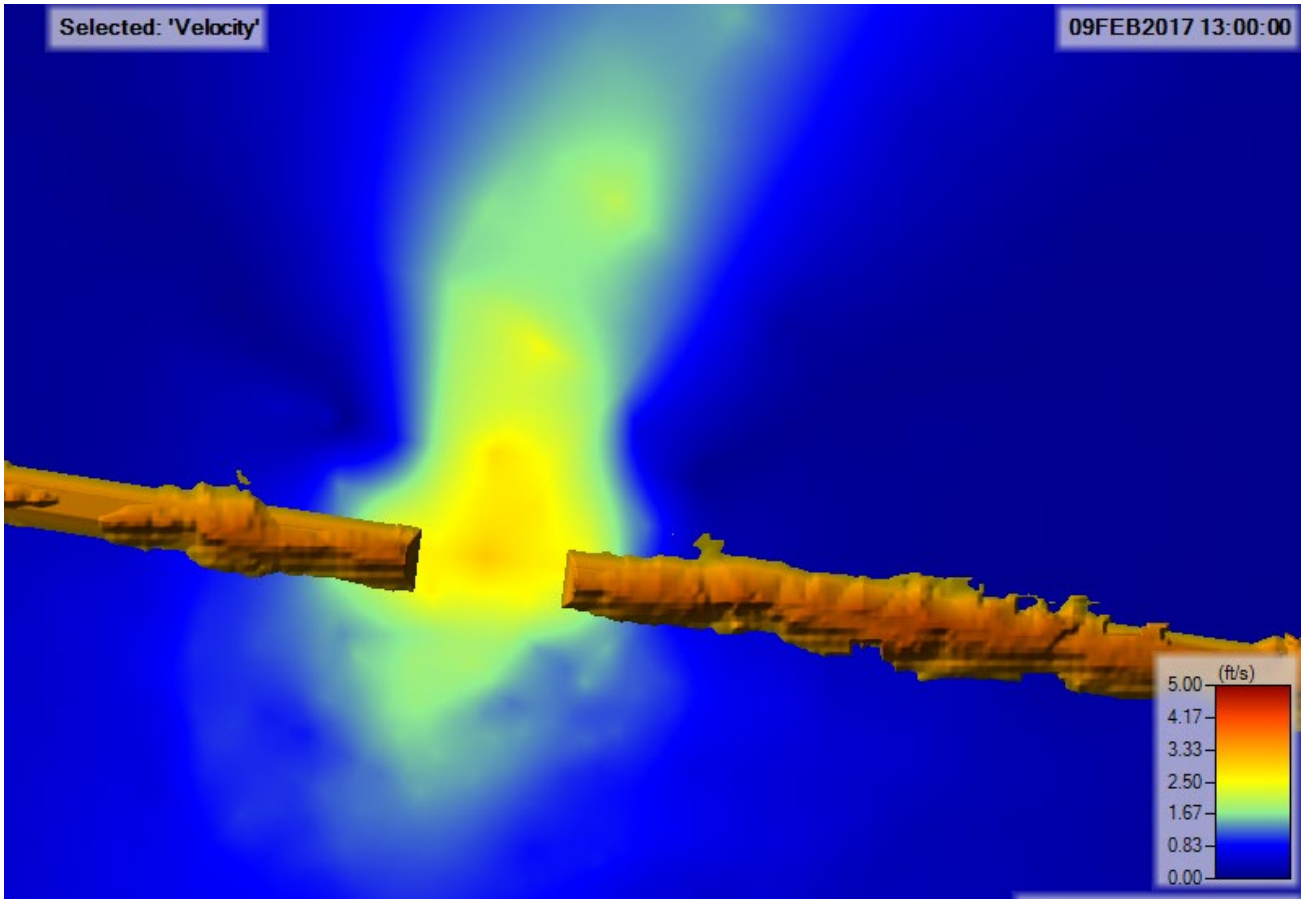




2D Modeling Results – Peak Velocity 100-foot dike breach

PEAK VELOCITY DURING 100-YR STORM RUN (MAX TIDE SWING)

Peak velocity ~ 3ft/sec (short duration peak, majority of time is less than 2 ft/sec: fish passage velocity threshold)



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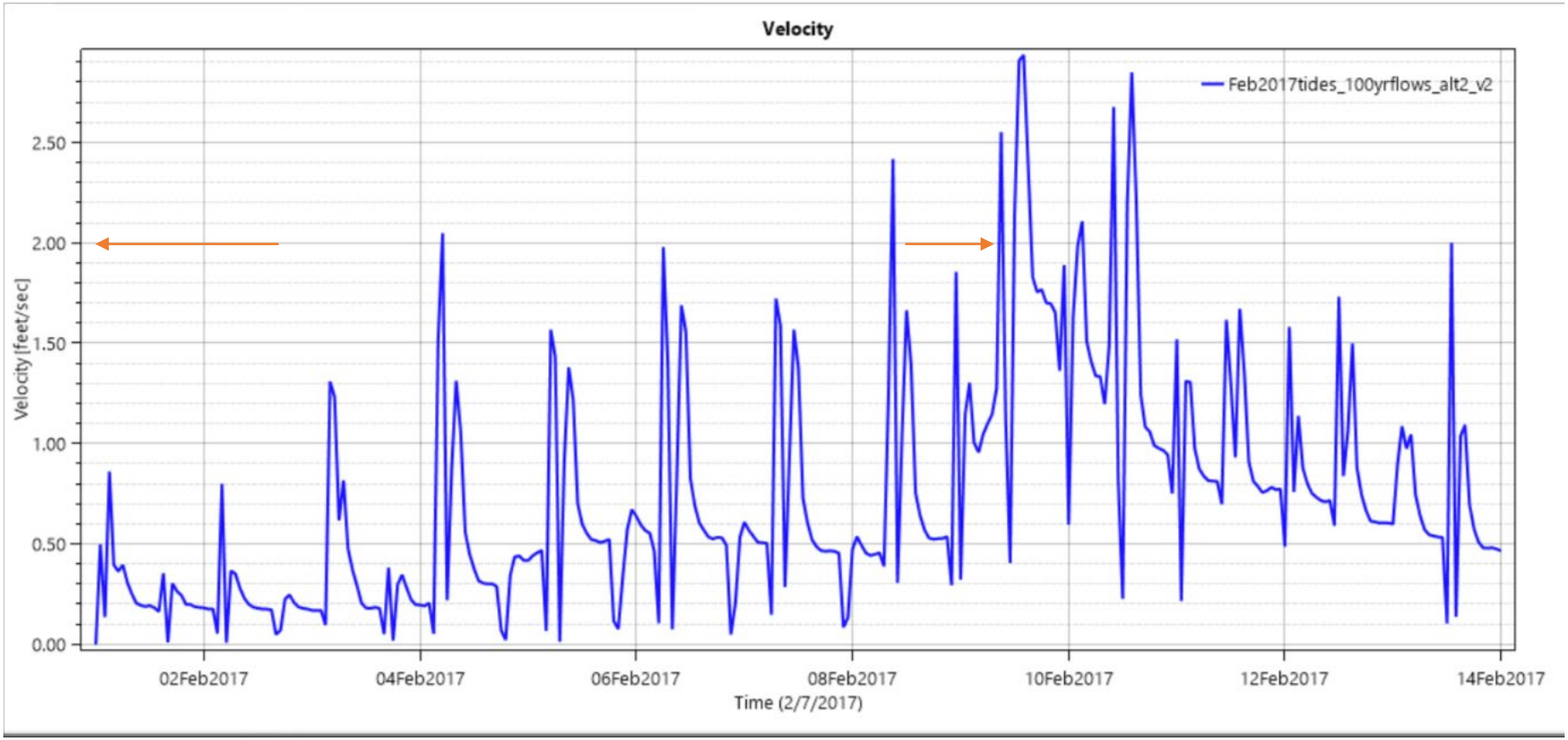
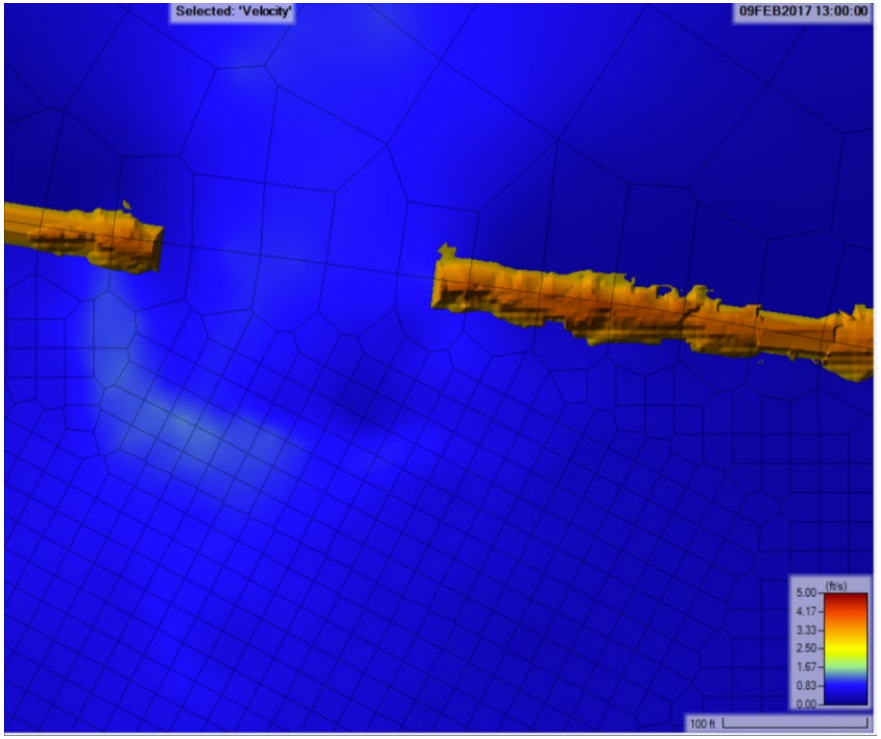


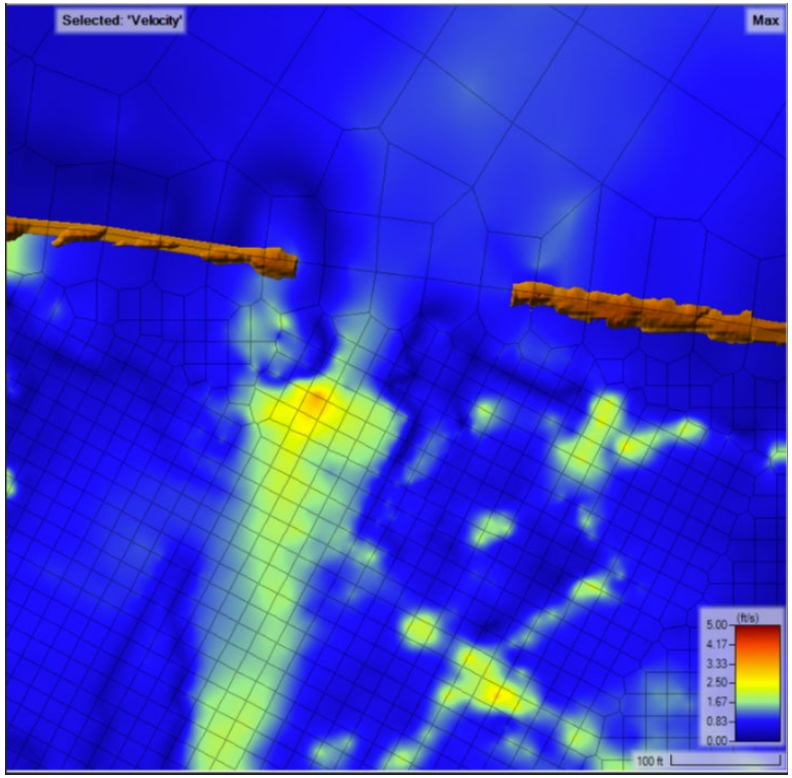
2D Modeling Results – Peak Velocity 200-foot dike breach

PEAK VELOCITY DURING 100-YR STORM RUN (MAX TIDE SWING)

Peak velocity ~ 1ft/sec across breach

Slightly higher velocities in internal channels





Whalen Island Bridge

Whalen Island Rd Bridge

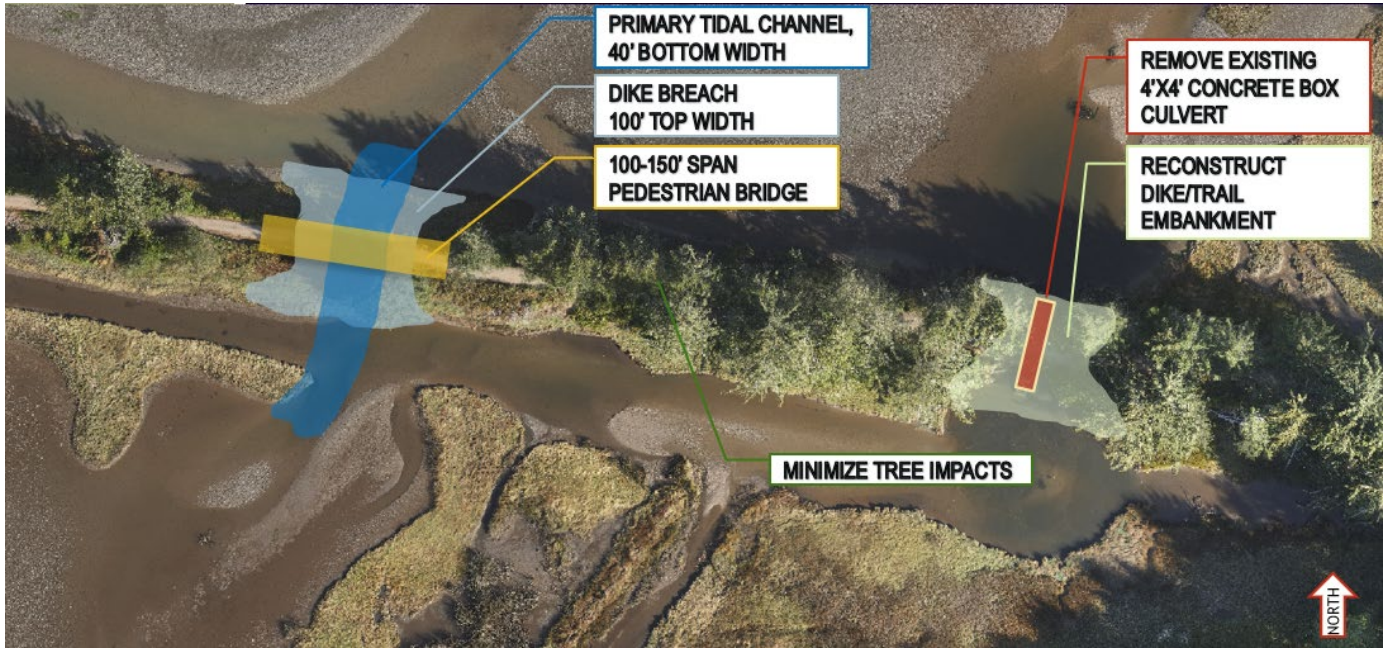
- 180-acre contributing marsh area (80 acres at Sitka Sedge)
- 80-foot span
- Heavily armored opening/banks with riprap

Conclusions on Dike Breach Configuration

- **Single beach would be much more predictable than multiple breaches**
- **100-foot breach is a 'constriction' compared to historical conditions, but peak modeled velocity (and shear stress) are modest ~3 ft/sec (0.19 lb/sf) within the breach (much lower on marsh plain)**
- **150-foot bridge span is reasonable, but larger span gets much more expensive**
- **No difference in water levels in marsh between 100'/200' Dike Breach vs. Full Removal**
- **Difference in circulation patterns at higher water levels (still funnels to channel at most water levels)**
- **Not clear if this difference would influence sedimentation/accretion**
  - **"Berms" can slow water and increase sedimentation by reducing wind/wave erosion. Remnant dike may act as 'wave break berm' and serve this function**
  - **More dependent on sediment supply and inundation duration than peak tide circulation (not affected by dike breach size)**
- **Substantial cost impact of full dike removal, trail reconfiguration, boardwalk**
- **Maintenance/longevity concerns about boardwalk (or higher cost for concrete walk)**

Summary of Alternatives Analysis

- Dike Breach - Location/Dimensions/Trail Accommodations
  - Considered 100’ breach, 200’ breach, and Full Dike Removal (multiple breaches)
  - Dike Breaches spanned by pedestrian bridges
  - Full dike removal would require ~2,000 LF boardwalk to replace dike trail
  - Full removal would restore most natural condition, but significantly more expensive
  - 100’ dike breach sufficient to equalize water levels and keep velocities low
  - Unclear/mixed whether full dike removal would benefit sediment dynamics/accretion



Other Considerations for Dike Breach with Pedestrian Bridge Option

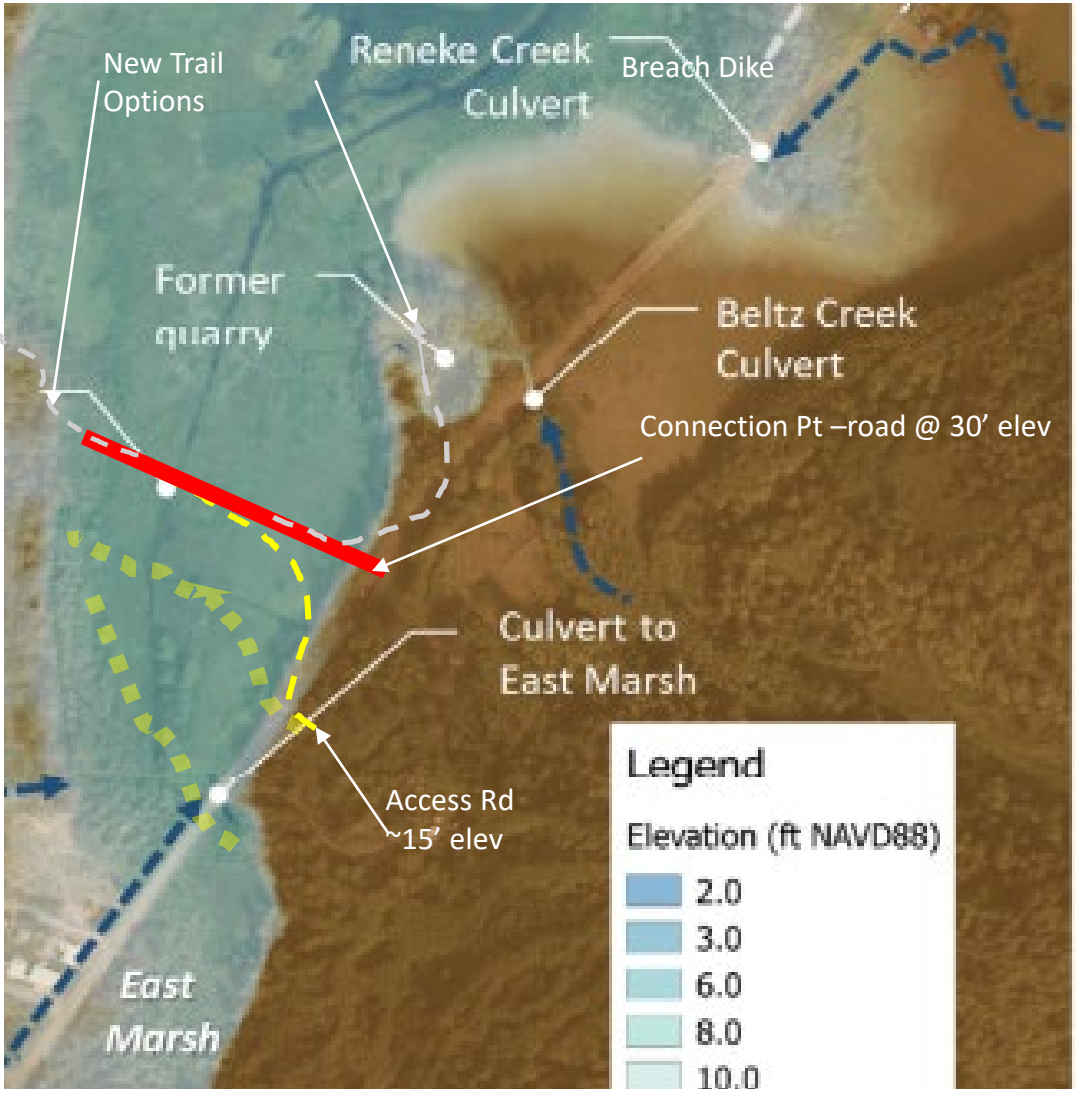
- **Existing Dike needs some repairs for long term use as trail**
  - Reconstructing dike where existing culvert/tide gate is removed
  - Several large trees on dike slope are leaning (may fall and create holes in embankment). Evaluate stability (risk)/Preemptively cut/snag?
  - Consider raising low point(s) on dike – far west end low point overtops in model during 12' tides (to increase with sea-level rise)

- **Construction Logistics to build new ped bridge**
  - Pile supported foundation, ~60' deep piles
  - Narrow width of dike trail for truck/crane/pile driving access
  - Significant tree limbing required
  - Consider micro-piles for smaller pile driver
  - Challenging to build bridge from one side (sequencing/logistics)
  - Trail closure during construction (could be in off-season)

Optimizing Setback Dike Location and Functionality

- Prior study: high-level feasibility assessment of Initial Location
- Estimated storm inflows under 100-year storm event vs. storage volume
- Initial location feasible from a storage capacity standpoint. Need to consider other factors (logistics, maintenance, long-term function)

Setback Dike Alternative – Logistics & Considerations



- Provide protection against highest water levels in Sand Lake/Beltz Marsh
- Provide adequate storage volume for stormwater runoff
- Minimize direct wetland impacts in Beltz Marsh due to dike footprint and indirect impacts due amount of wetland left behind setback dike
- Consider groundwater upwelling locations and geotechnical conditions
- Consider tie-in locations, access for maintenance, construction logistics

Setback Dike Alternatives –

- Evaluated 4 potential setback dike locations
  - Alt 1 – at/near existing beaver dam
  - Alt 2 – 300 feet south of existing beaver dam
  - Alt 3 – at Park boundary (configured to allow NW Ditch to flow outside of dike)
  - Alt 4A – raise Sandlake Rd and Roma Ave to 15’ as the setback dike (with tide gate to East Marsh)
  - Alt 4B – no tide gate at Sandlake Rd setback dike (free flowing connection to East Marsh)

    Alt 4B is full tidal reconnection while raising Sandlake Rd and east end of Roma Ave to 2-3’ above maximum water levels.

Setback Dike Alternatives – Considerations

- Reducing wetland impact also reduces storage volume for storm performance
- Setback dike alignments are in an area of heavy beaver activity (maintenance/function implications)
- Alts 4a/4b are associated with county roadway improvements and pending culvert replacement at East Marsh

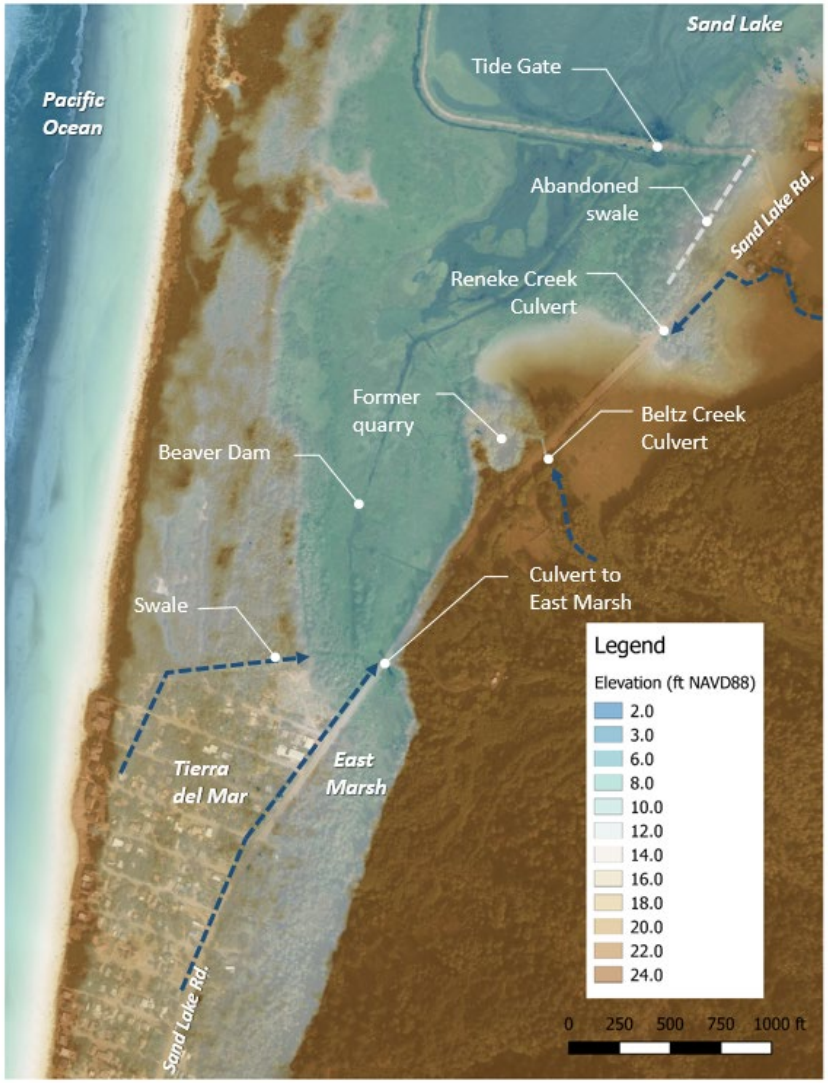
Setback Dike Alternatives – Comparison of Wetland Impacts

	Setback Dike Location	Wetland Impact Area (dike footprint) (acres)	Wetland Area behind Setback Dike (acres)
Existing Conditions	None (outer Beltz Dike)	0	82.1
Alternative 1	At Extg Beaver Dam	1.5	10.9
Alternative 2	300' South of Beaver Dam	0.9	5.1
Alternative 3	At Park Boundary (NW Ditch outside)	0.7	1.2
Alternative 4a	At Sandlake Rd	0.1	0.0
Alternative 4b	At SandLake Rd (no tide gate)	0.1	0.0
Alternative 5	300' South of Beaver Dam	0.9	5.1

Flow inputs to area behind a setback dike

- East Marsh drainage is the largest contribution of runoff/flow
- Sand Lake Rd Ditch drains more than 2/3 of TDM west of Sandlake Rd
- NW Ditch drains ~1/3 of TDM to Beltz Marsh

Key Study Area Elevations (NAVD88)



FEMA Base Flood (100-year) EL. +11.8 ft
Mean Higher High Water EL. +7.9 ft
Low tide in Sand Lake EL. +5.5 ft
Mean Sea Level in Ocean EL. +3.8 ft
Max Observed Tide (South Beach) EL. 12.66 ft

Top of Beltz Dike (low point) EL. +12.1 ft
Bottom of Tide Gate EL. +1.3 ft
Scour hole at Tide Gate EL. -4.5 ft

Reneke Ck. Culvert Invert EL. +9.6 ft
Beltz Ck. Culvert Invert EL. +20.7 ft

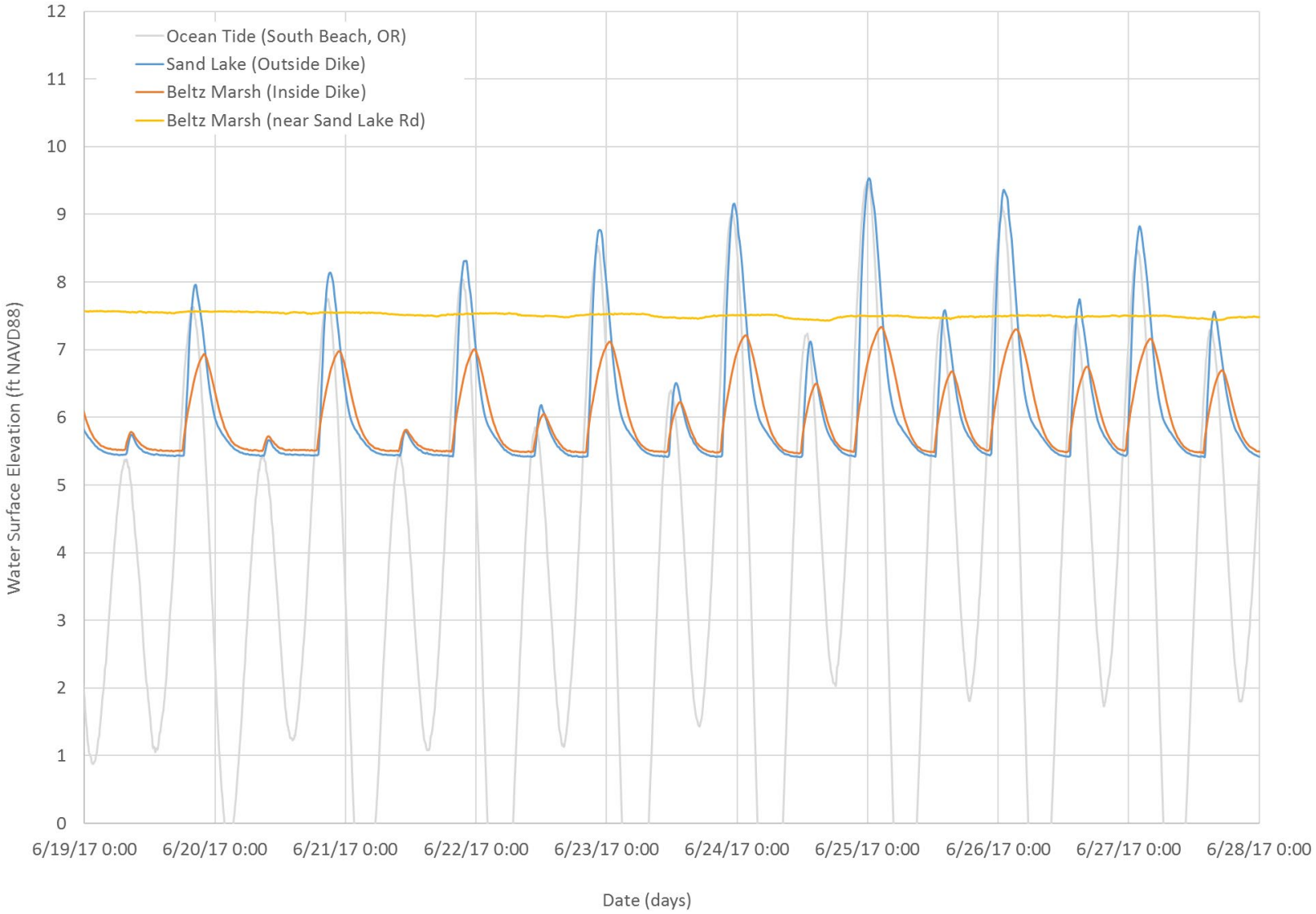
Top of Main Beaver Dam EL. ~7.0-8.0 ft

Culvert to East Marsh Invert EL. 5.15 ft
Low Point in Sand Lk. Rd EL. ~11.6 ft

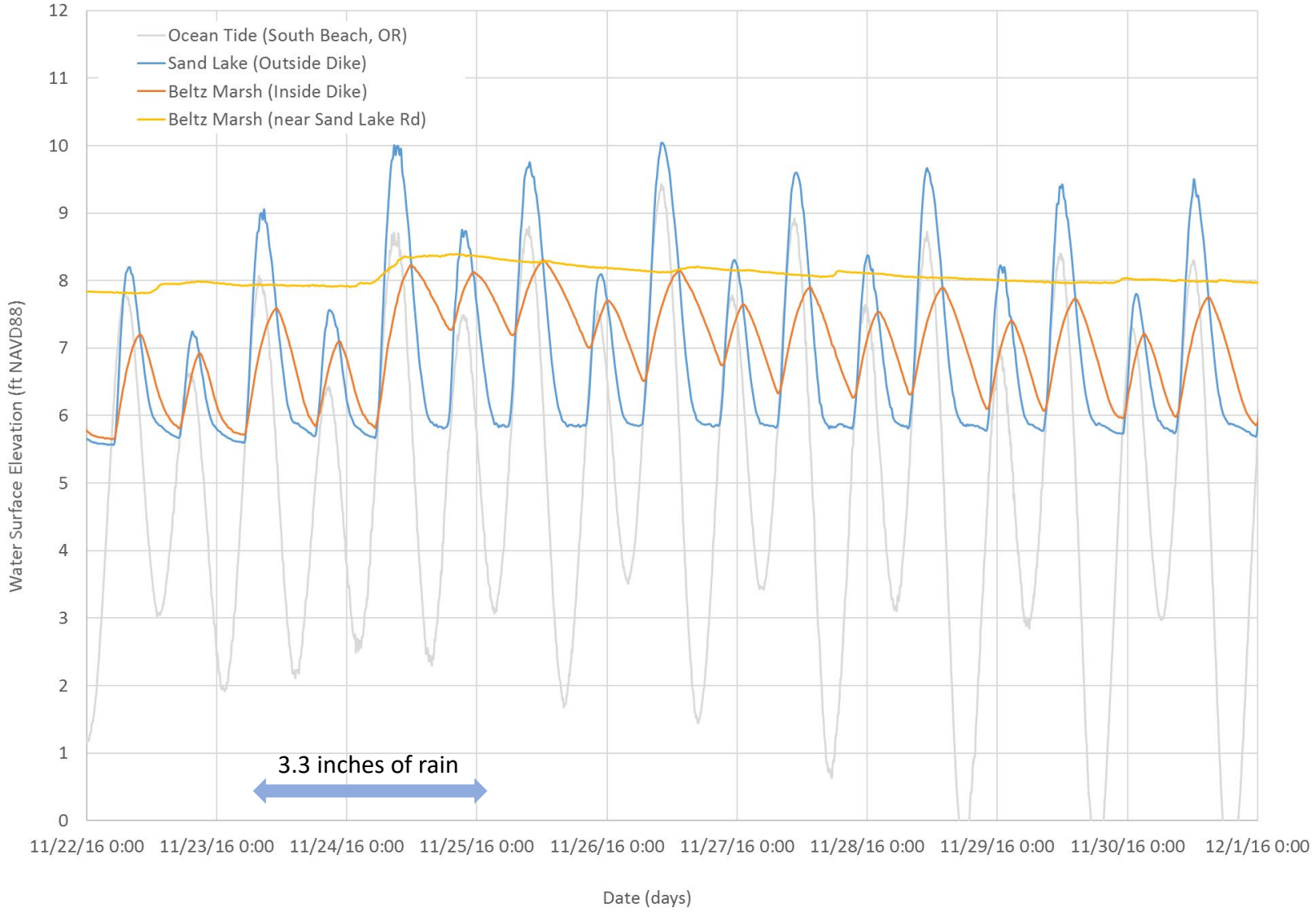
Culvert Invert at Roma Ave = +11.7 ft
Land in Tierra del Mar EL. +14 to 22 ft*

(All elevations referenced to NAVD88)

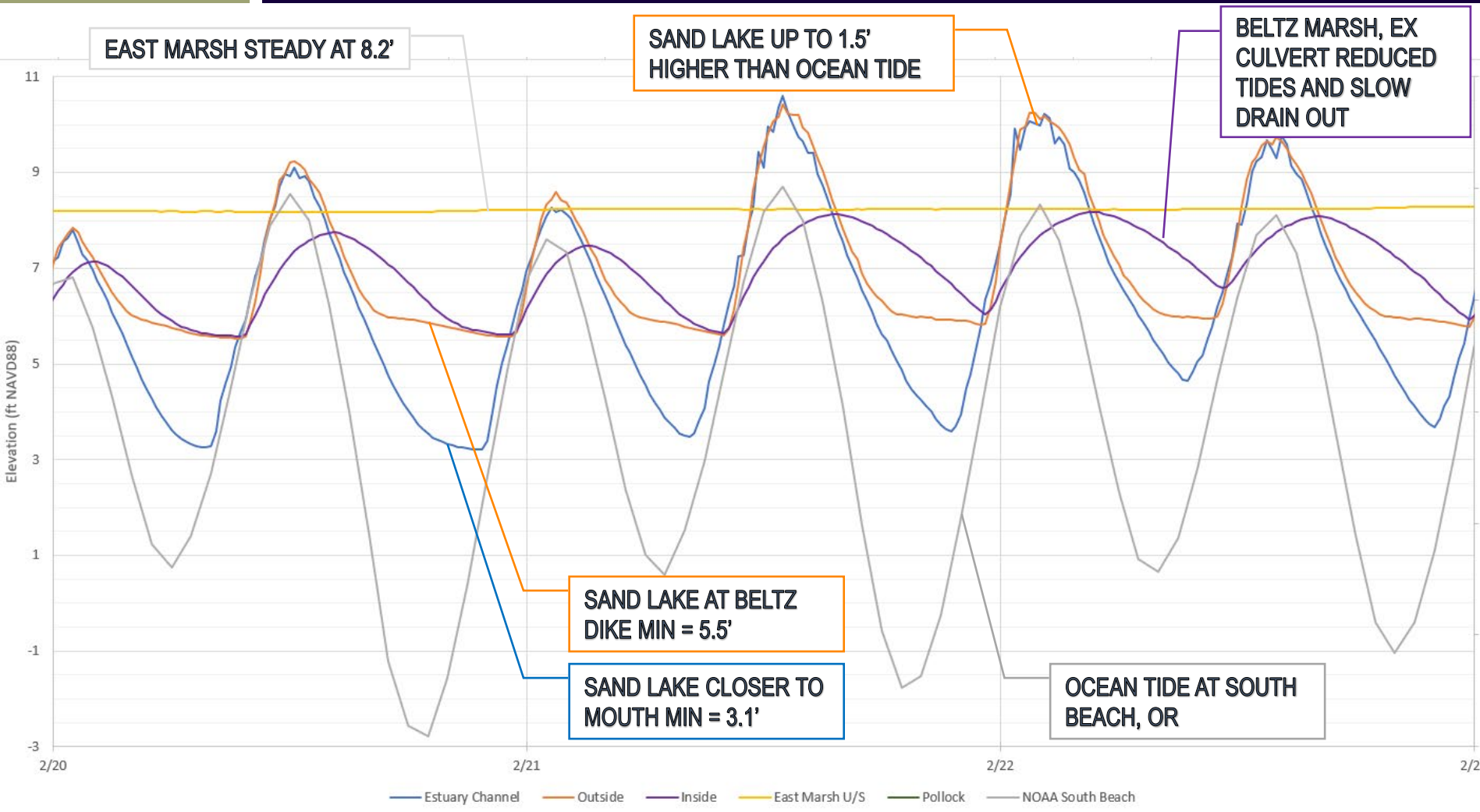
Dry Season – Example Water Levels



Wet Season – Example Water Levels

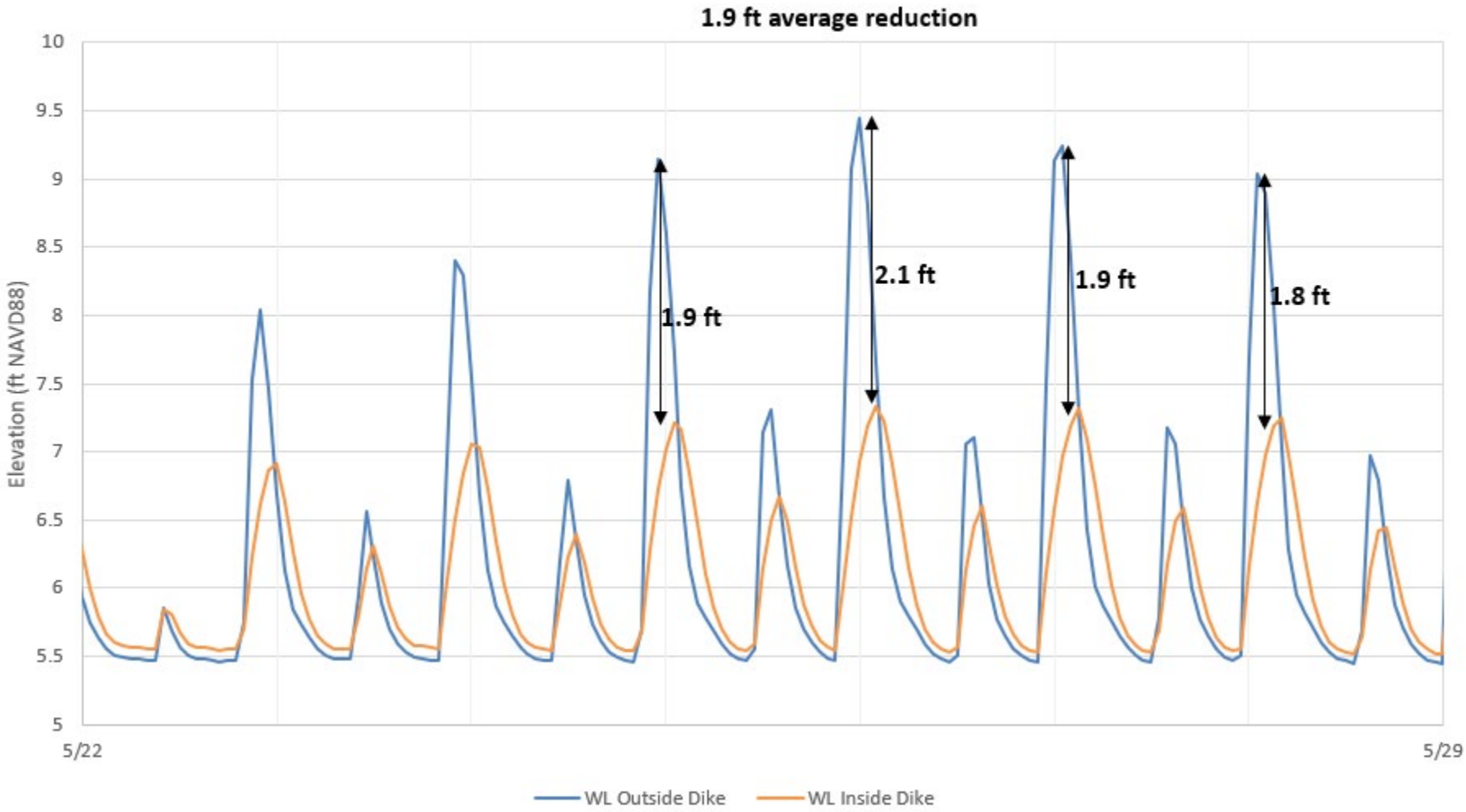


Water Level Monitoring – Feb 2023 King Tide with modest stream flows



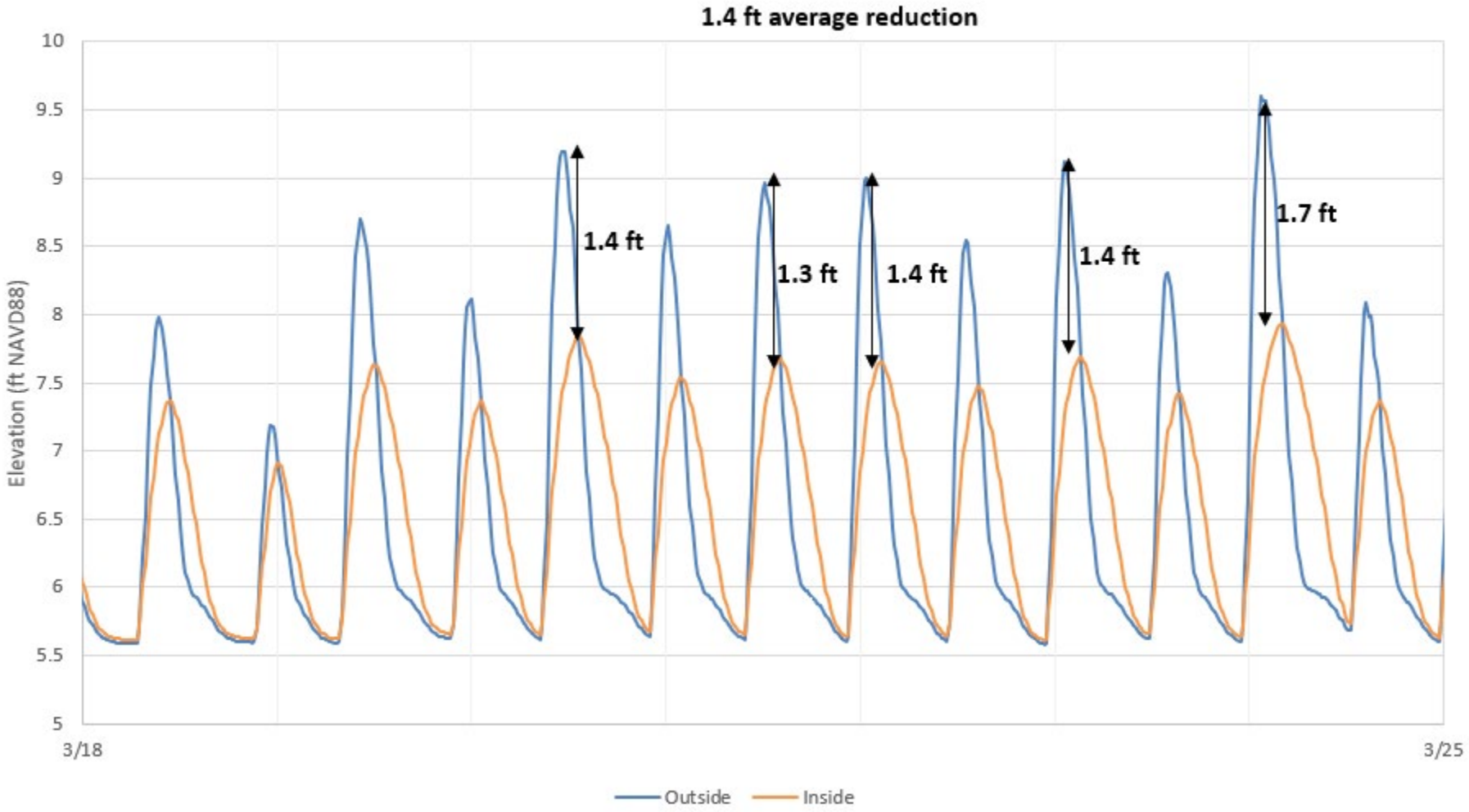
How has missing tide gate changed water levels?

2017 Water Level Data

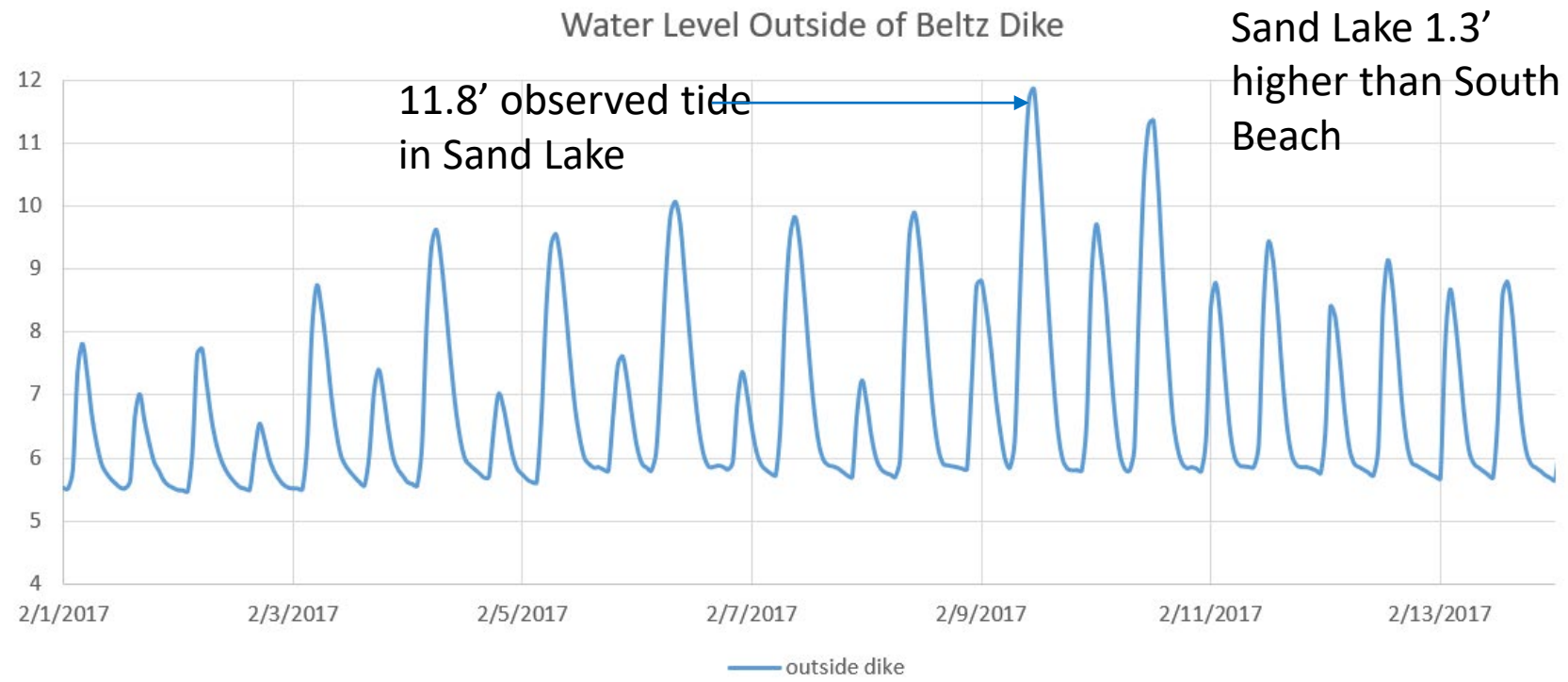


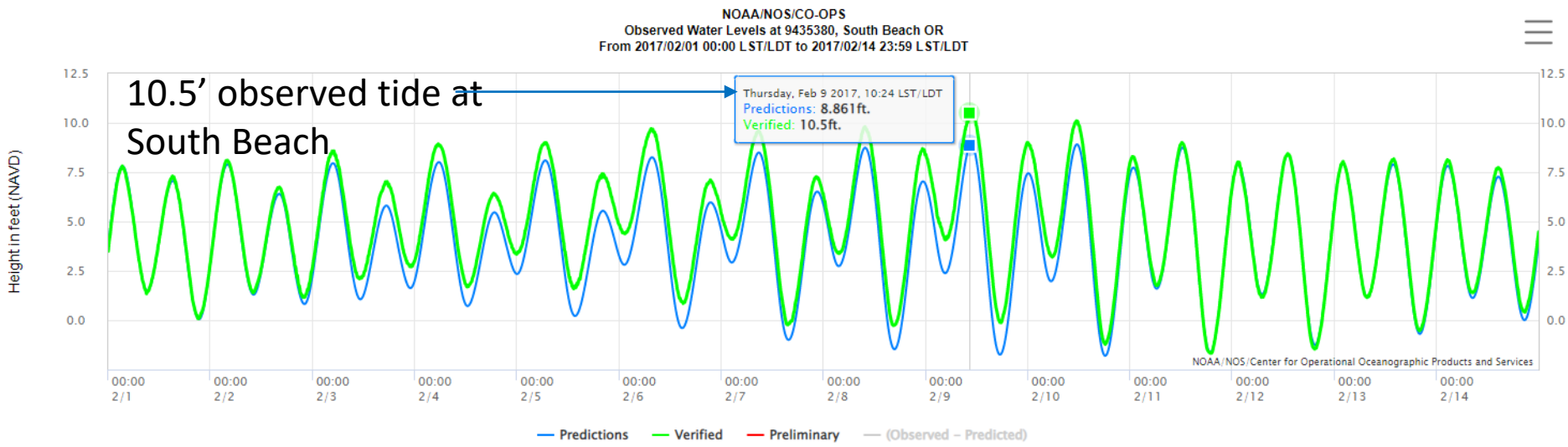
Missing tide gate now allows ~0.5' higher water levels than in 2017

2023 Water Level Data



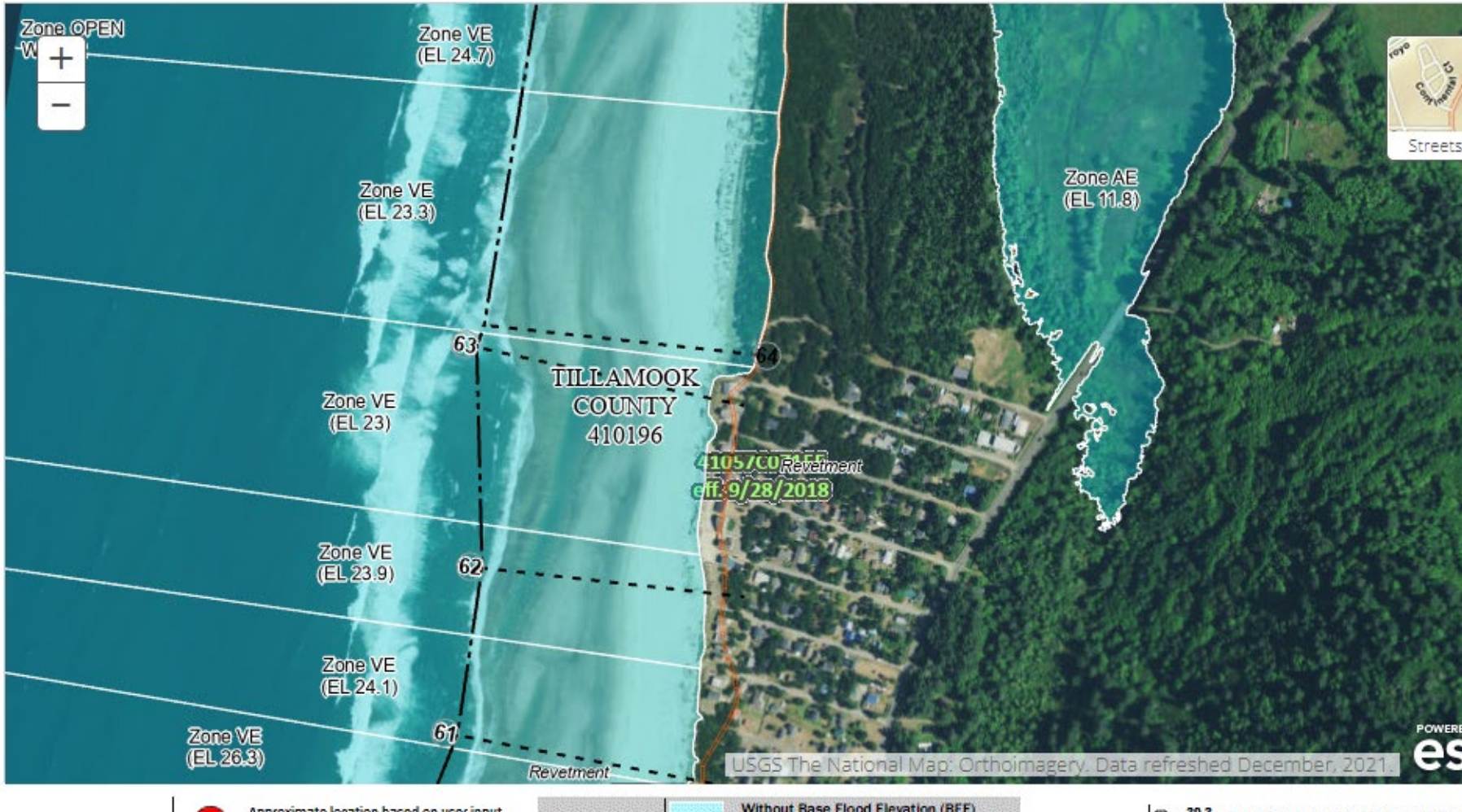
2D Modeling – Hydrologic Scenarios



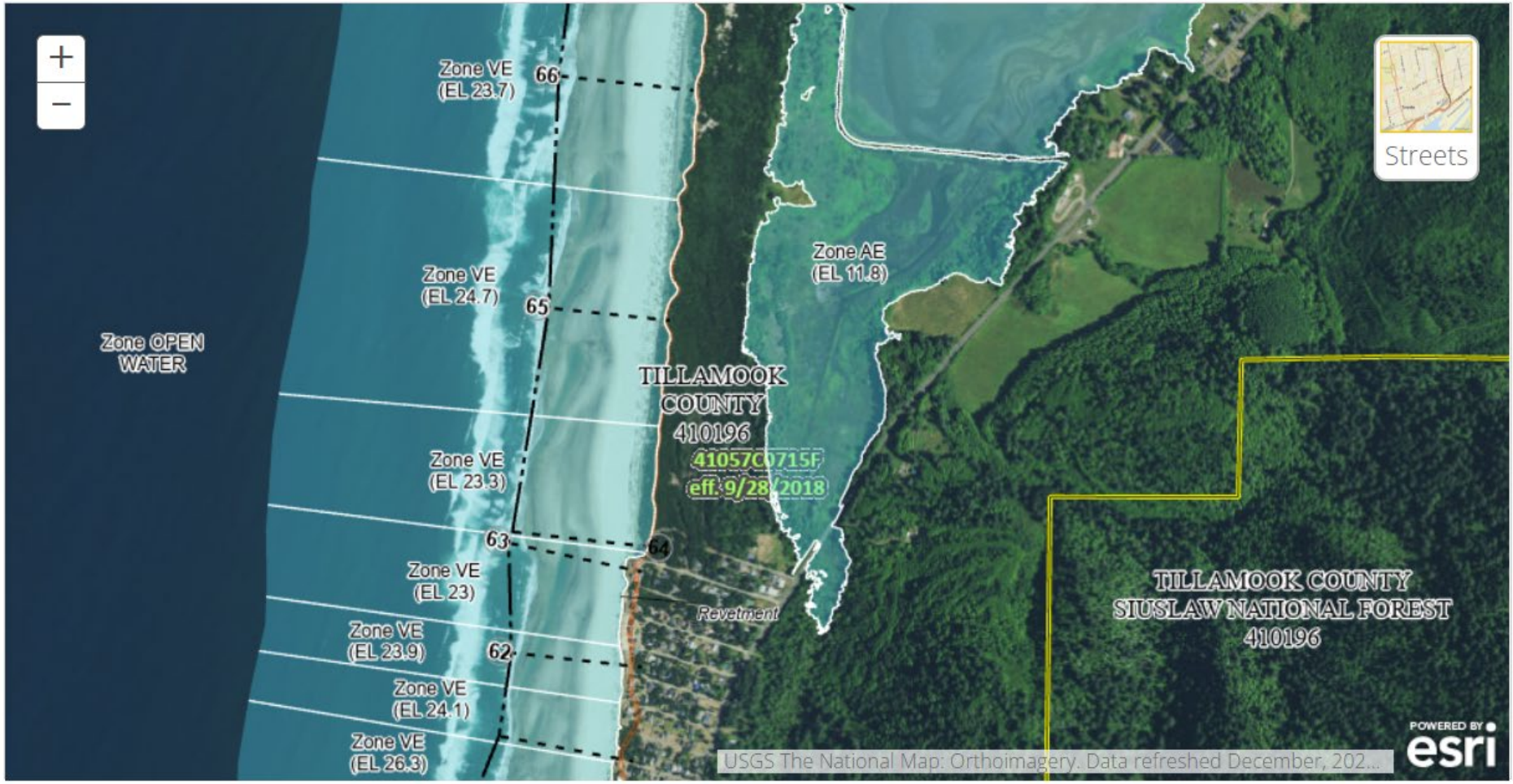


2D Modeling – Hydrologic Scenarios
FEMA 100-year floodplain

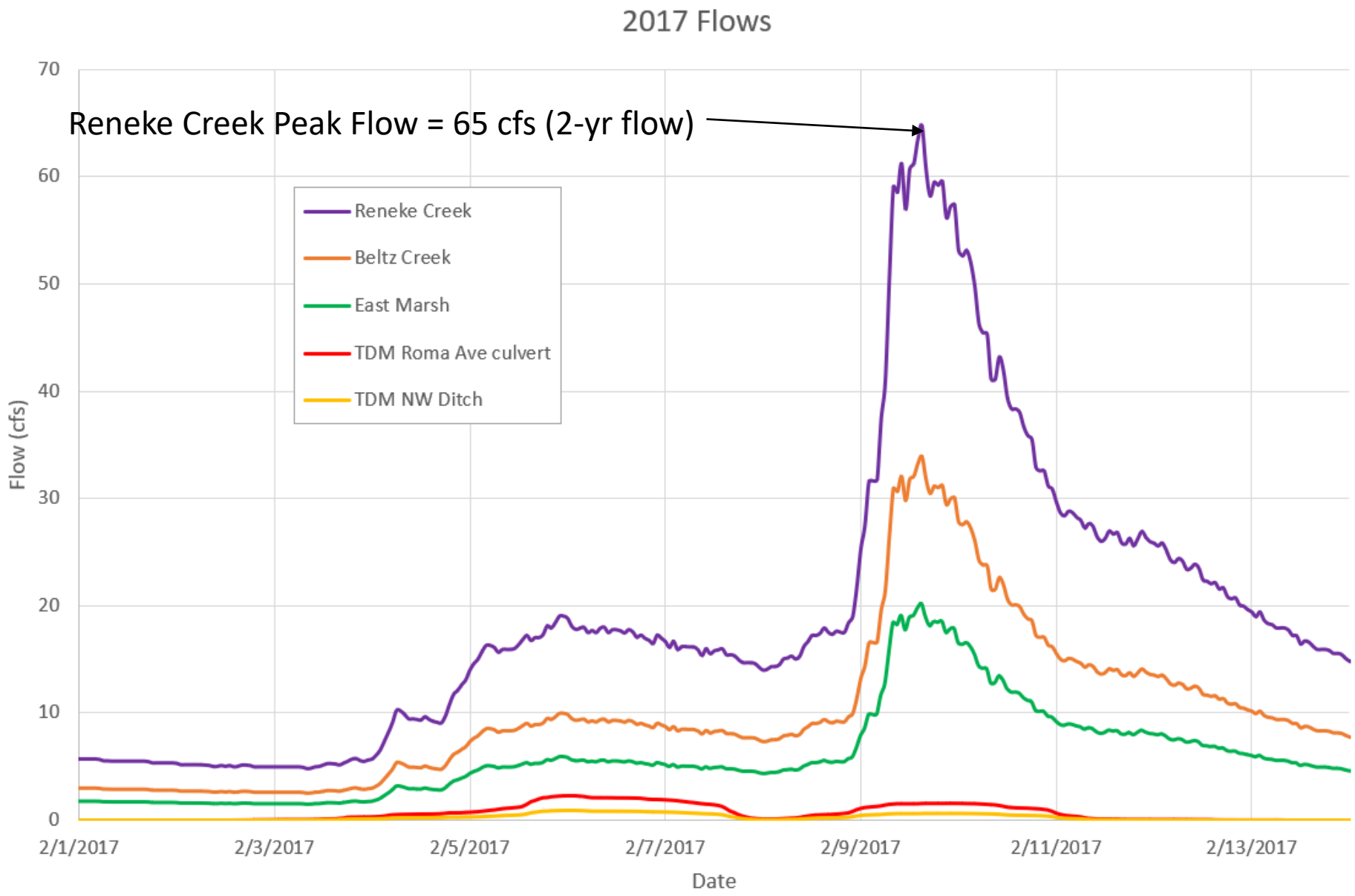
FEMA 100-Yr (Base Flood Elevation) = 11.8’ NAVD88)



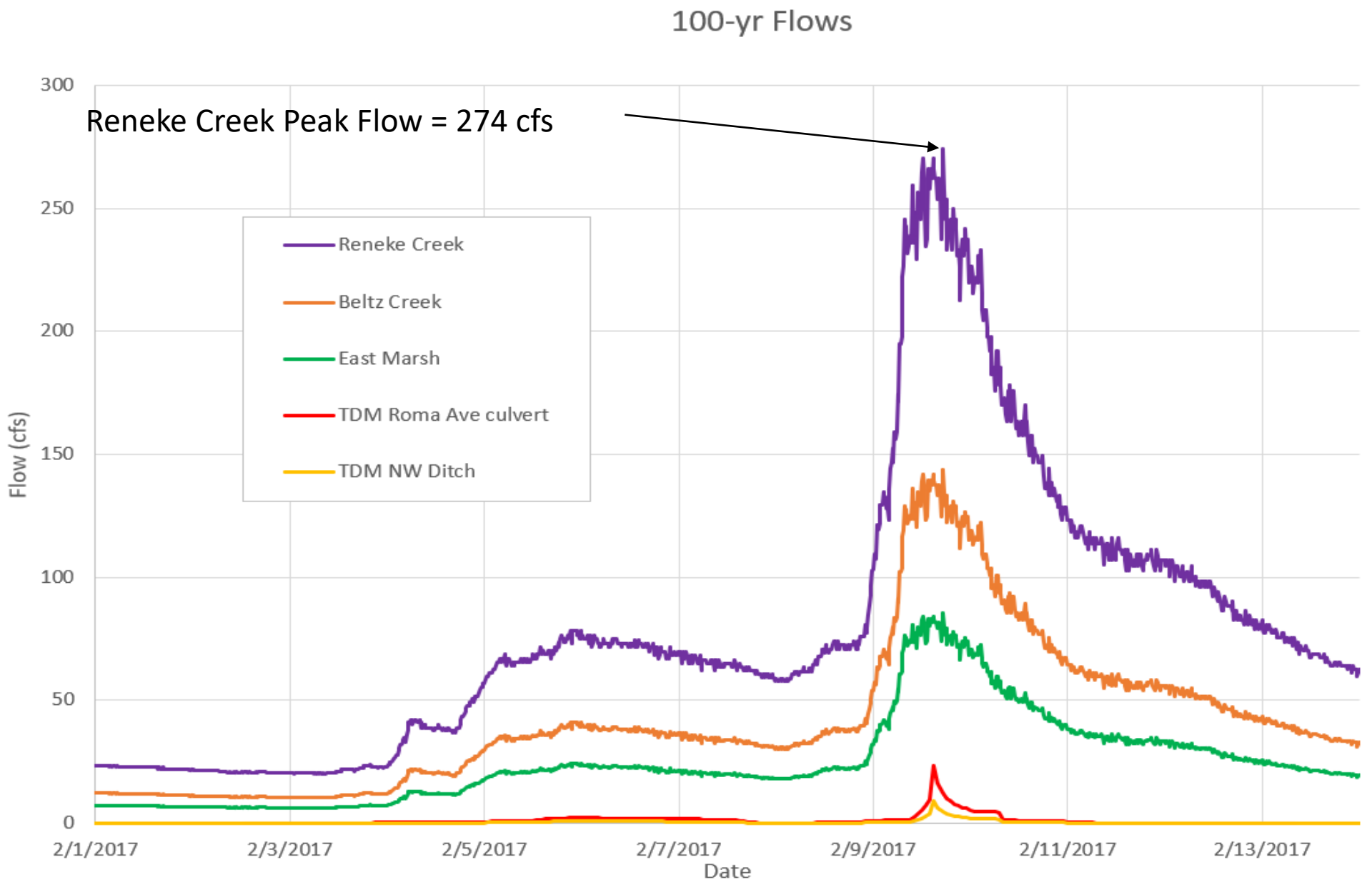
FEMA 100-year floodplain



2D Modeling – Hydrologic Scenarios



2D Modeling – Hydrologic Scenarios



2D Modeling – Hydrologic Scenarios (Reneke Ck – StreamStats)

Reneke Creek 100-yr (1%) Flood Flow = 238 cfs

Peak-Flow Statistics Flow Report [Reg 1 Coastal Cooper]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	ASEp	Equiv. Yrs.
50-percent AEP flood	78.6	ft^3/s	53.7	115	26.8	26.8	2.4
20-percent AEP flood	117	ft^3/s	75.7	181	25.3	25.3	3.7
10-percent AEP flood	145	ft^3/s	91	231	25.6	25.6	5
4-percent AEP flood	181	ft^3/s	97	338	26.6	26.6	6.4
2-percent AEP flood	209	ft^3/s	141	309	27.8	27.8	7.2
1-percent AEP flood	238	ft^3/s	187	303	29.1	29.1	7.9
0.2-percent AEP flood	309	ft^3/s	158	604	32.6	32.6	8.9

Peak-Flow Statistics Citations

Cooper, R.M.,2005, Estimation of Peak Discharges for Rural, Unregulated Streams in Western Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5116, 76 p. (http://pubs.usgs.gov/sir/2005/5116/pdf/sir2005-5116.pdf)

Summary - Setback Dike Alternatives Performance vs. Existing Conditions (at south end of marsh)

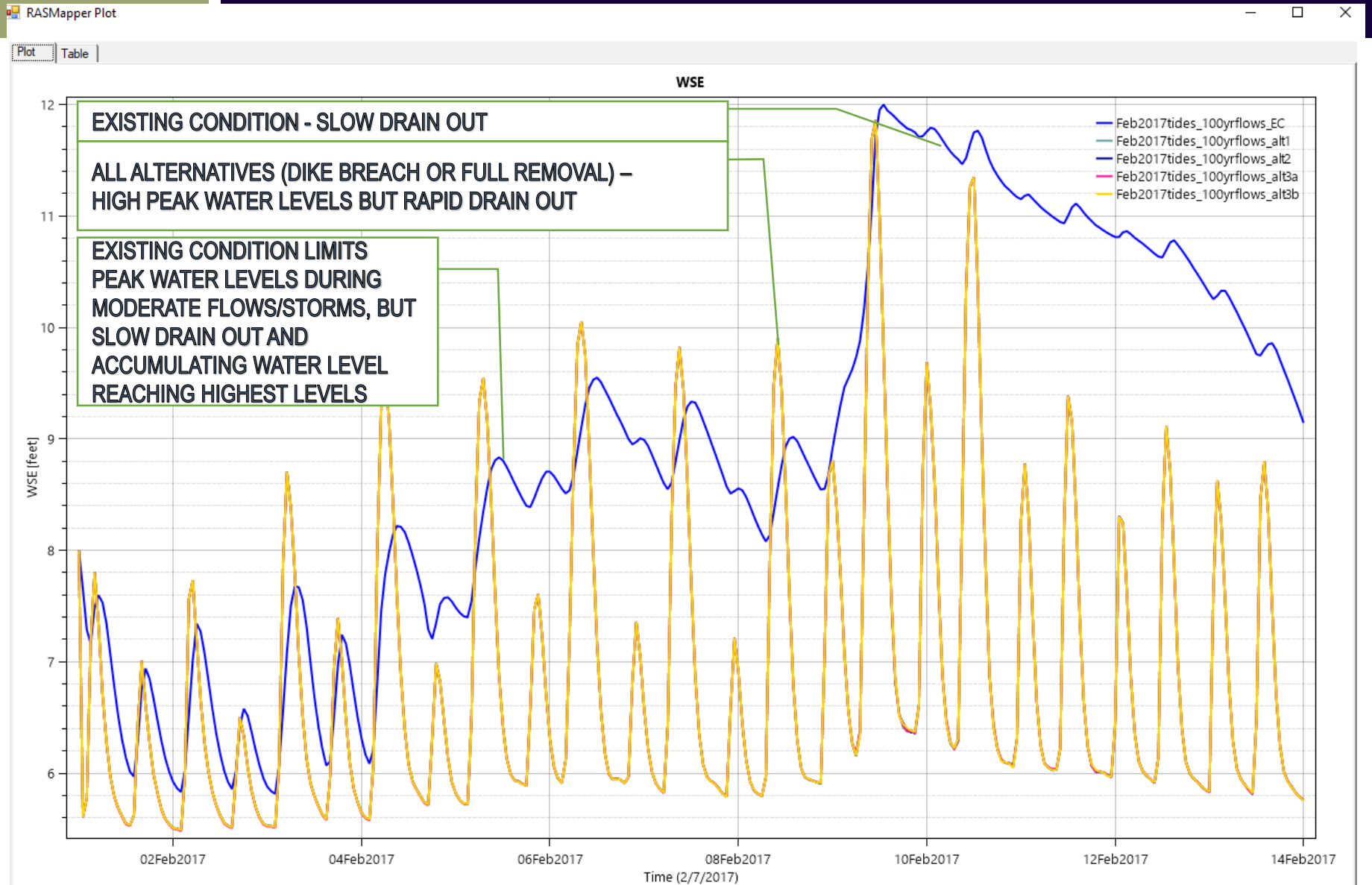
Existing Conditions –

- Tide Gate is now completely missing allowing muted tidal inflow. System currently reduces high tides by ~1.5’ compared to Sand Lake (0.5’ higher tide levels in marsh than in 2017)
- Existing 4’x4’ box culvert causes slow drain out during storms and prolonged high-water levels
- Existing beaver dams maintain water level at ~8’ NAVD88

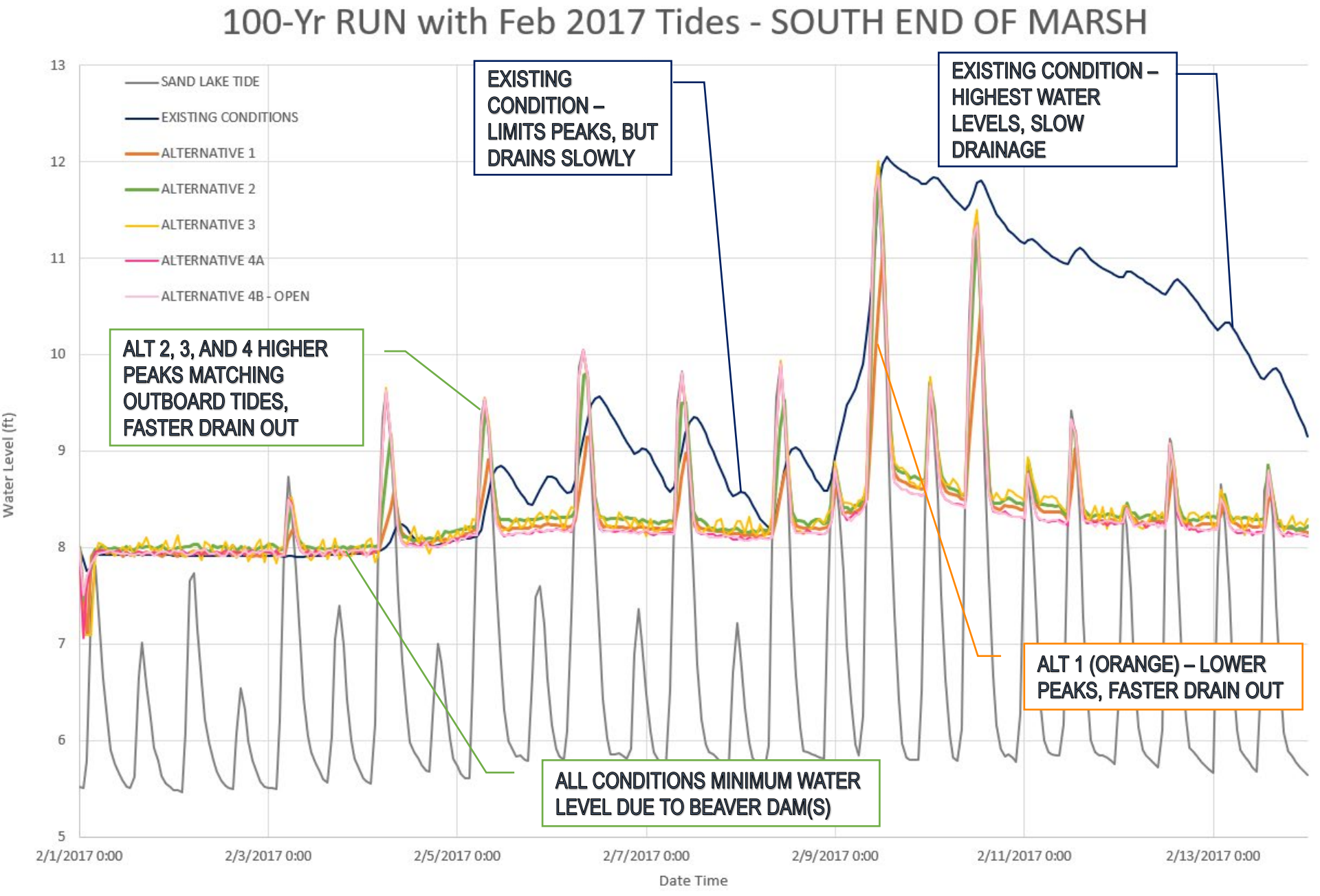
Setback Dike Alternatives

- All setback dike alternatives (including 4B) perform better than existing conditions during large storm events due to slow drain out of existing 4’x4’ box culvert
- Alternative 1 has sufficient storage during 100-year storm to reduce peak water levels
- Alternatives 2 and 3 cause similar peak water levels to Existing Conditions during storms, but drain out much faster
- Alternatives 4A and 4B allow higher daily tides than Existing Conditions, but drain out much faster during storms

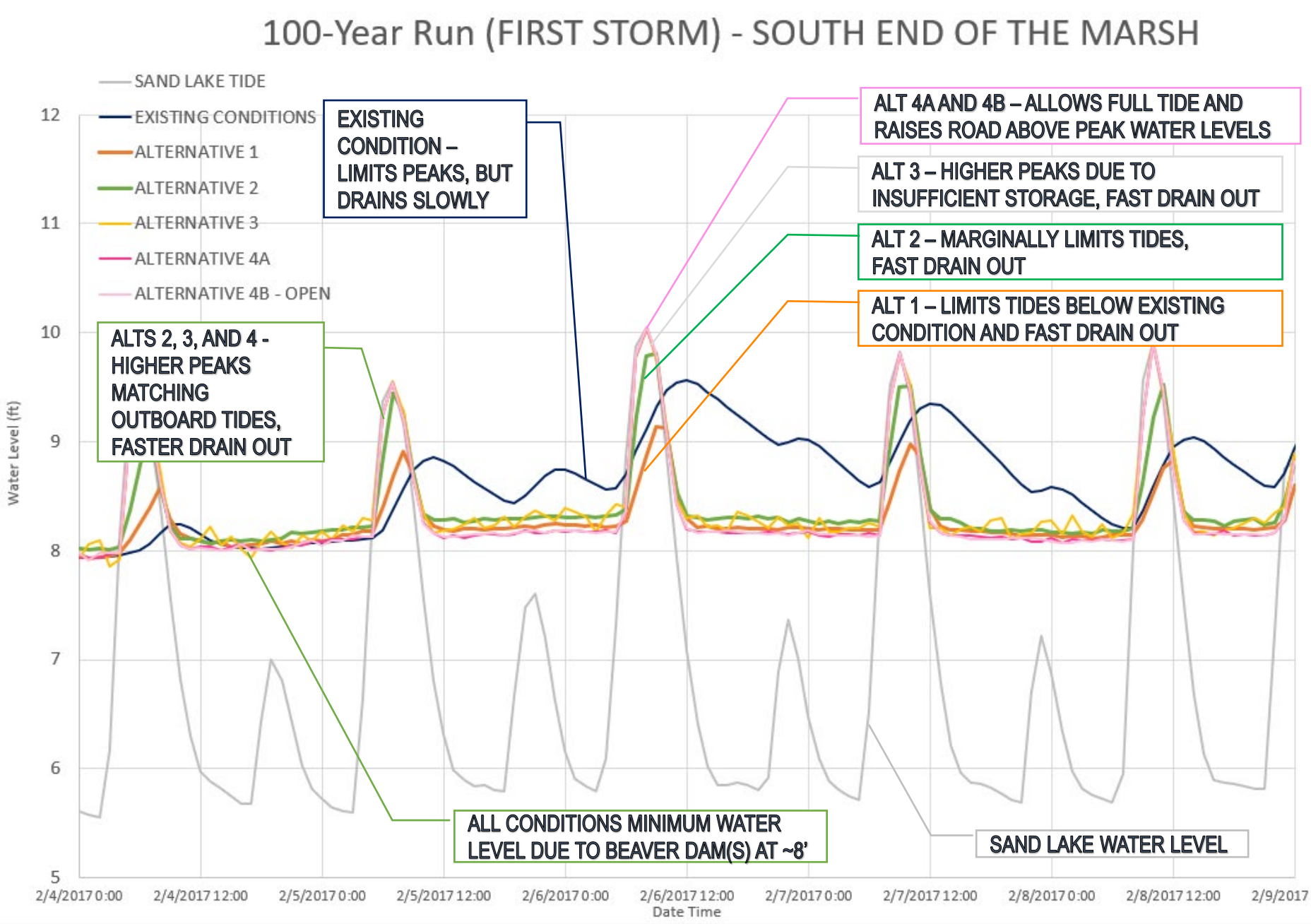
2D Modeling Results – Inside Beltz Dike



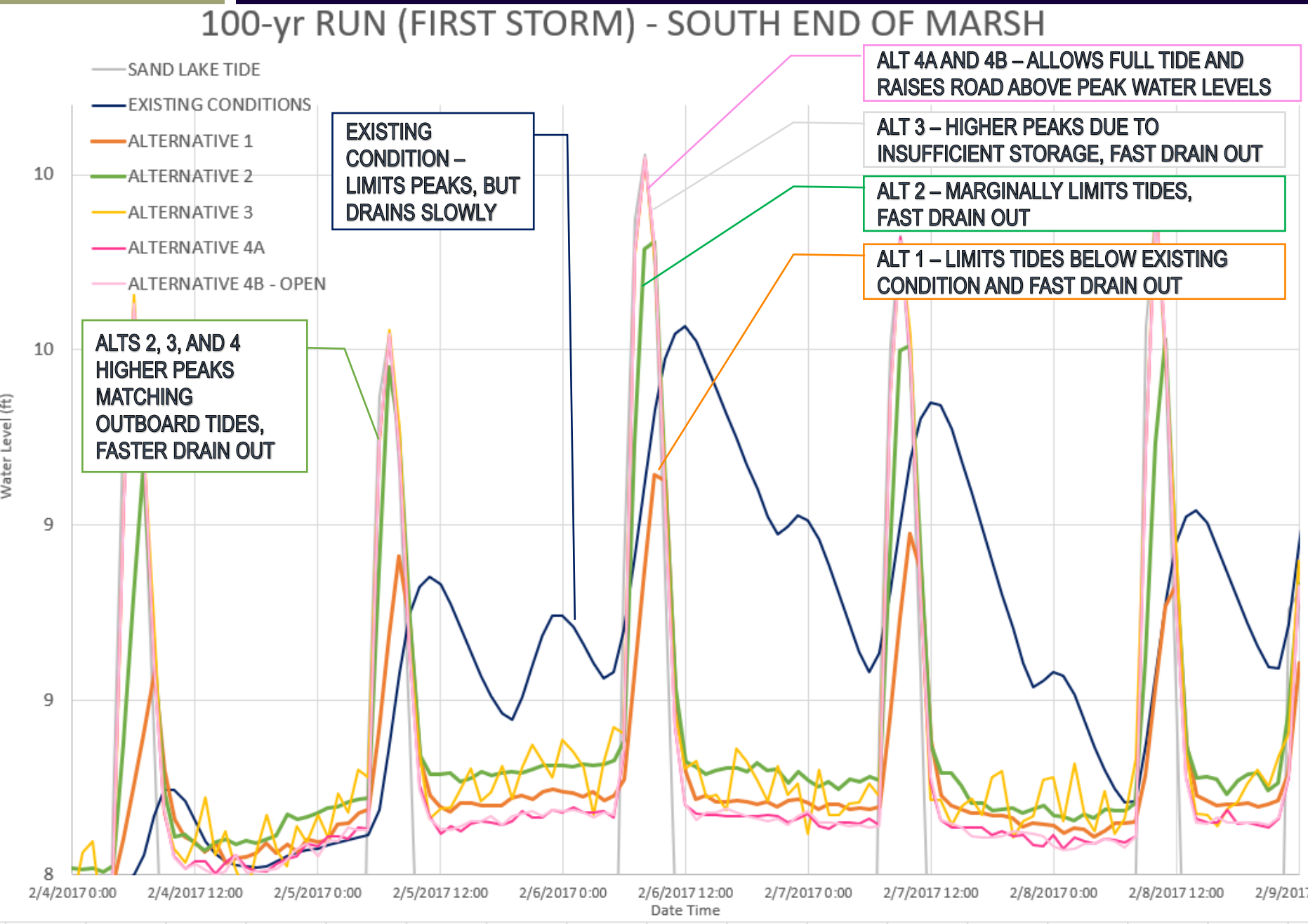
2D MODEL RESULTS – 100-YR RUN



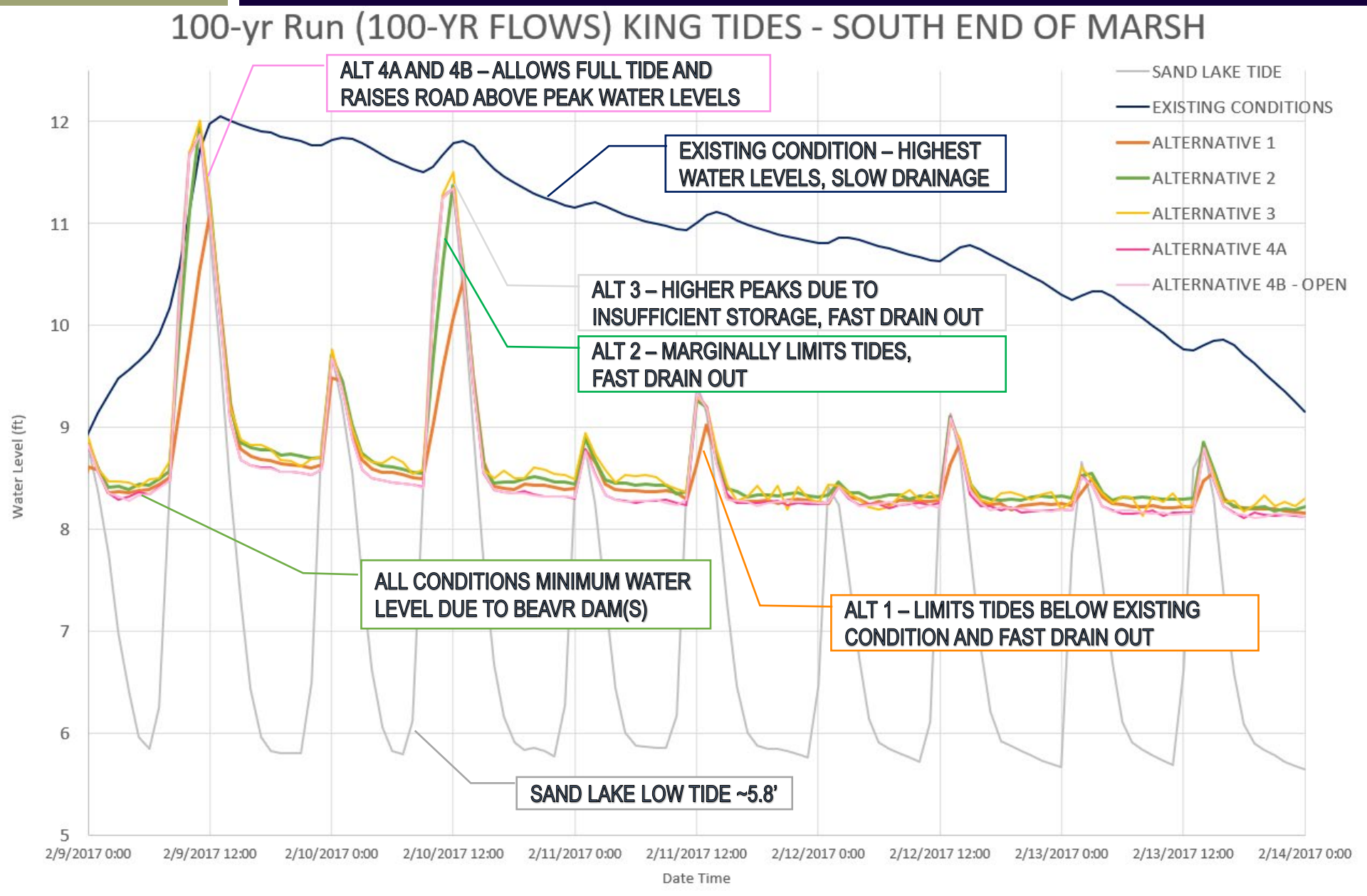
2D MODEL RESULTS – 10' TIDES, 2-YR FLOWS



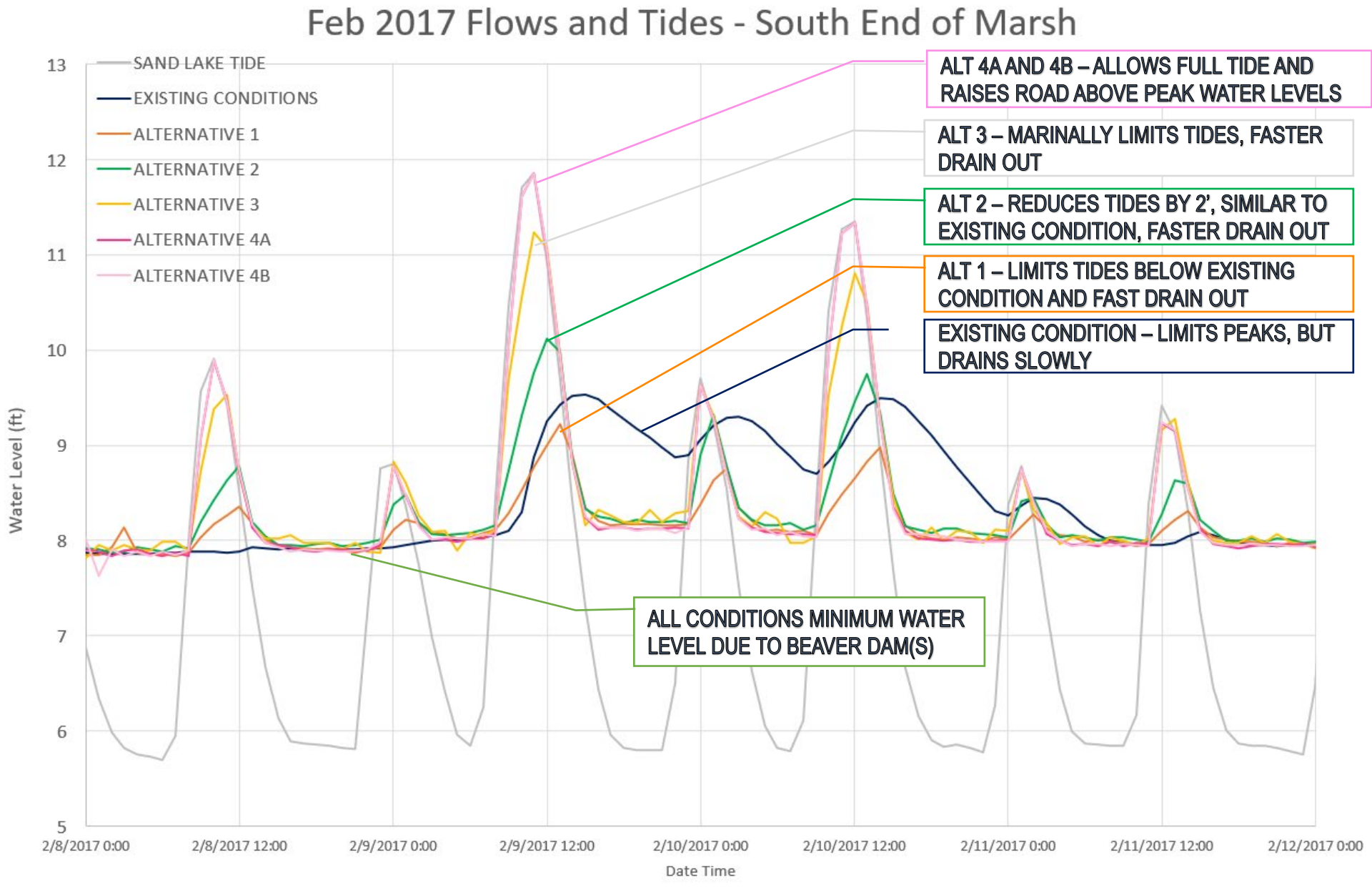
2D MODEL RESULTS – 10' TIDES, 2-YR FLOWS



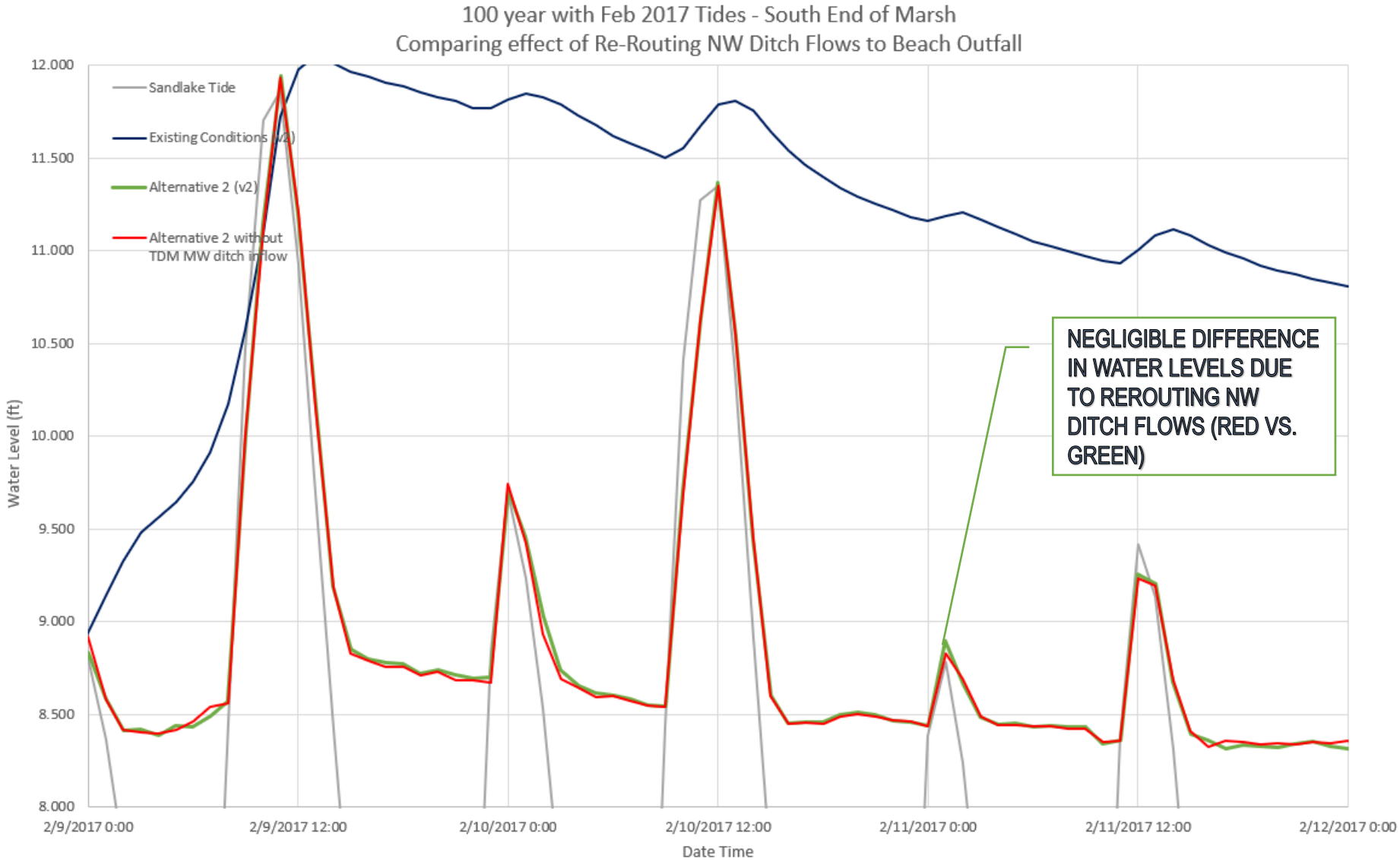
2D MODEL RESULTS – 100-YR FLOWS + KING TIDES



2D MODEL RESULTS – 2017 FLOWS AND TIDES (ANNUAL WINTER FLOOD EVENT)



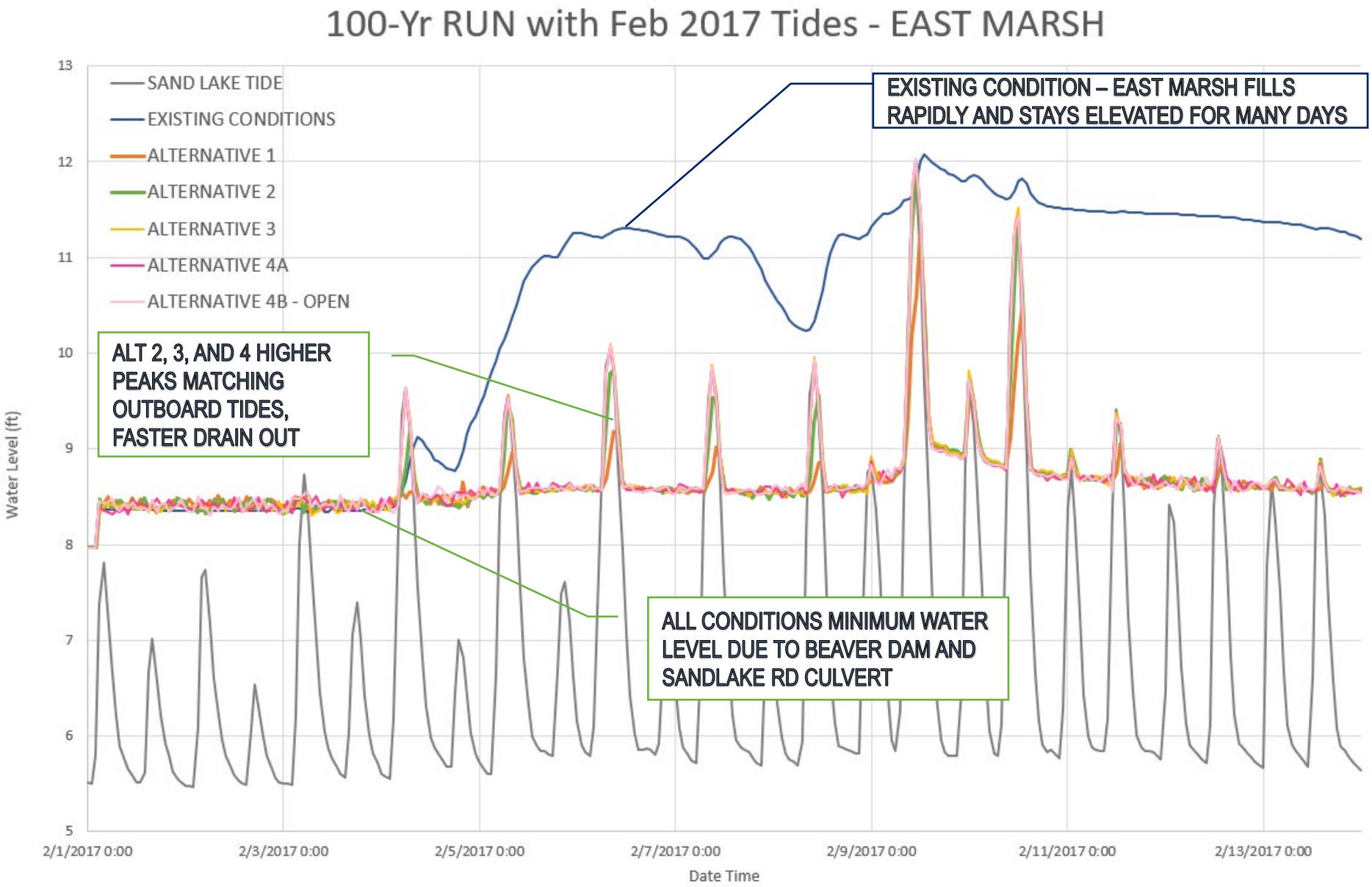
Testing effect of re-routing NW Ditch flows to new beach outfall(s)



Testing effect of re-routing NW Ditch flows to new beach outfall(s)

- **Re-routing NW Ditch Flows to new beach outfall(s) does not improve setback dike performance**
- **Would still be beneficial to relieve localized ponding in depressional areas (Lake Austin, Pier Ave, Jasmine)**

East Marsh Levels (All Alts assume upsized culvert at Sand Lake Rd)



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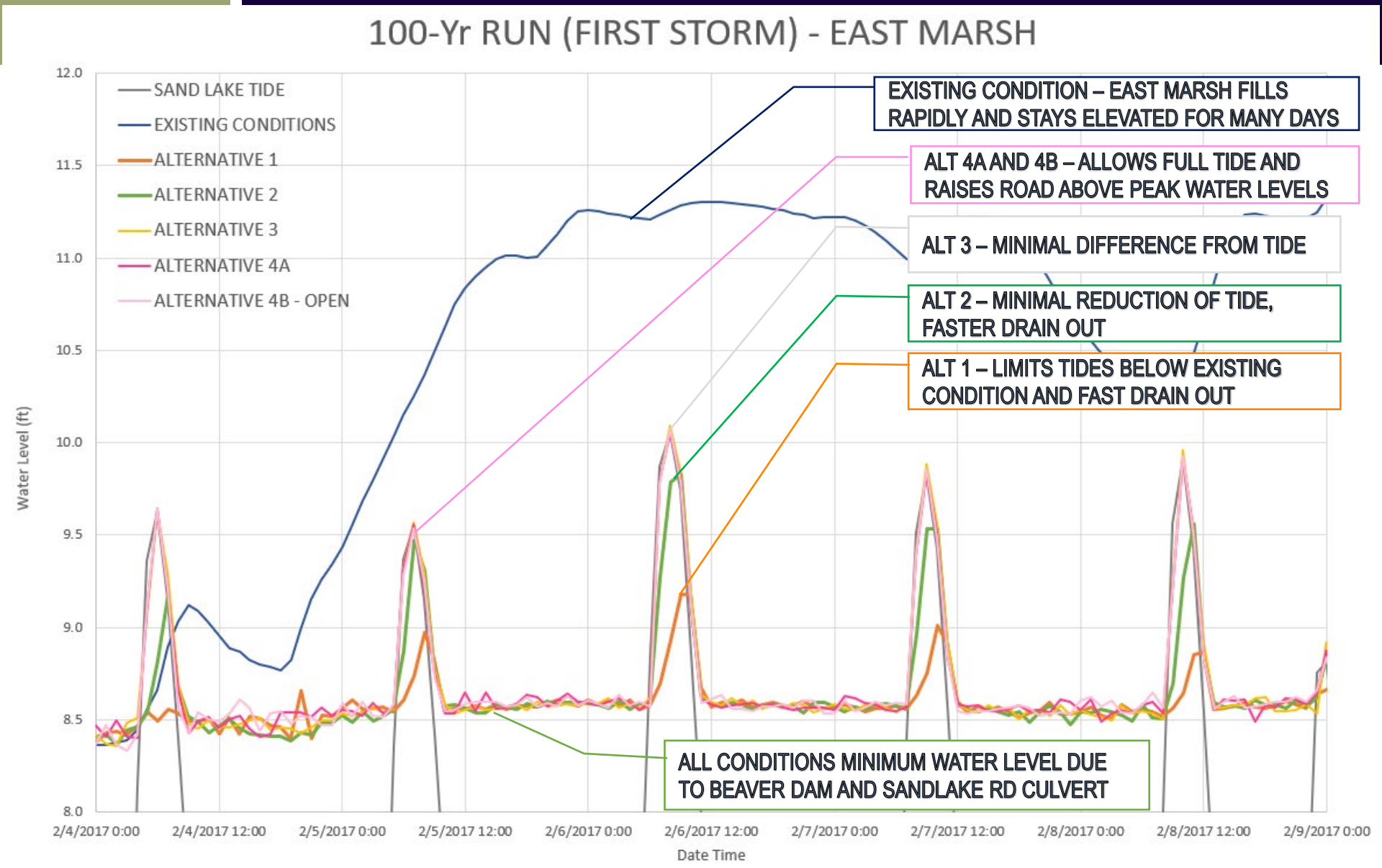

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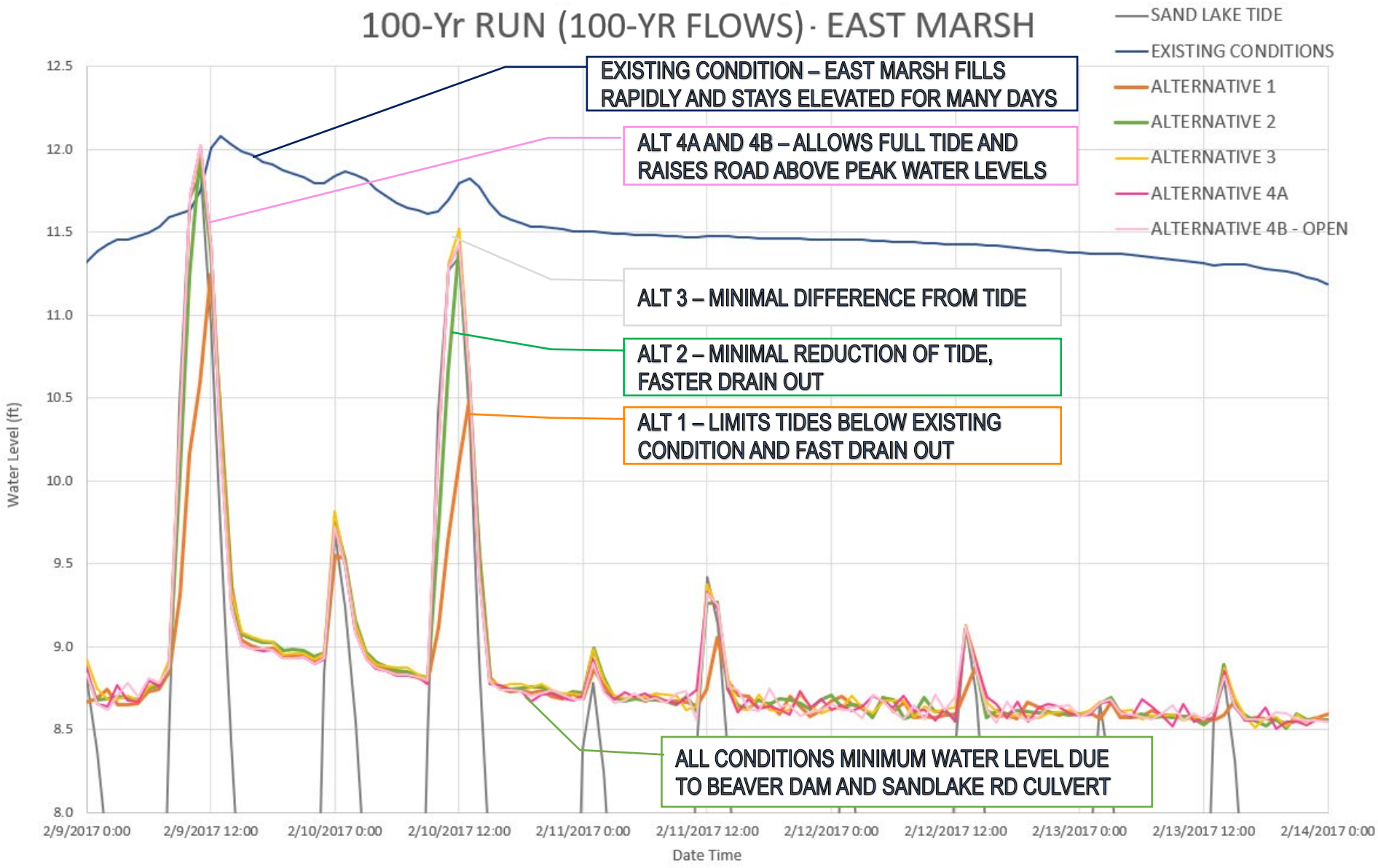
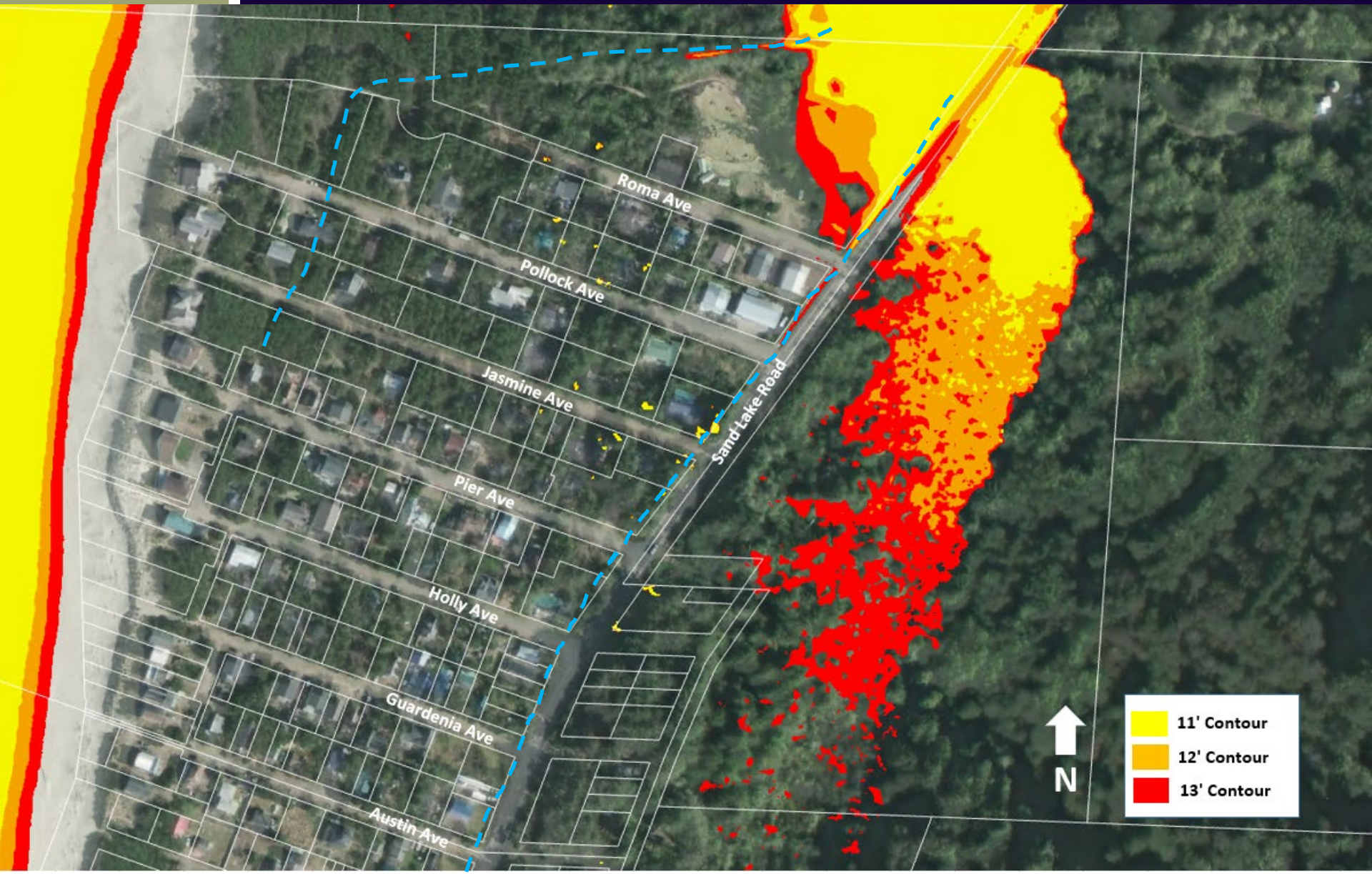
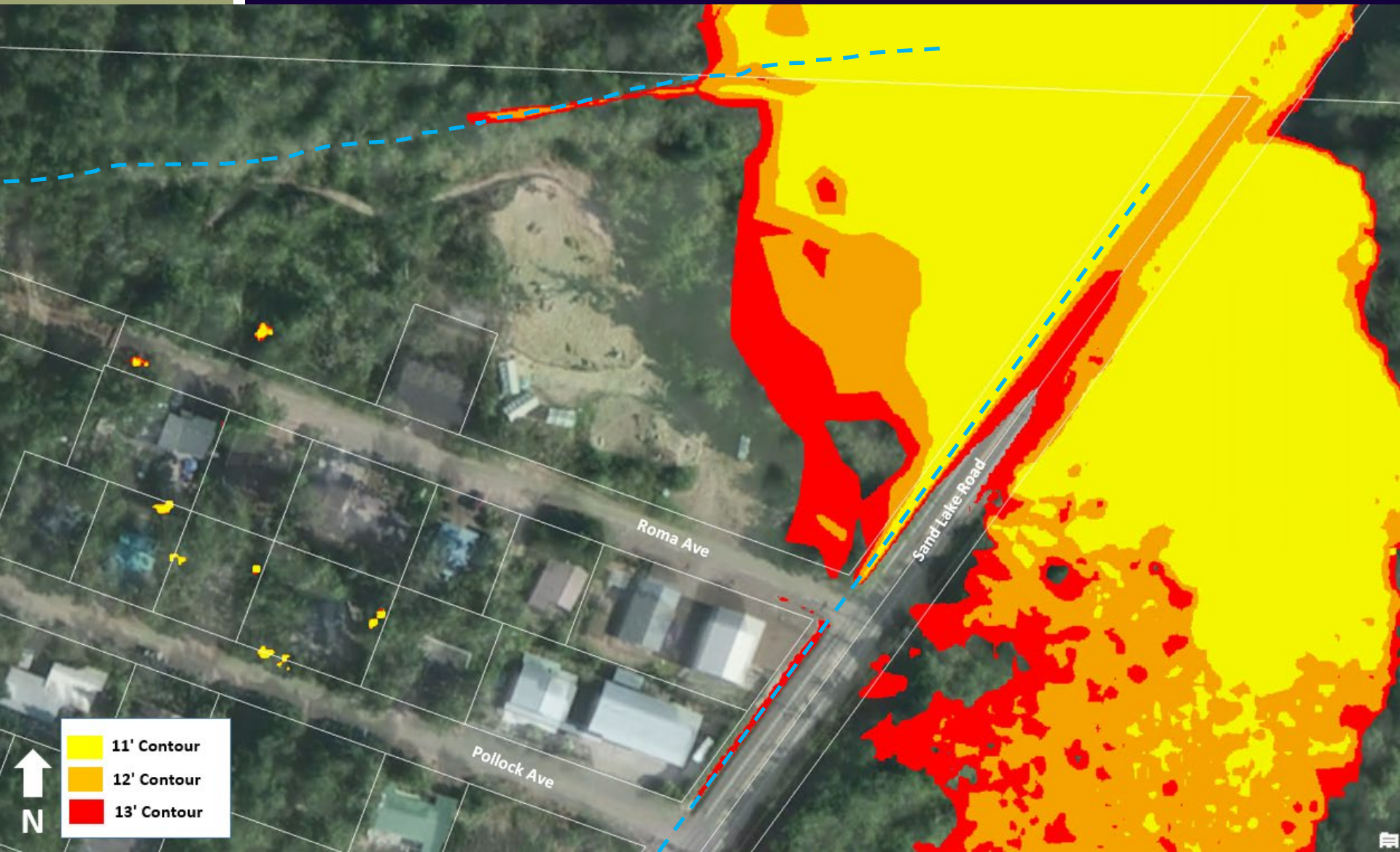


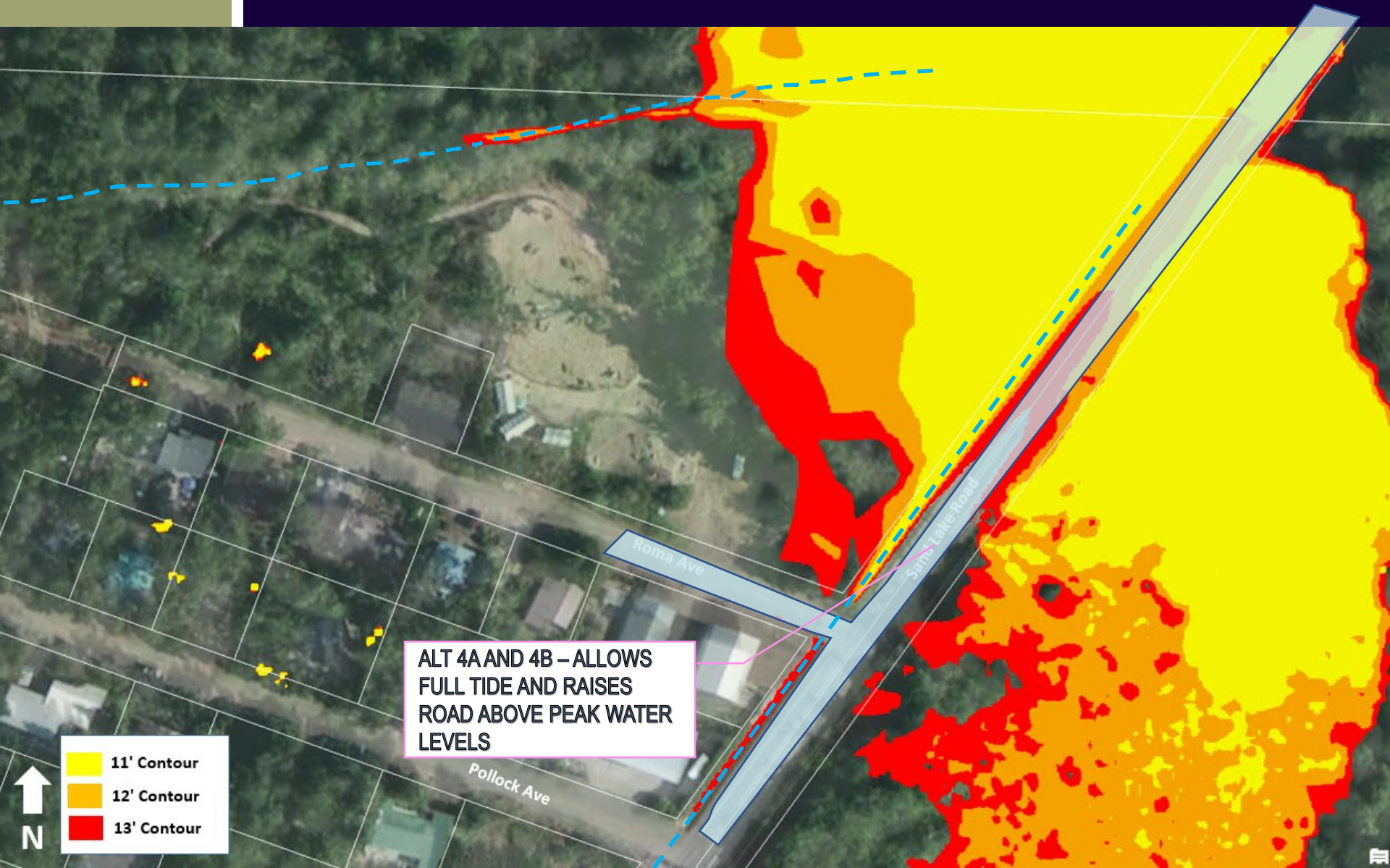
Inundation Extent Mapping (up to 13' NAVD88)



Inundation Extent Mapping (up to 13' NAVD88)



Inundation Extent Mapping (up to 13' NAVD88) - Raise Sand Lake Rd to 15'



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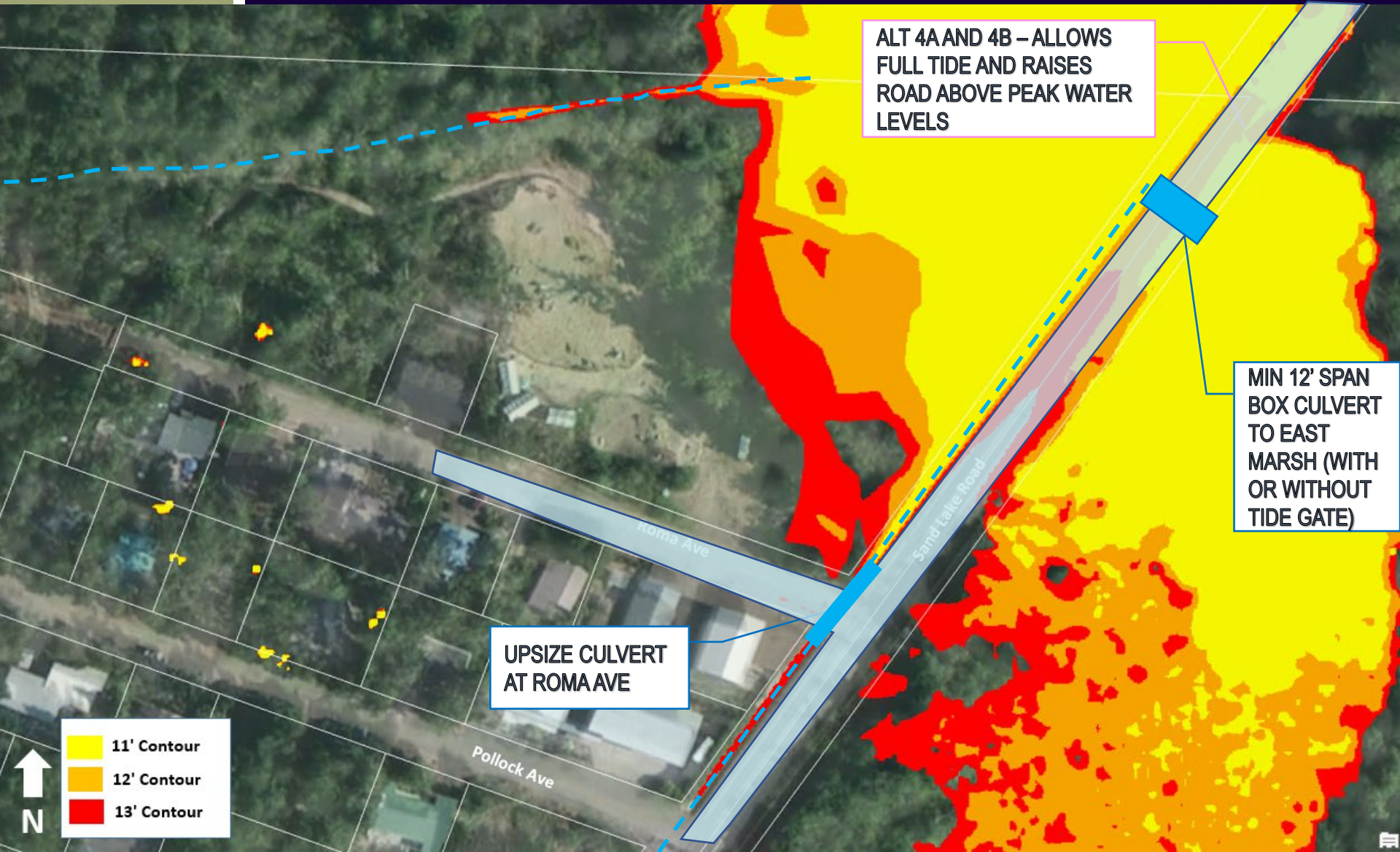
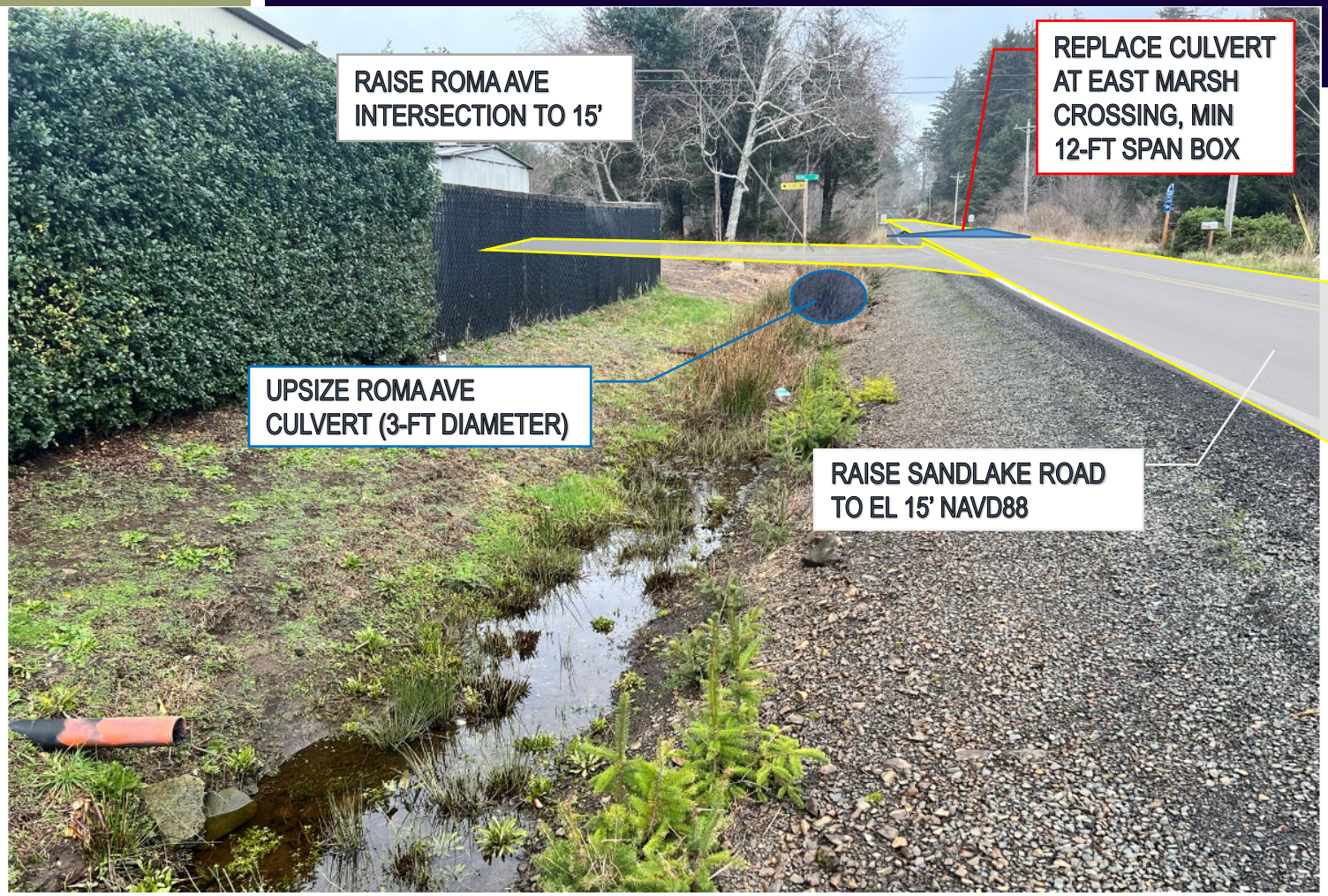
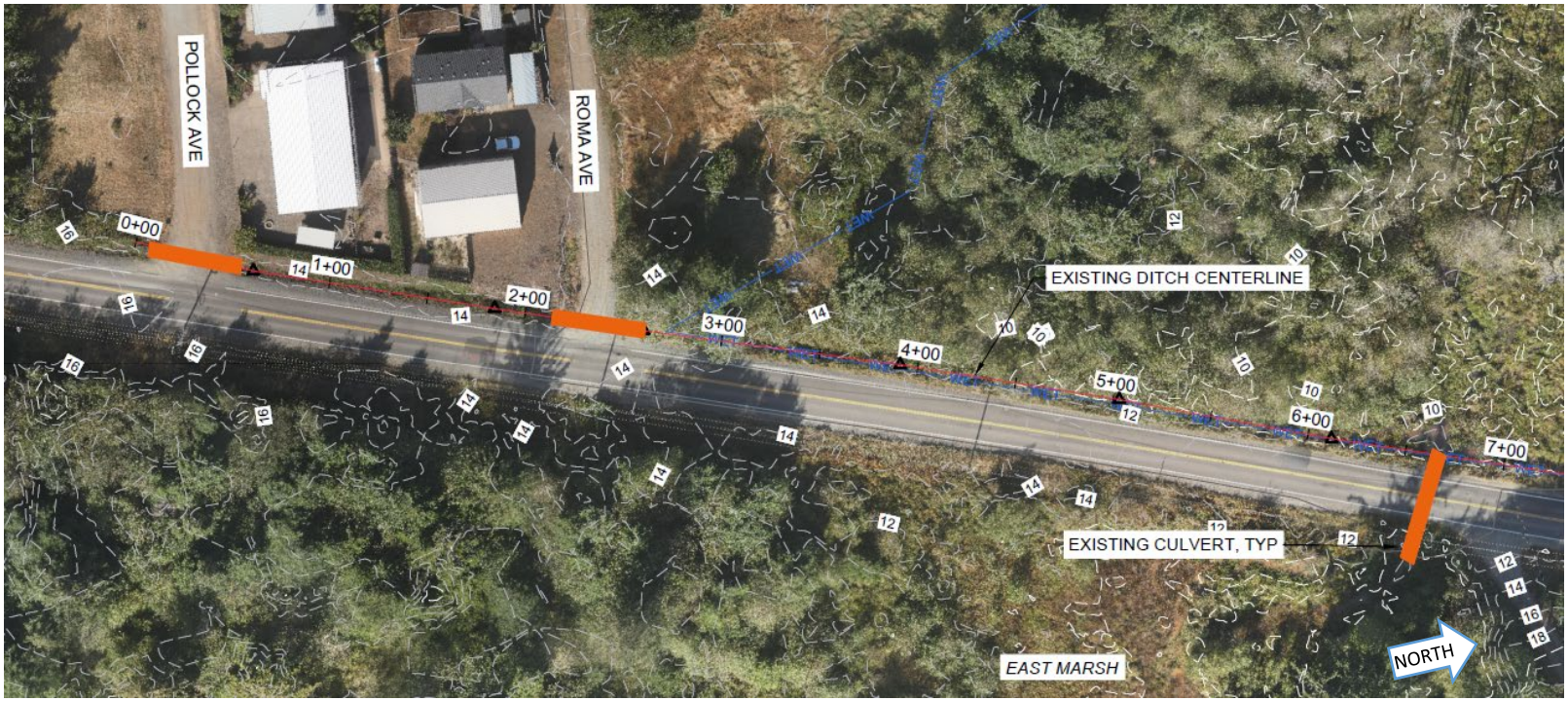


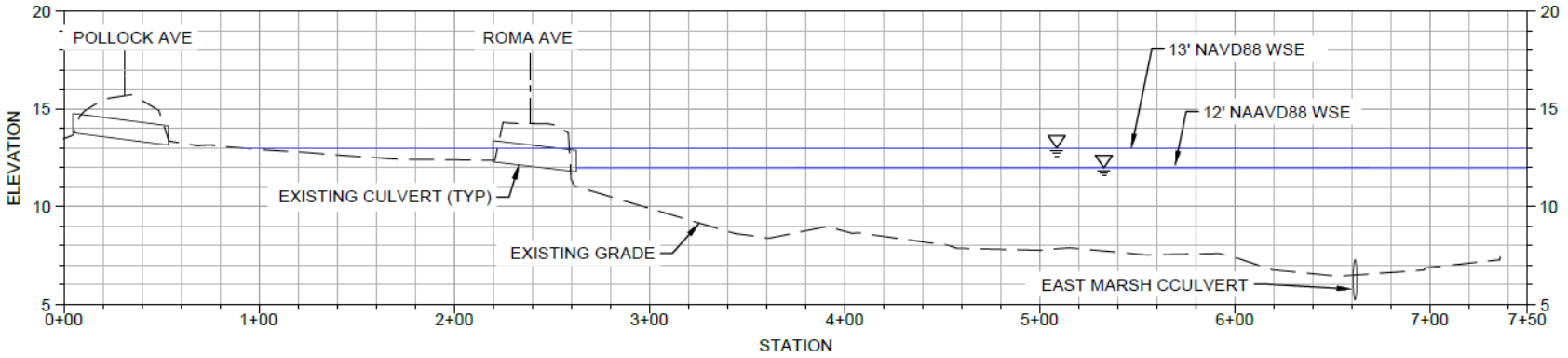
Sandlake Rd and Roma Ave – potential road raising (Alt 4a and Alt 4b)



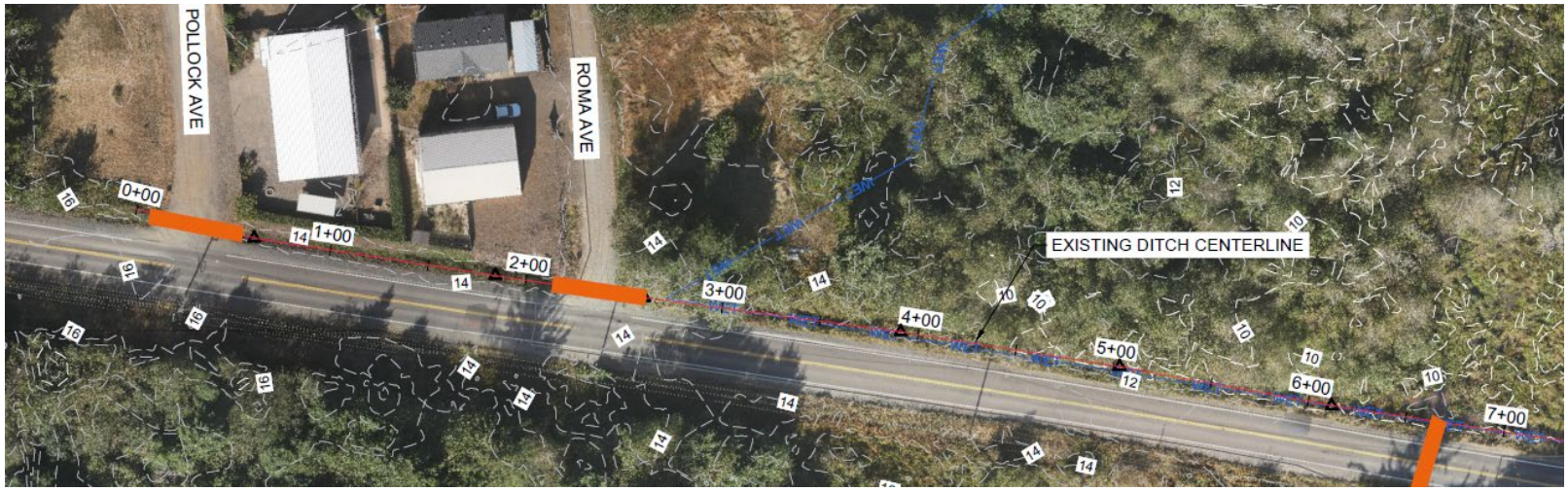
- Facing north, looking at Sand Lake Rd/Roma Ave intersection. Consider raising both roads by 3-4 feet to act as high ground/setback dike

Sandlake Rd Ditch Profile relative to 12' and 13' water levels





Sandlake Rd Ditch Profile w/ Alt 4 Improvements

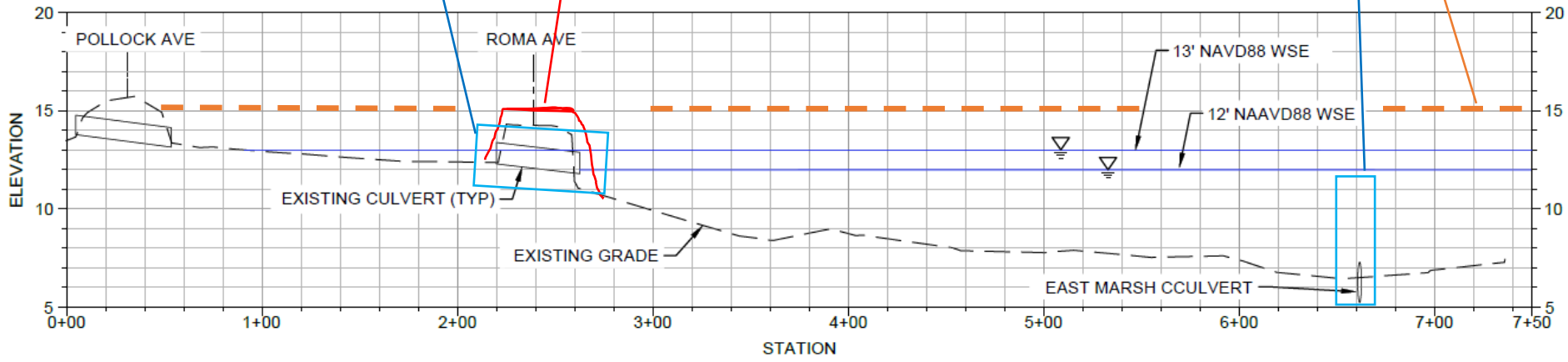


RAISE SAND LAKE RD TO 15' NAVD88

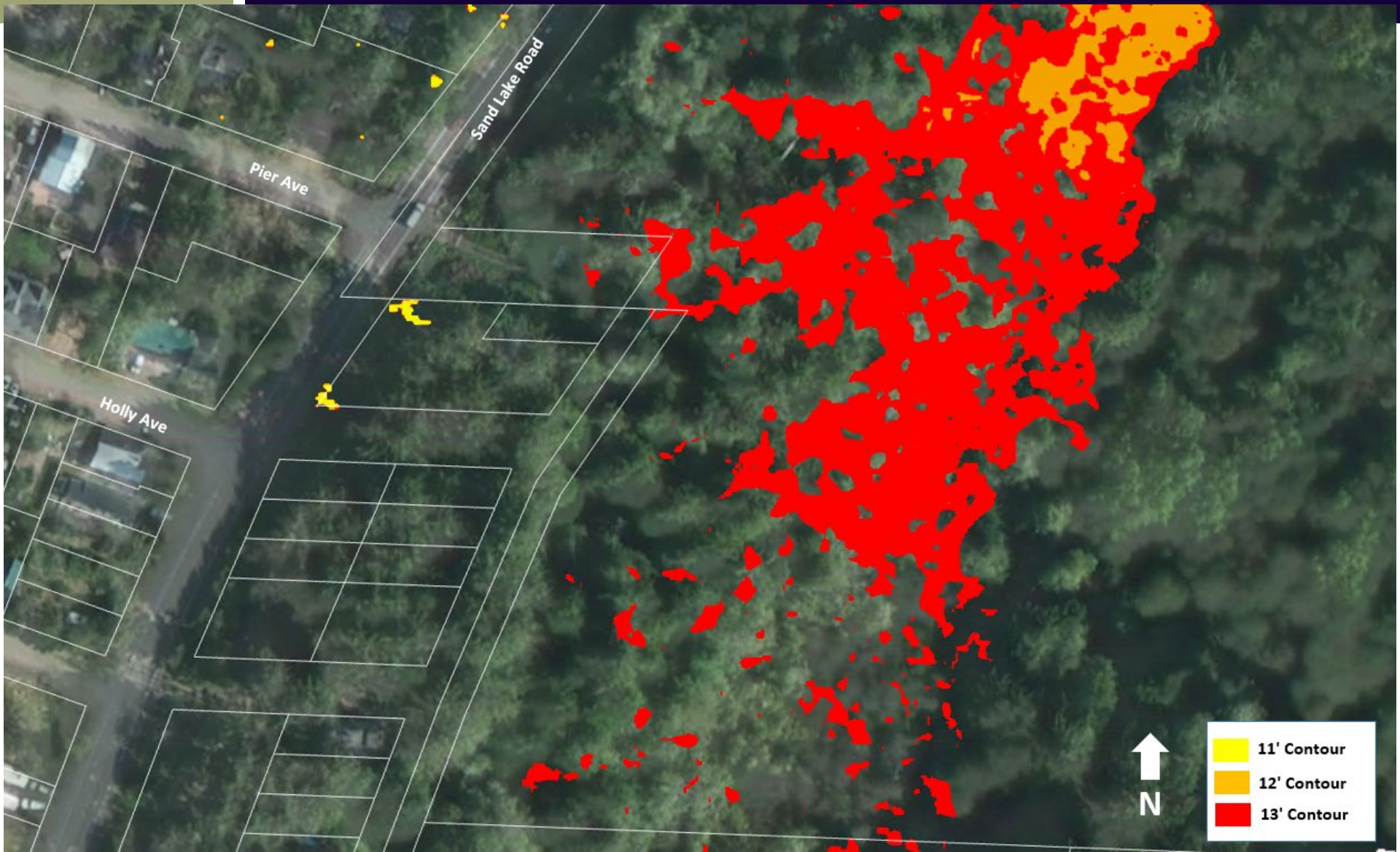
UPSIZE EAST MARSH CULVERT TO 12' BOX, WITH OR WITHOUT TIDE GATE

UPSIZE ROMA AVE CULVERT (3-FT DIAMETER)

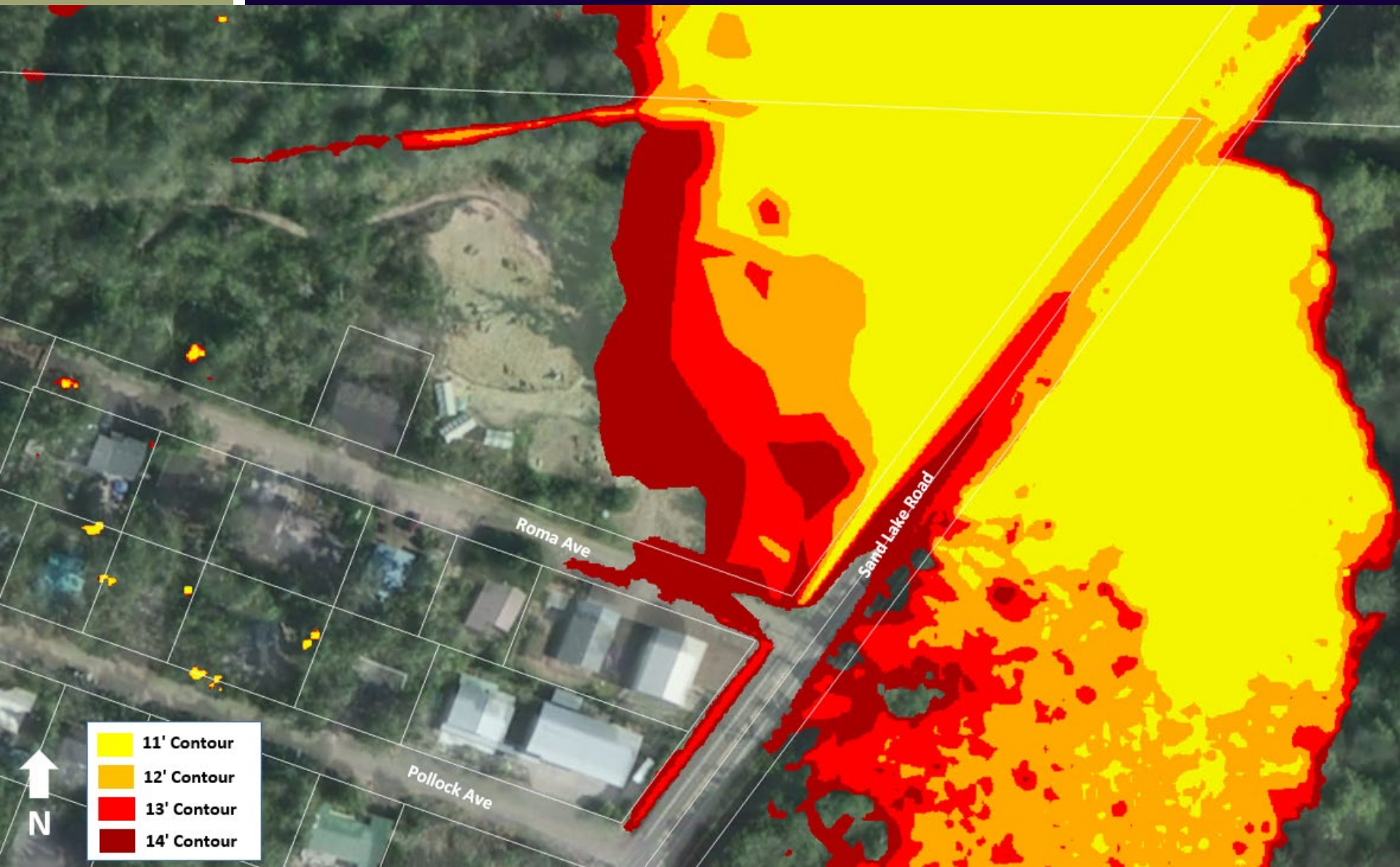
RAISE END OF ROMA AVE ~1' TO EL 15' NAVD88



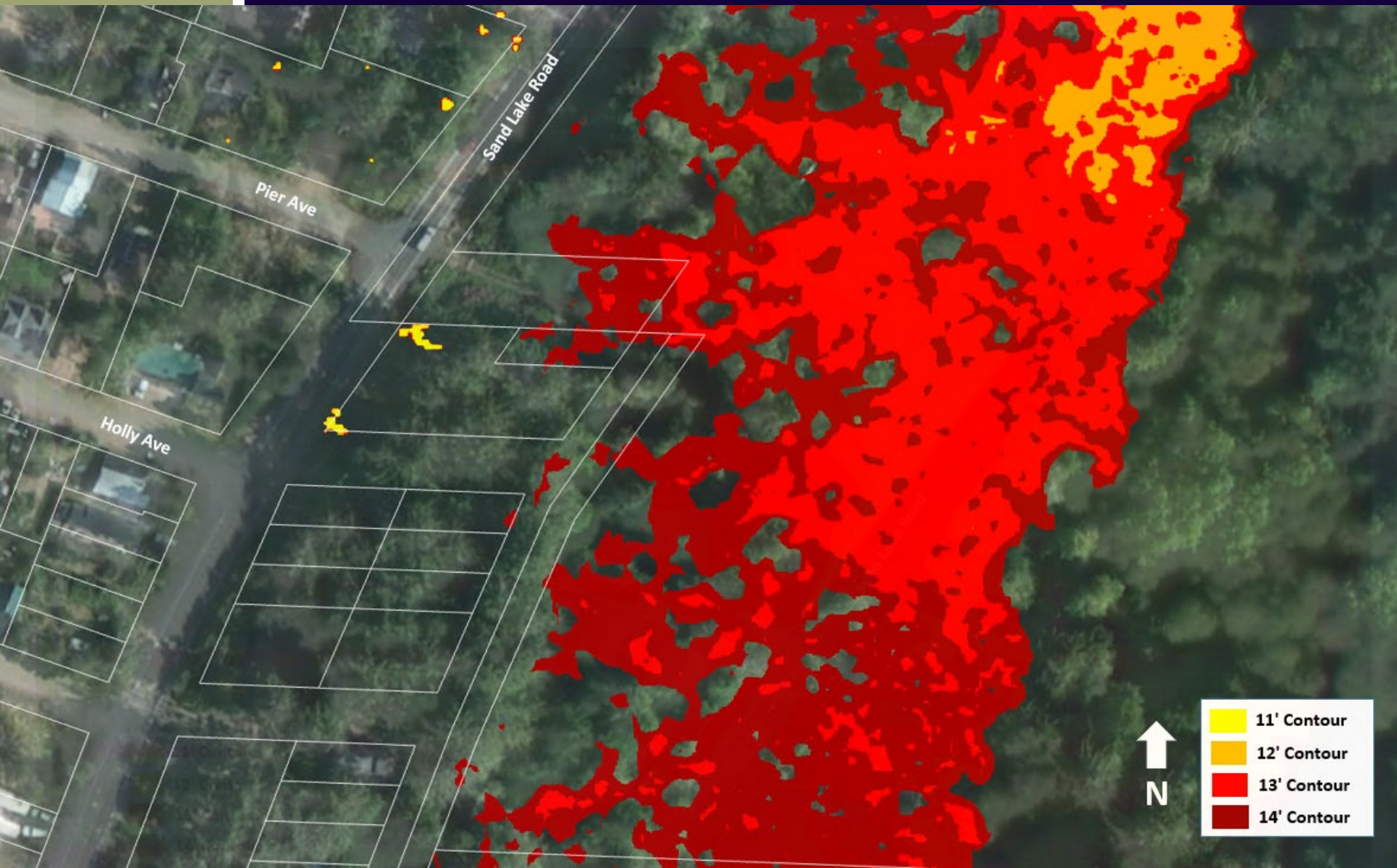
Potential Inundation Extent Mapping (up to 13' NAVD88)



Potential Inundation Extents (up to 14' NAVD88 does not currently occur)



Potential Inundation Extents (up to 14' NAVD88 does not currently occur)



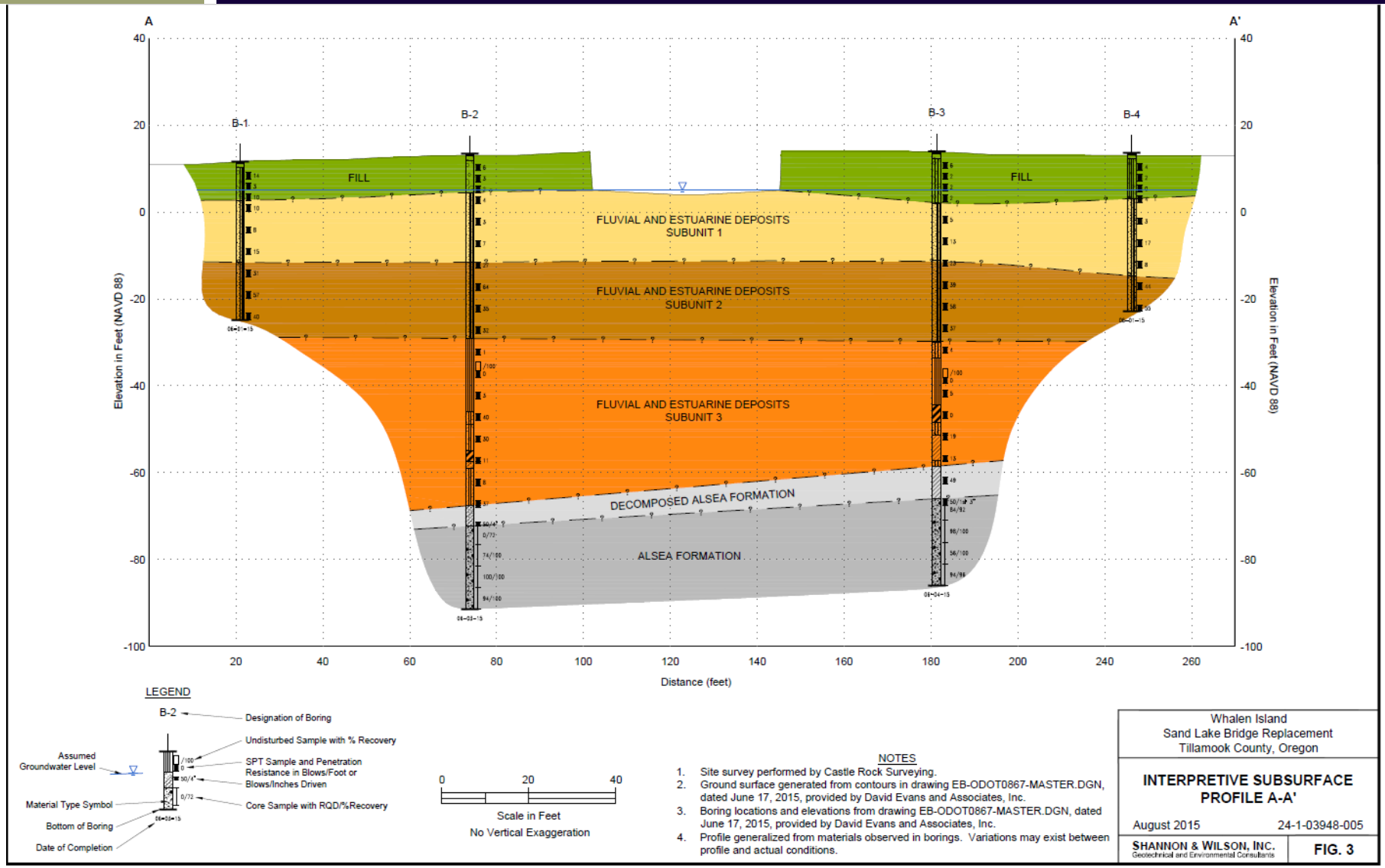
Setback Dike Feasibility Considerations

- **Storage area/volume** needed for 100-year storms vs. wetland impact/restored area

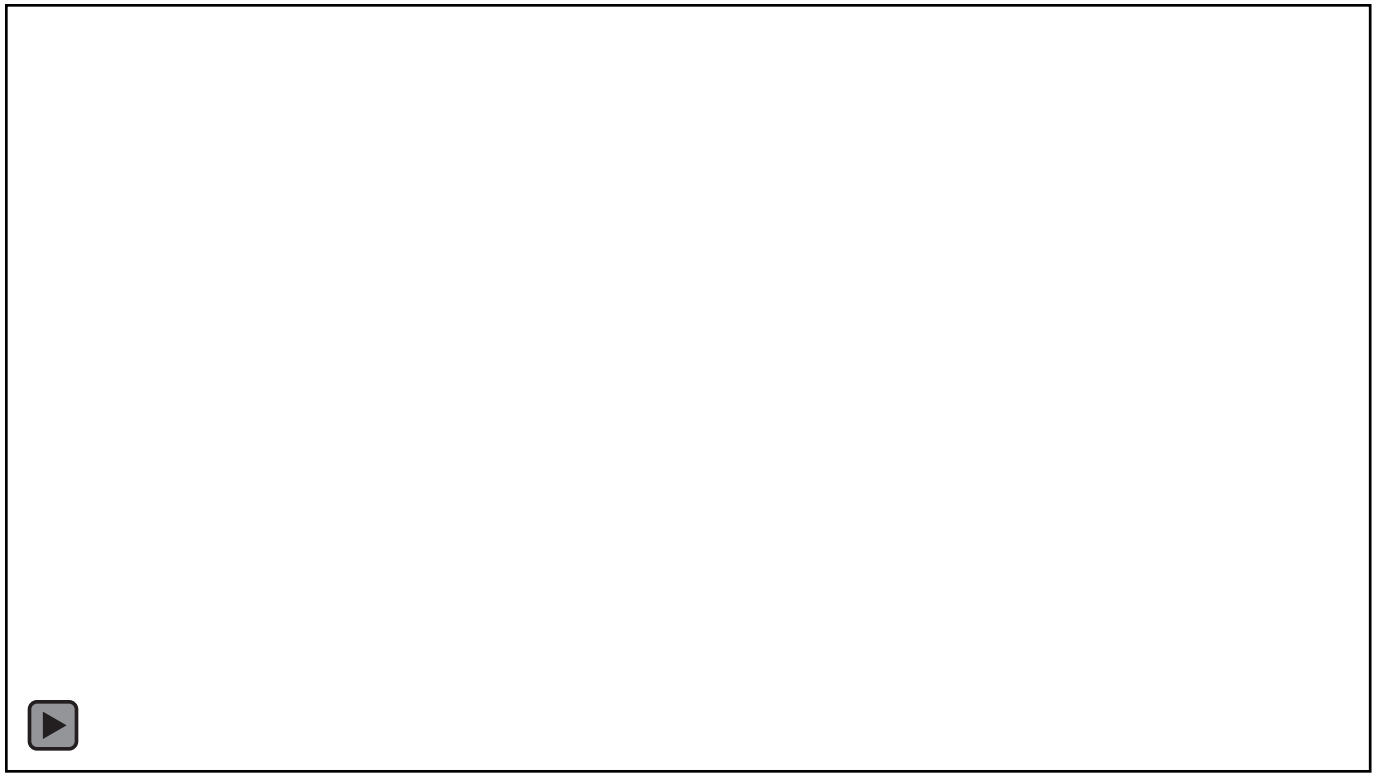
- New culvert(s) and tide gate(s) in area of **heavy beaver activity**
  - Alt 1 setback dike at/adjacent to location of existing dam and lodge
  - Alts 2 & 3 setback dike upstream of beaver dam (backwatered to 7.5’ to 8’ NAVD88)
  - Maintenance and functionality implications

- **Functionality of culverts and tide gate**
  - MTR tide gate almost always open, only closing at higher tides (MTR setting = 8’ or higher)
  - Invert elevation of culvert(s)
    - Lower inverts permanently submerged/backwatered by impoundments, and subject to blockage by beaver
      - Sand Lake low tide = 5.5’ NAVD88
      - Beaver Dam impounds water at 7.5-8’ NAVD88
    - Additional/higher elevation culverts with flap gates could drain off marsh plain during higher flows

Geotechnical Conditions/Considerations



Setback Dike Area – challenging geotechnical conditions



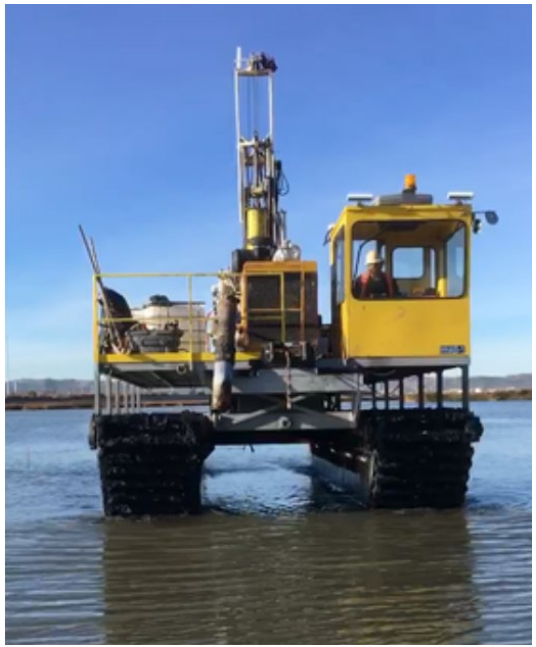
- Cattail mat over very soft/saturated soils – pumping with foot traffic

Setback Dike Feasibility Considerations

- **Geotechnical Engineering Challenges and Considerations**
  - Expect several feet of settlement along setback dike due to weight of fill
  - Settlement at new culvert/tide gate structure
  - Seepage in sandy soils – seepage analysis needed
  - Extent of subgrade excavation, preparation, stabilization
  - Suitability/sourcing fill material
  - Tie-in locations on either end – benching into existing embankments
  - Potential settlement on Sandlake Rd at tie in
  - Groundwater upwelling locations
  - Pockets of very soft surface soils and floating mats of vegetation

Setback Dike Feasibility Considerations

- Challenging to collect geotechnical borings along setback dike and tide gate location
- Specialized amphibious drill rig, expensive to mobilize from out of state and would impact vegetation/marsh surface to access
- Hand auger borings difficult, holes would collapse with very wet soils
- First steps would be to collect additional borings at existing dike, Sandlake Rd, and possibly edge of marsh using traditional drilling equipment
    - While collecting useful data for culvert replacements and bridge design



Setback Dike Alternatives – Cost Comparison

1 - Setback Dike near Extg Beaver Dam - 12' box with MTR

	Low Est	High Est
Setback Dike across marsh	$500,000	$1,000,000
Box culvert and MTR Tide Gate	$350,000	$500,000
Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$55,000	$150,000
Reveg/Habitat Enhancements	$25,000	$75,000
TOTAL (range)	**$995,000**	**$1,875,000**

2 - Setback Dike 300' S of Dam - 12' box with MTR

	Low Est	High Est
Setback Dike across marsh	$350,000	$750,000
Box culvert and MTR Tide Gate	$350,000	$500,000
Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$55,000	$150,000
Reveg/Habitat Enhancements	$25,000	$75,000
TOTAL (range)	**$845,000**	**$1,625,000**

3 - Setback Dike at Park Boundary - 12' box with MTR

	Low Est	High Est
Setback Dike across marsh	$200,000	$500,000
Box culvert and MTR Tide Gate	$350,000	$500,000
Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$55,000	$150,000
Reveg/Habitat Enhancements	$25,000	$75,000
TOTAL (range)	**$695,000**	**$1,375,000**

4 - Raise Sandlake Road and Roma Ave Approach

	Low Est	High Est
Setback Dike across marsh	$0	$0
Box culvert and MTR Tide Gate	$350,000	$500,000
Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$1,500,000	$2,200,000
Reveg/Habitat Enhancements	$25,000	$75,000
TOTAL (range)	**$1,940,000**	**$2,925,000**

Setback Dike Alternatives – Construction Cost Comparison

1 - Setback Dike near Extg Beaver Dam - 12' box with MTR

	Low Est	High Est
Setback Dike across marsh	$500,000	$1,000,000
Box culvert and MTR Tide Gate	$350,000	$500,000
Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$55,000	$150,000
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Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$55,000	$150,000
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TOTAL (range)	**$845,000**	**$1,625,000**

3 - Setback Dike at Park Boundary - 12' box with MTR

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Setback Dike across marsh	$200,000	$500,000
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Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$55,000	$150,000
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TOTAL (range)	**$695,000**	**$1,375,000**

4 - Raise Sandlake Road and Roma Ave Approach

	Low Est	High Est
Setback Dike across marsh	$0	$0
Box culvert and MTR Tide Gate	$350,000	$500,000
Water management, ESC	$65,000	$150,000
Access/Traffic/Roadway	$1,500,000	$2,200,000
Reveg/Habitat Enhancements	$25,000	$75,000
TOTAL (range)	**$1,940,000**	**$2,925,000**

*** - Minimum/Additional Sandlake Rd Improvements with Alts 1-3**

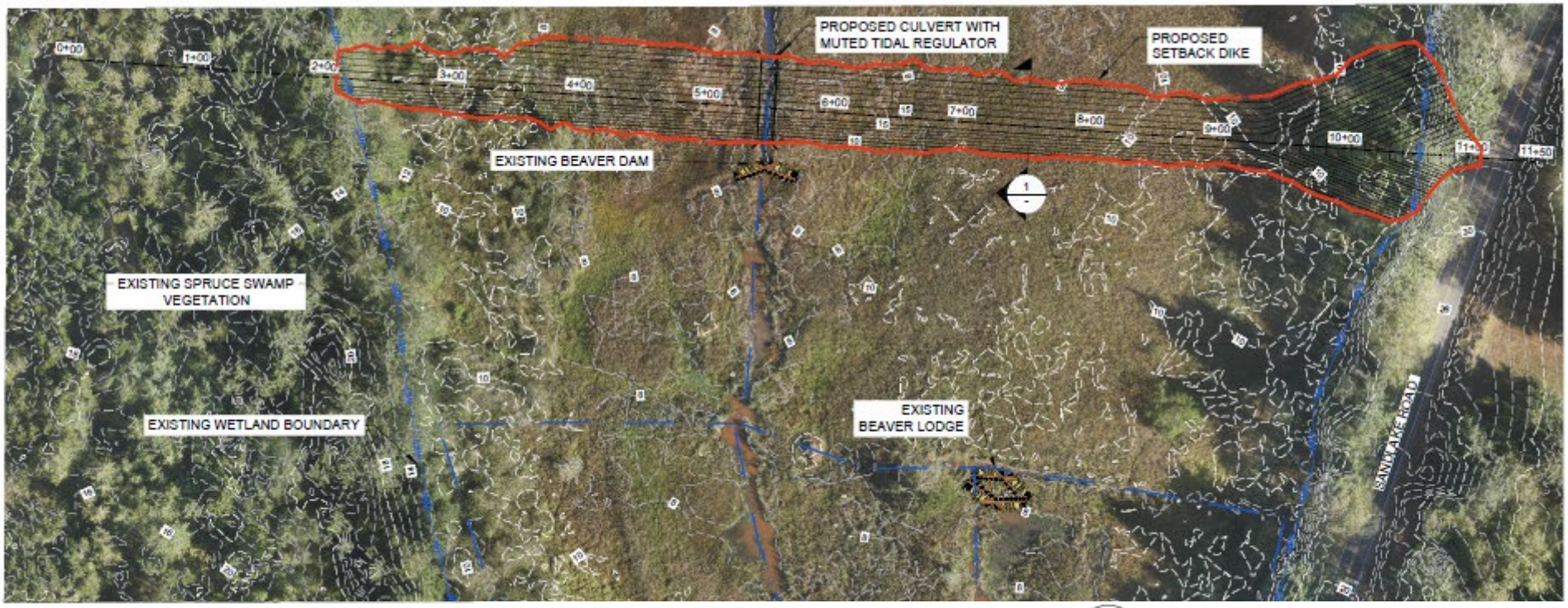
Box Culvert and Min road raising to more extensive improvements

	Low Est	High Est
Box Culvert (or bridge)	$250,000	$800,000
Water Mgmt, ESC	$65,000	$150,000
Access/Traffic/Roadway	$350,000	$800,000
Reveg/Habitat Enhancements	$25,000	$75,000
TOTAL (range)	**$690,000**	**$1,825,000**

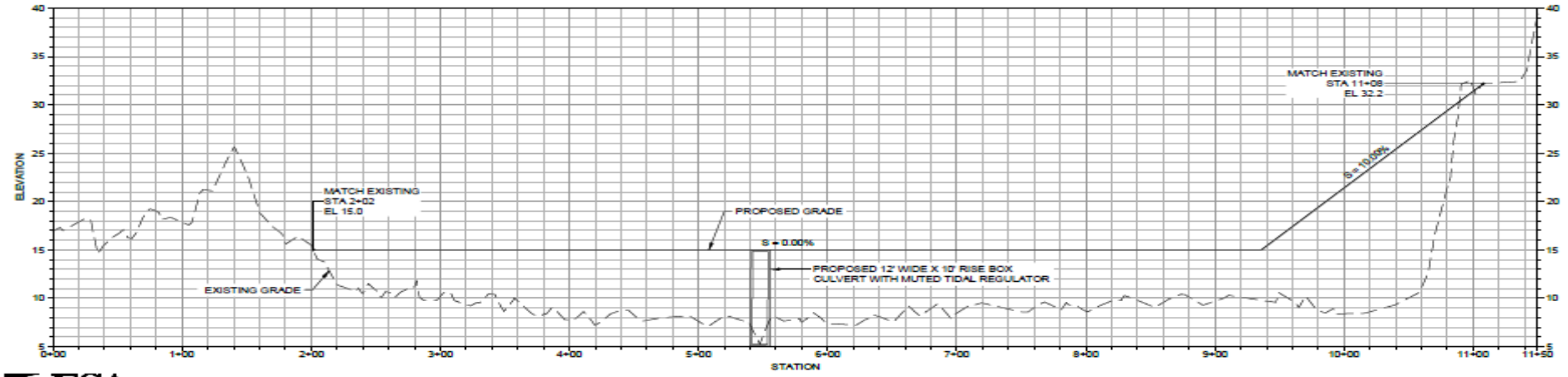
Alternatives – Construction Cost Comparison Summary

Alt	*Description*	Low Est	High Est
A	100-150' dike breach with Pedestrian Bridge	$700,000	$1,600,000
B	200-250' dike breach with Pedestrian Bridge	$1,350,000	$2,300,000
C	Full Dike Removal with Boardwalk across Marsh	$4,150,000	$6,750,000
1	Setback Dike near Extg Beaver Dam - 12' box with MTR	$995,000	$1,875,000
2	Setback Dike 300' S of Dam - 12' box with MTR	$845,000	$1,625,000
3	Setback Dike at Park Boundary - 12' box with MTR	$695,000	$1,375,000
4	Raise Sandlake Road and Roma Ave Approach	$1,940,000	$2,925,000
*	Minimum/Additional Sandlake Rd Improvements with Alts 1-3	$690,000	$1,825,000

Refining Setback Dike Alt 1



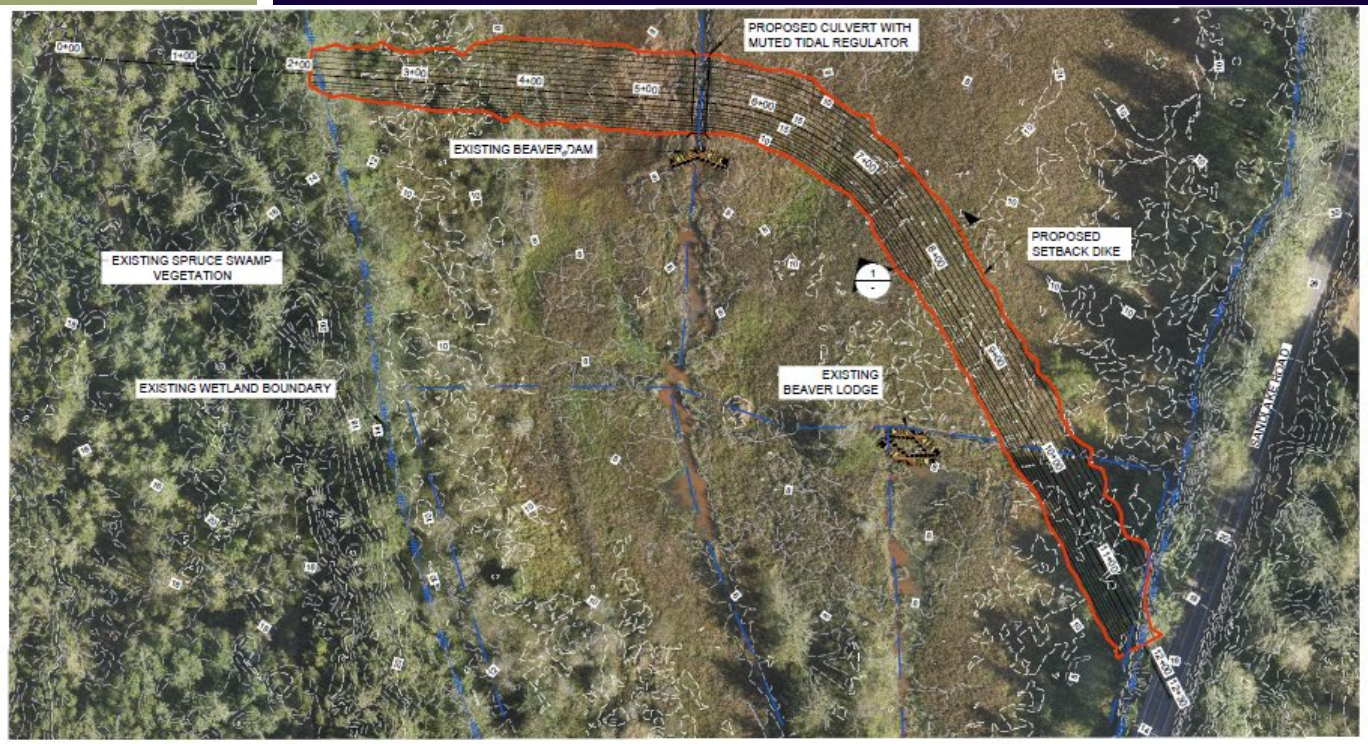
SITKA SEDGE PROPOSED SETBACK DIKE ALT 2
PLAN
SCALE: 1"=50'



SITKA SEDGE PROPOSED SETBACK DIKE ALT 2
PROFILE
SCALE: H=1"=50'
V=1"=5'

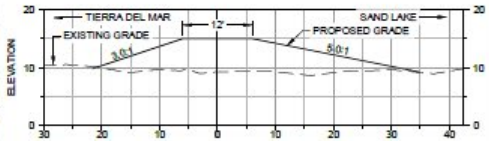
ESA

Refining Setback Dike Alt 1

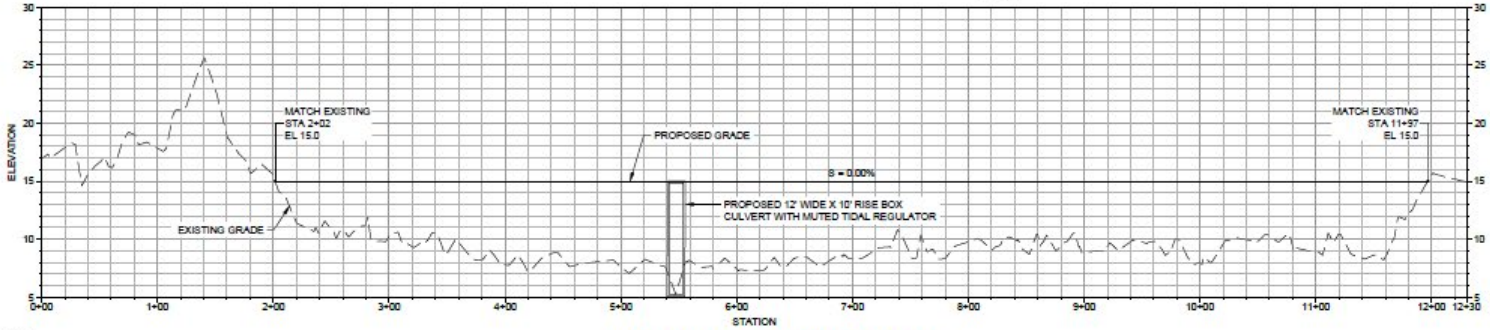


SITKA SEDGE PROPOSED SETBACK DIKE ALT 1
PLAN
SCALE: 1"=50'

WETLAND IMPACTS	
AREA OF IMPACT	1.3 ACRES
VOLUME OF IMPACTS	7760 CY



SITKA SEDGE PROPOSED SETBACK DIKE ALT 1
SECTION
SCALE: 1"=10'



SITKA SEDGE PROPOSED SETBACK DIKE ALT 1
PROFILE
SCALE: H=1":50'
V=1":5'

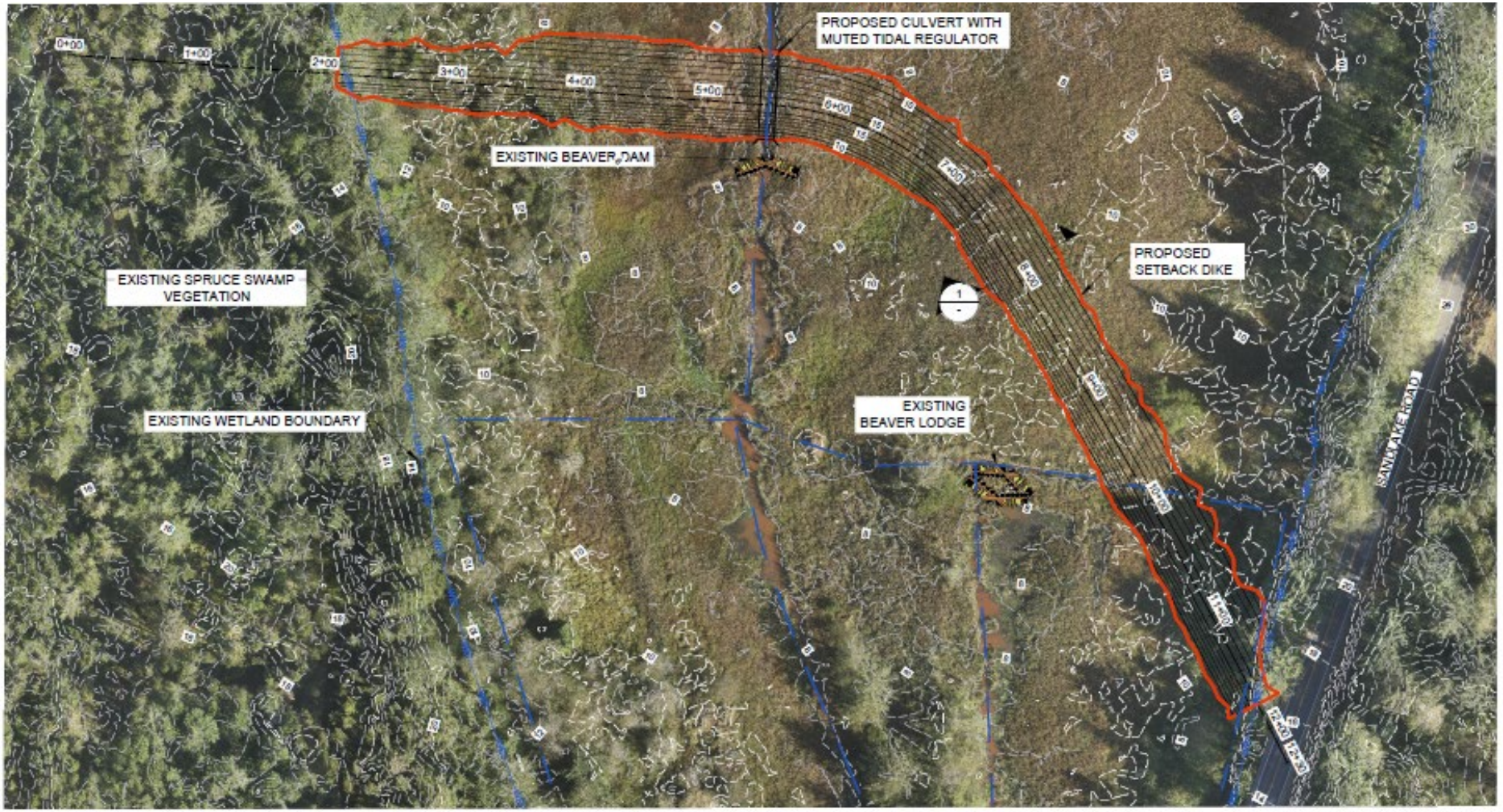
0 25 50
Feet

ESA

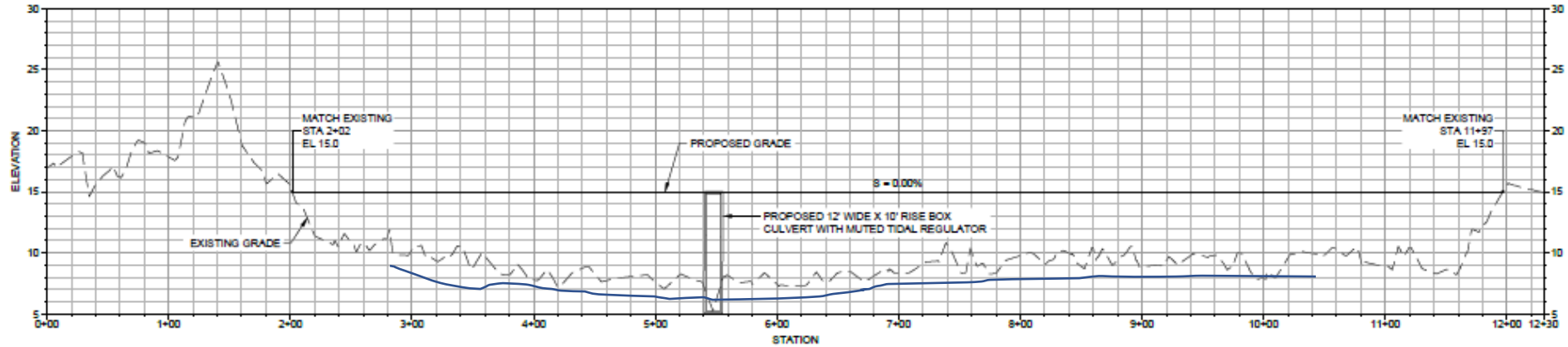
SITKA SEDGE TIDAL WETLAND ENHANCEMENT

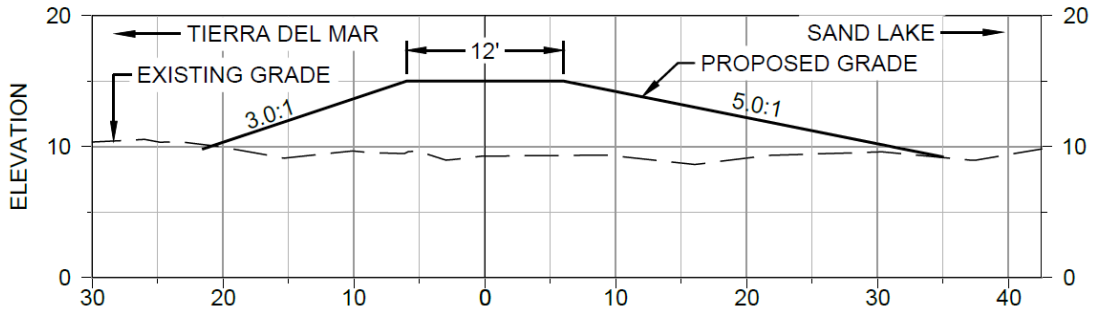
FIGURE 1
PROPOSED SETBACK DIKE ALT 1

Refining Setback Dike Alt 1



Refining Setback Dike Alt 1





Setback Dike tie-in point to Sandlake Rd

- Setback Dike Tie-in points to Sandlake Rd Embankment (min elev = 15')

Setback Dike tie-in point to Sandlake Rd

- Setback Dike Tie-in points to Sandlake Rd Embankment (min elev = 15')

Setback Dike Area

- Facing north, looking at beaver pond (beaver dam impounding water). Note, bedrock outcropping just SE of beaver dam.

Setback Dike Area

- Facing west, looking at East-to-west ditch. Potential setback dike alignment area. Active beaver lodge to the south of ditch

Setback Dike Area

- Facing west, looking at East-to-west ditch. Potential setback dike alignment area. Active beaver lodge to the south of ditch

Setback Dike Area

- Facing west towards forested dune to tie into

Setback Dike Area

- Facing north along primary ditch. Smaller existing beaver dam downstream. Potential setback dike located between two existing dams

Setback Dike Area

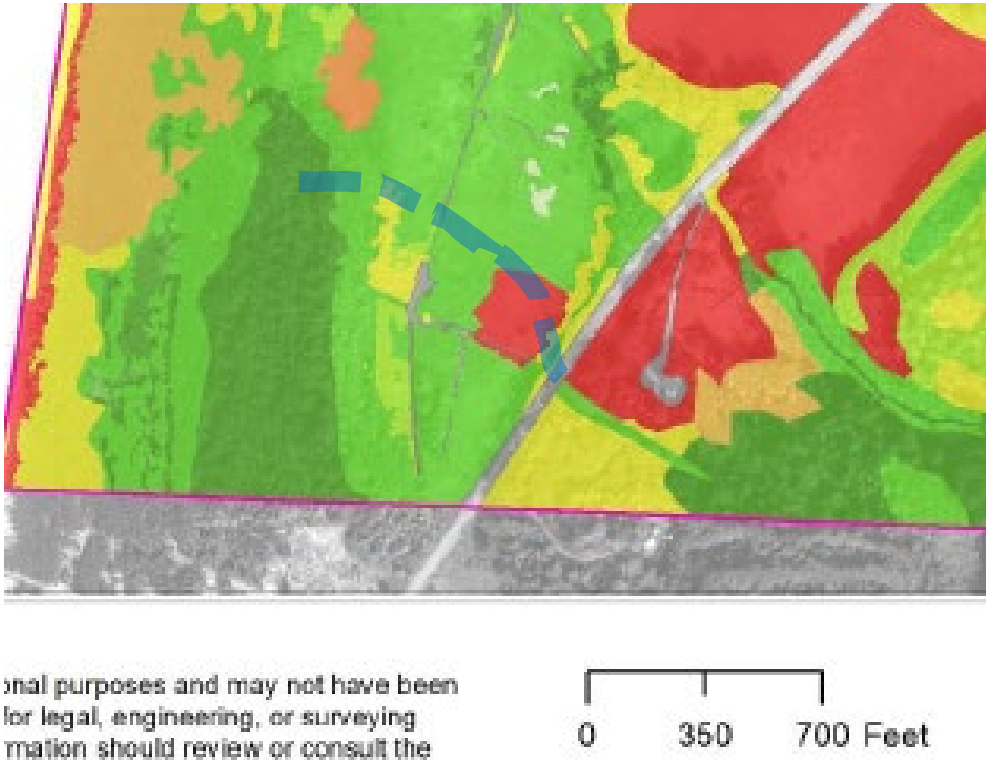
- Facing north/downstream along primary ditch. Smaller existing beaver dam downstream. Potential setback dike located between two existing dams

Setback Dike Area

- Forested dune to tie into on west end of setback dike

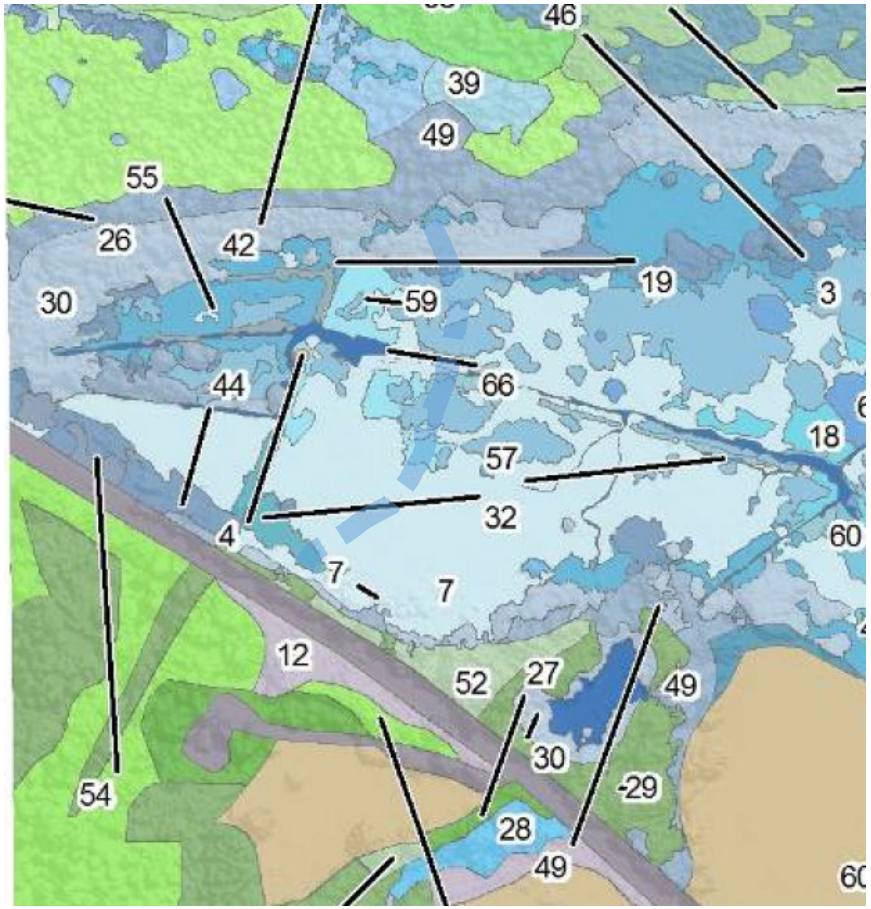
Setback Dike Area – Wetland/Vegetation Impacts

Figure 21. Native Plant Community/Habitat Condition.



Vegetation Inventory and Botanical Resource Assessment for Sitka Sedge State Natural Area (2016 – Noel Bacheller)

Setback Dike Area – Wetland/Vegetation Impacts



7, CATTAIL MARSH

30, RED ALDER FORESTED WETLAND

32, REED CANARYGRASS DEGRADED MARSH

44, SHRUB SWAMP

45, SILVERWEED DOMINATED MARSH

46, SITKA SEDGE MARSH

49, SITKA SPRUCE-RED ALDER FORESTED WETLAND

57, SPIKERUSH-BALTIC RUSH MARSH

59, THREE RIBBED ARROWGRASS DOMINATED MARSH

Vegetation Inventory and Botanical Resource Assessment for Sitka Sedge State Natural Area (2016 – Noel Bacheller)

Long-term Beaver Influence on Setback Dike, Culvert, and Tide Gate

- **Beavers will likely remain at Sitka Sedge after reconnection**
  - **Likely to maintain blockages in channel network**
  - **Assume potential dams throughout upper marsh to adjacent marsh elevation**

- **How will beavers behave around new setback dike's culvert and tide gate?**
  - **Beavers plug culverts when able and beneficial for their habitat (create ponded area)**

- **Drainage and flooding implications**

- **Maintenance implications**

(Courtesy of Lizotte Solutions)

What can be done to mitigate impacts of beaver activity at a new culvert/tide gate?

- **Select exact location relative to existing dam and lodge, pinch points**

- **Culvert/Channel Features to Make it Harder to Dam:**
  - **Wider Culvert, minimum 10’ wide**
  - **Over widen and deepen channel at inlet/outlet (min 3’ deep at low water, deeper around tide gate to avoid interference with opening/closing)**
  - **Concrete Bottom/No substrate**

- **Beaver Exclusion (Beaver Deceiver/fencing)**

- **Allow/encourage damming where acceptable**
- **Beaver removal (conflicts with habitat goals, not permanent)**

Fish Passage Considerations with Beaver Exclusion Devices

Greg Apke, 2020 Beaver Working Group Presentation
https://www.dfw.state.or.us/wildlife/living_with/docs/2020_beaver_wg/6%20Fish%20Passage_Apke_BWG%20Feb%202020.pdf

Fish Passage Considerations with Beaver Exclusion Devices

are designed to fit a given site (Lisle 2003), though the most common shape is trapezoidal (Figure 2). Designs have evolved since invention, and these devices are now frequently made of metal framing (Figure 3). Other designs may be V-shaped, semi-circular, and even long rectangles.

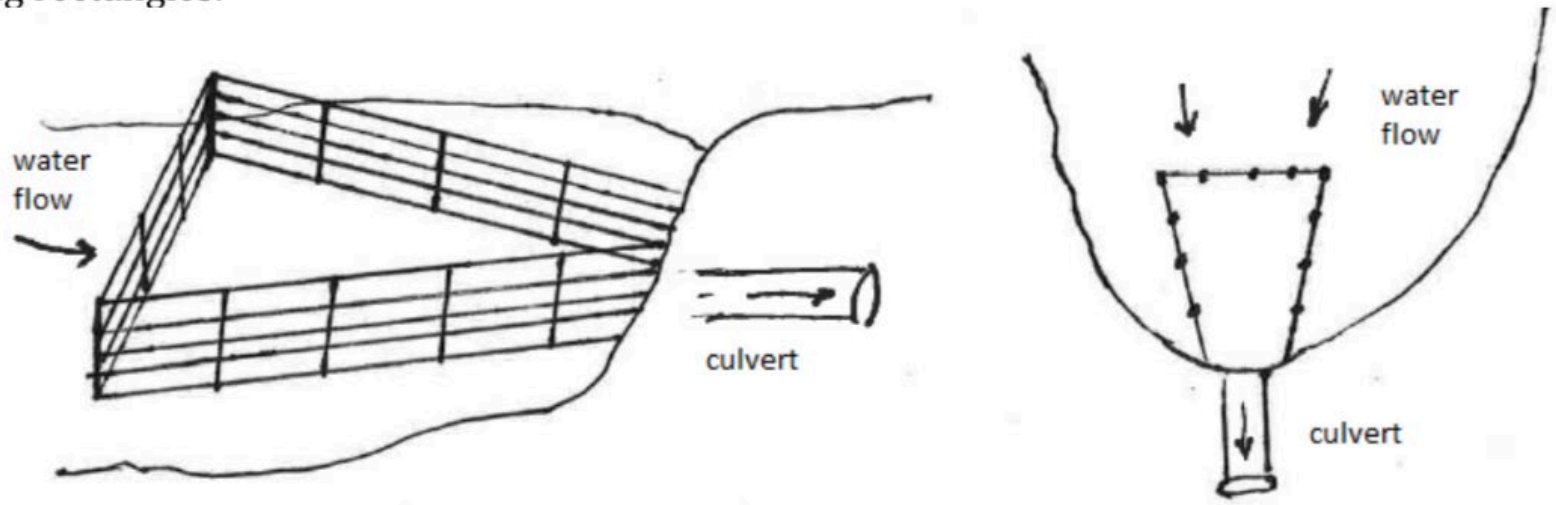


Figure 2. Culvert fencing, trapezoidal in shape, is installed on the upstream side of a culvert.

King County, WA – Beaver Management Technical Paper#1

Fish Passage Considerations with Beaver Exclusion Devices

Figure 3. **King County example: trapezoidal aquatic exclusionary fencing on box culvert inlet at Lower Stensland Creek.**

King County, WA – Beaver Management Technical Paper#1

Beaver Deceiver/Exclusion devices

Skip Lisle, Beaver Deceivers International
https://beaverdeceivers.com/the-beaver-deceiver/

Smuggler's Slough Tide Gate
Lummi Nation – Bellingham, WA

Smuggler's Slough Tide Gate
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Smuggler's Slough Tide Gate
Lummi Nation – Bellingham, WA

Fish Passage Considerations with Beaver Exclusion Devices

EXCLUSION DEVICES

- Exclusion Devices associated primarily with undersized culvert facilities where flooding or public safety issues exist
  - Purposefully designed to preclude beaver activity within or adjacent to culverts
  - Can be made with fencing materials or welded metal devices
  - Typically are 6-inch square fencing
  - Hydraulic facility (culvert) may be undersized and ideal for beaver activity
  - How to best balance non-lethal beaver management options while also balancing habitat connectivity (fish passage)

Greg Apke, 2020 Beaver Working Group Presentation
https://www.dfw.state.or.us/wildlife/living_with/docs/2020_beaver_wg/6%20Fish%20Passage_Apke_BWG%20Feb%202020.pdf

How will beaver activity influence performance and maintenance of new culverts/tide gate?

- Alternative 1 setback dike could be located downstream of existing main beaver dam effectively preserving freshwater wetland/beaver complex as-is
  - Could also be just upstream or in place of the existing beaver dam (likely more prone to beaver blockage)
- Alternative 2 upstream of beaver dam across ponded area. New culvert/tide gate backwatered at 8’ NAV88
- Alternative 4 new culvert at Sandlake Rd subject to beaver blockage
  - (existing culvert has beaver exclusion cage)
  - Easier location to monitor/maintain clear than on setback dike

- Beaver activity implications for maintenance effort/cost
- Beaver activity and sedimentation influence on culvert/tide gate function and associated drainage/flooding
- Design measures, exclusion/flow control devices to mitigate beaver activity

Setback Dike Alternatives Summary

- **Alternative 1 (near beaver dam)**
  - Performs better than existing conditions during daily tides and storm events
  - Locating downstream of main beaver dam has best chance to mitigate beaver activity
  - Geotechnical Engineering Challenges
  - Wetland/vegetation impacts and reduces estuarine restoration

- **Alternative 4 (raising Sandlake Rd)**
  - Less challenging to build and maintain
  - Minimal wetland/vegetation impacts and max restoration
  - Increases frequency of tidal inundation on two private properties in TDM
  - Performs better than existing conditions under large storm events, even at those private properties
  - Addresses roadway improvements at the same time

Next Steps

- **Questions/discussion at townhall**
- **OPRD Soliciting feedback/comments on project webpage**
- **OPRD to finalize decision on preferred alternative elements at dike breach and setback dike**
- **ESA team to advance to 30% Design with geotechnical investigation**
- **TEP applying for grant funds**
- **Work towards implementation/construction**

Questions and Discussion

- **Thank you for your time and interest in this important project!**

Questions and Discussion

OPRD Soliciting comments on project webpage (open for 2 weeks):

https://www.oregon.gov/oprd/prp/pages/pla-sitka-sedge-hydro.aspx

Or search for “Sitka Sedge Hydrology” to find OPRD project webpage