CSA 6 South Fork Gallinas Creek
2024 Geomorphic Dredge Design Progress Update

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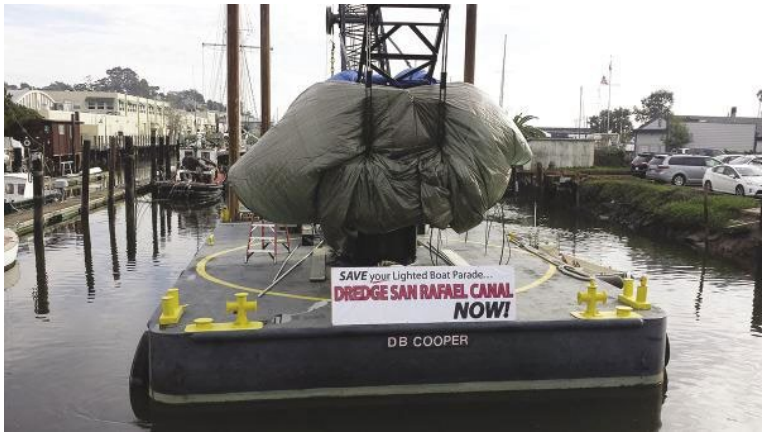
COUNTY OF MARIN

publicworks.marincounty.org/gallinas-creek-csa6

Small Channel Dredging in SF Bay…

Petaluma River dredge protest (above)



San Rafael Canal dredge protest (right)

Gallinas Creek, Marin County

Details in 2015 Technical Report

TECHNICAL MEMORANDUM
DEPARTMENT OF PUBLIC WORKS
FLOOD CONTROL ENGINEERING DESIGN GROUP

LOWER LAS GALLINAS CREEK DREDGE CHANNEL
CONCEPTUAL DESIGN STUDY
FINAL DRAFT
MARIN COUNTY, CALIFORNIA

MARCH 20, 2015 (rev1)

Available online

Meetings 2014-2019
One sentence summary of "geomorphic" dredge channel approach

The channel shape that would be expected to form in equilibrium and thus maintain its shape (width and depth) with the available daily tidal volume (the "tidal prism")

Developed from studies of other natural marsh systems around the Bay (field data).

Why take a geomorphic approach to dredge design?

1. Channel should be more self-sustaining and require less frequent dredging
2. Easier to permit and **less mitigation costs**
3. Less volume = less often = less costly
4. Maybe eligible for grants

However the trade-off is less depth and width. Not designed to achieve specific goals for flood control and navigation. Provides these benefits but not to a specific design specification.

Dredge Quantities Changes

LOCATION	*2010 W-K ESTIMATE (cy) Historic Dredge*	*2014 GEOMORPHIC DREDGE TEMPLATE (cy)*	*Updated 2018 Geodredge Template (cy) [with 2016 survey]*
Channel dredge (11+00 to 157+28)	182,173	~ 48,000	~ 70,500 cy
Overdepth (toe and side slopes)	113,319	0	25,500 cy
TOTALS:	295,492 cy	48,000 cy	~ 97,000 cy

2024 quantity is 105,000cy and using 120,000 for design and cost estimating

Part I – Brief Recap of 2022 Meeting

Costs per cubic yard vary greatly among USACE districts, indicating that local circumstances are relevant (Table 1).

Table 1. Average Unit Cost of Dredging by Selected USACE District

(contracts >100,000 cubic yards, 2014 to 2018)

USACE District	Cubic Yards Dredged	Cost per Cubic Yard
San Francisco	5,398,939	$ 24.27
New York	11,908,916	$ 23.17
Philadelphia	6,037,757	$ 19.93
Jacksonville	22,447,059	$ 14.86
Los Angeles	1,283,153	$ 13.20
Detroit	3,064,310	$ 9.40
Alaska	5,550,057	$ 8.58
Savannah	37,140,202	$ 6.52
Portland (OR)	30,983,332	$ 5.29
Galveston	76,646,189	$ 3.80
New Orleans	105,894,803	$ 2.62

Recent Petaluma Bid - 2020

- Dredging Marina
  - $563,054/18,605cy = $30cy for an easier dredge from a local dredger (Lind)
  - 100,000 cy *$30/cy = $3,000,000
  - Inflation and diesel prices are raising rapidly

Sediment Sampling Results (2018)

- Sediment sampling and analysis completed in January 2018 – brought to DMMO in February 2018
- Results for one composite slightly elevated in two COCs; Three discrete samples from composite were then analyzed as requested by DMMO
- Results show one discreet sample slightly elevated for one COCs (approx. 9,000 cy)
- **2023/2024 Update – plan to resample once disposal location is known**

2022-2023 Disposal Site work

McInnis

- Work with Parks to permit placement of 100,00 cy in main basin

In-Bay

- Go to DMMO to assess if possible to direct pump and place at SF-10

Tonight - 2024 Work Update

- updated creek survey
- Evaluation of direct disposal at SF-10
- Permitting of placement at McInnis

Updated Survey and Shoaling Plots

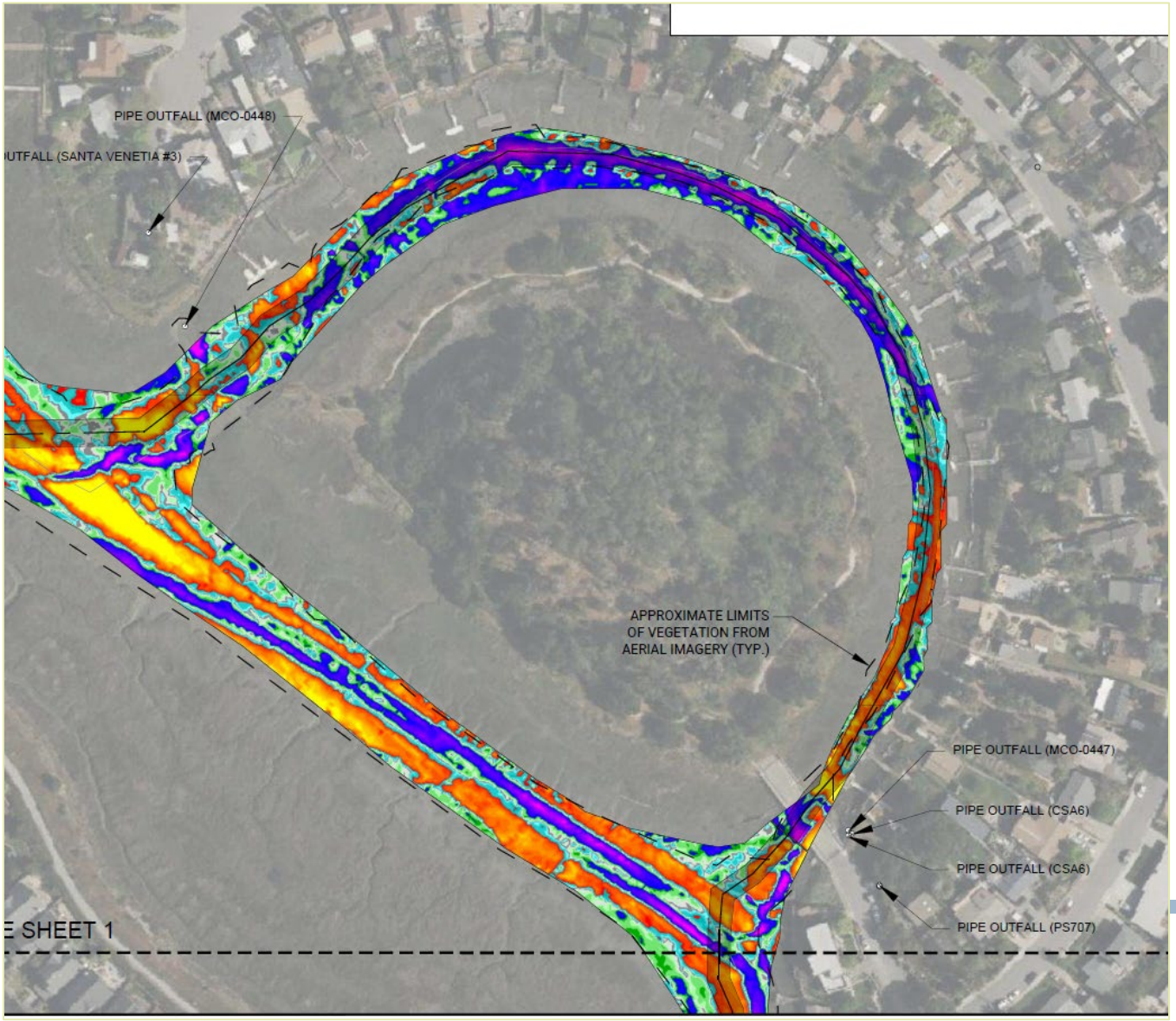
Both Posted to CSA 6 website
https://publicworks.marincounty.org/gallinas-creek-meetings/

Results indicate migration of sediment with small increase in aggradation. Quantity increases from 93,000 to 105,000 cy

Las Gallinas Creek Dredging Volumes			
	Volume to Grade (CY)	Volume to OD (CY)	Total Volume (Full Las Gallinas Creek Template) (CY)
North of the Island (STA 70+00):	41,000	19,000	**60,000**
South of the Island (STA 70+00):	35,000	10,000	**45,000**
			105,000

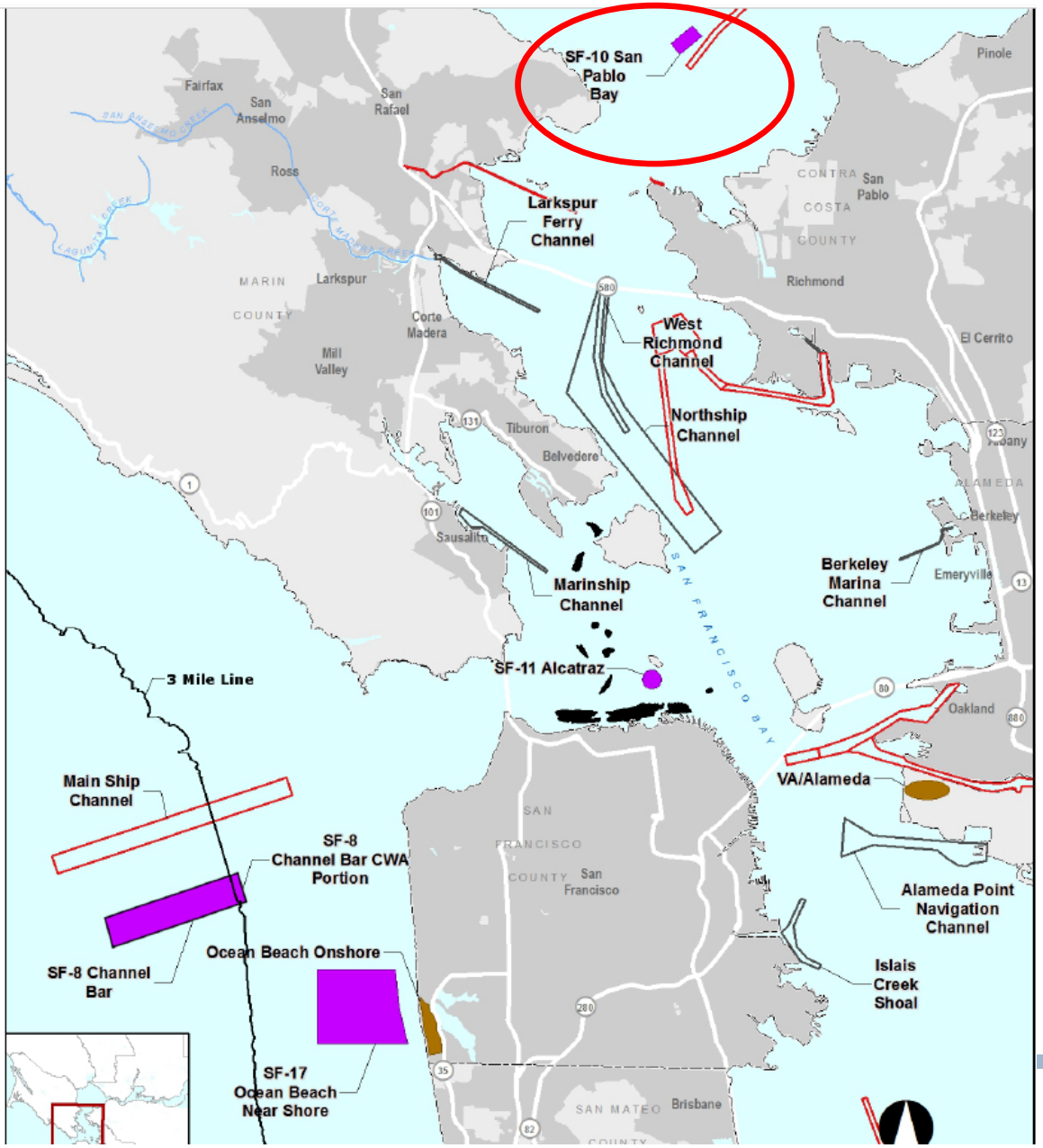
[1]Volumes include 3H:1V side slopes
[1]Volumes include an additional 10% contingency

Focus On Inner Bend SM Island



Direct Pump to SF-10 Update

Permitted San Francisco In-Bay Disposal Sites SF-10



DMMO Feedback

- Presented at DMMO in September 2023 on a direct pump-out to SF-10 which has never ben done before
- Feedback was les than positive. RWQCB indicated that mitigation costs would be required
- Concerns over pipeline placement across SP Bay
- Feedback was DMMO desire to place at McInnis
  - ✓Staff take-away that this is not viable option unless McInnis is proven to be not viable

McInnis Marsh Placement Update

McInnis Wetland Project Placement Update

- Staff has worked closely with Parks since 2017 to incorporate dredge sediment placement into a future restoration of the marsh.

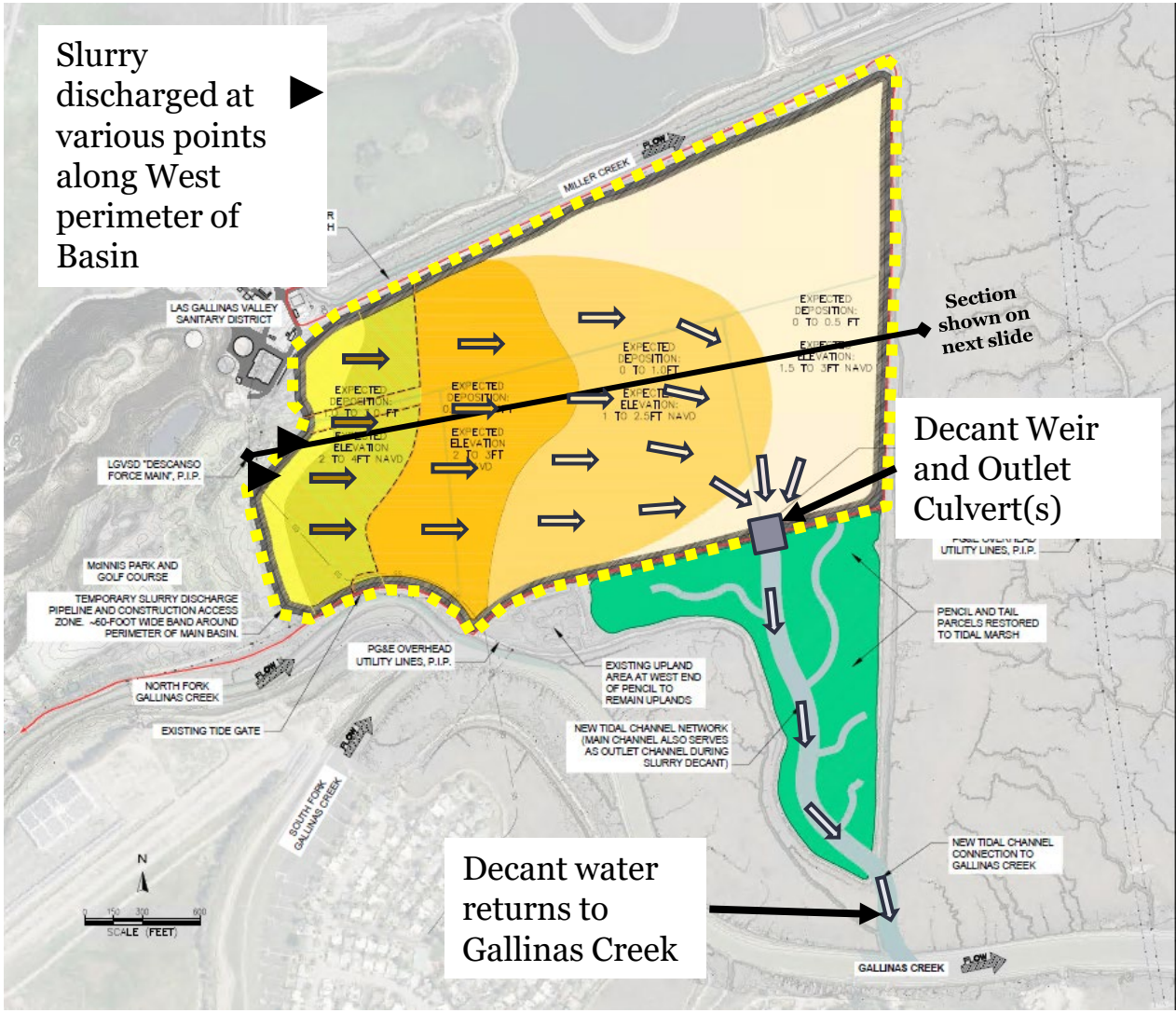
- Summer 2022, Parks revised restoration designs to prioritize placement of dredged sediments within the main basin without tidal restoration and opening the southern marsh to tidal action

Disposal Site Design – McInnis Wetland 2023

- In 2022, DPW staff refocused on placement of dredged sediments into McInnis without tidal restoration main basin
  - Much more difficult to permit sediment placement only – agencies consider it fill placement in wetlands
- **NEW for 2023** – Parks agrees to restore pencil and tail of McInnis! Major benefit to our project
- Went back to BRRIT in September 2023

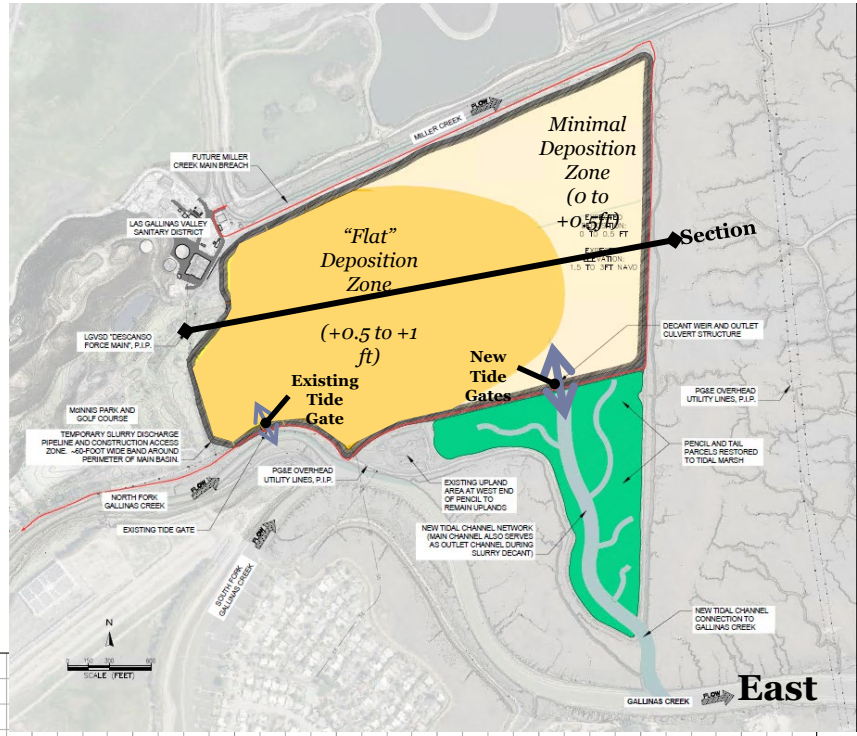
Main Basin Subsidence Reversal

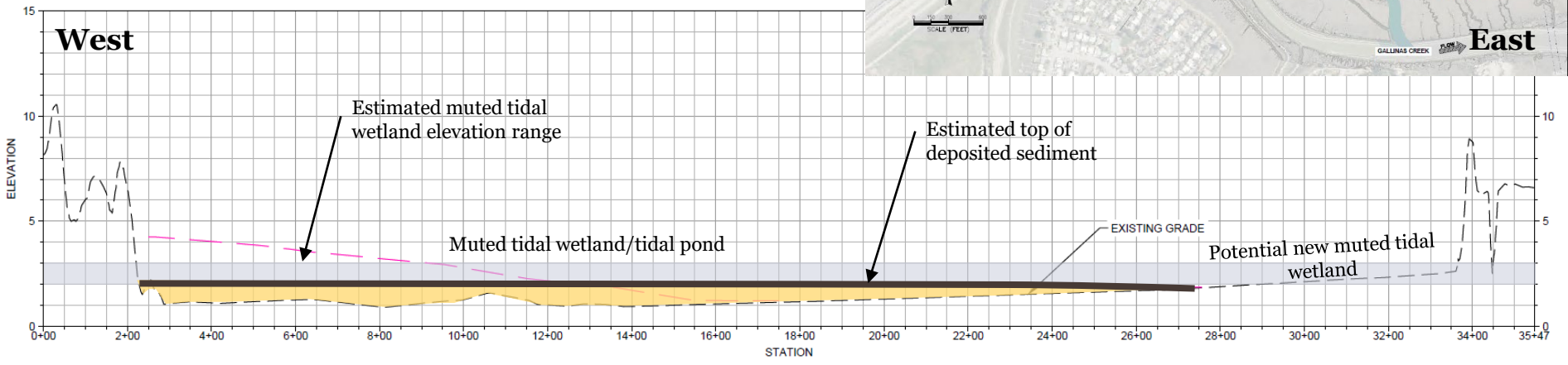
- 100k to 130k CY of material dredged from South Fork of Gallinas Creek
- Slurry material discharged along west side of Main Basin
- Slurry flows eastward, depositing sediment across the basin.
  - Sediment thickness will vary from 0 to up to ~3 feet
  - Average thickness: 0.5 to 1ft
- Decant water drains over outlet control weir(s) and turbidity controls, into new tidal channel, and out to Gallinas Creek



"Flat Sediment Deposition" Scenario

- 0.5 to 1ft of deposition over ~70% of the main basin
  - 0 to 0.5ft of deposition over remainder of basin
- Estimated Muted Tidal Elevation Range:
  - ~2.0 to ~3.0 ft NAVD
- Deposition area expected to remain wetlands or ponds
  - Potential gain of 5 to 15 acres of muted tidal wetlands and ponds





BRRIT September 2023 Meeting Feedback

- Generally very positive to the project!
  - No muted tidal system – good
  - Overall positive to dredge placement

- ✓DPW still wants to confirm two main items with BRRIT
  - No grading of sediment after placement
  - No major movement of discharge pipe into main basin
  - Limited invasives management in monitoring period

- Planning to go back to BRRIT in summary 2024 to confirm the major work and cost items above

- Parks is managing MTC/BCDC concerns over current Bay Trail alignment

Rough Capital Costs – Dredge Project

Item	Rough cost ($)	Comments
Final design and permitting	$700,000	Final design and permitting split with Parks
Mob/Demob	$1,100,000	Assumes two mobs over two years
Dredging, Slurry Pumping	$3,240,000	$27/cy for 120,000 cy
Option 1 bulk placement and decanting	$1,200,000	$10/cy for 120,000 cy
Option 2: distributed placement and decanting	[$4,560,000]	$38/cy for 120,00 cy option
Turbidity curtains	$100,000	
Dewatering culvert and weir	$150,000	
Biological monitoring	$130,000	Likely required
Totals:	$6,620,000 ($9,980,000)	Available CSA 6 fund approx. $3,500,000

Rough Monitoring Costs – Dredge

Item	Rough cost ($)	Comments
Low intensity adaptive management	$300,000	Invasive removal
Post-Construction Monitoring and Reporting	$700,000 for 10 years	Assumes $70k per year
Totals:	$1,000,000	or $100,000 per year

Final McInnis Placement Notes

- Although local hydraulic placement has lowest dredging cost – the dredge only placement option will require minimum 5 to 10 years monitoring costs
- and possibly costs for mitigation if veg regrowth doesn't meet requirements
- Then need to work with Parks on CEQA etc.
- Also, need to resample to greatly reduce volume of NC sediments – no place for NC with sediment only project

Wrap Up and next Steps

- Placement at McInnis is permittable
- Costs exceed available CSA 6 funds
- County to work with Parks to use available funds to apply for a grant to construct
  - SFBRA grant round starts Sept 2024
  - Likely apply for final design and CEQA
  - If successful, apply for construction funding for 2027 dredge or beyond

Finally…Marin and Army Corps Innovative Pilot Study

- Marin DPW staff develop a design with nature dredging approach in 2022.
- Worked with SF District Corps staff to get $250,000 in Corps internal funding for a feasibility study
- Study began in Fall 2023 and due to be Done later 2024
- Gallinas Creek selected as study creek for analysis

✓Next phase may be field test (unclear)

STRATEGIC SEDIMENT PULSE DELIVERY PILOT STUDY

Source: International Association of Dredging Companies

Technical Working Group (TWG) Meeting #1

USACE SPN District
Floodplain Management Services (FPMS)
Marin County Public Works
29 SEPT 2023

U.S. ARMY

US Army Corps of Engineers®

PROJECT DELIVERY TEAM (PDT)

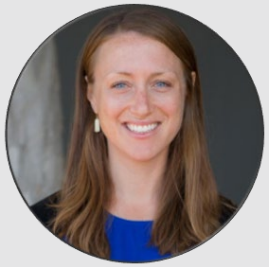
Marin County DPW

Roger Leventhal, PE

SPN District

Jessica Ludy

Tiffany Cheng, PE



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Strategic Sediment Pulse Dredge – Background and Approach

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MARIN COUNTY FLOOD CONTROL & WATER CONSERVATION DISTRICT

**All slides and opinions are my own and may not represent official Marin County or Flood District Policies*

STRATEGIC SEDIMENT PULSE DELIVERY PILOT

- Innovative pilot study investigating applicability of hydrodynamic dredging for reducing flood risk by tidal channels and boosting sediment supply to marsh/mudflats

- USACE Floodplain Management Services (FPMS) and Marin County Department of Public Works
  - Engineer Research & Development Center (ERDC)

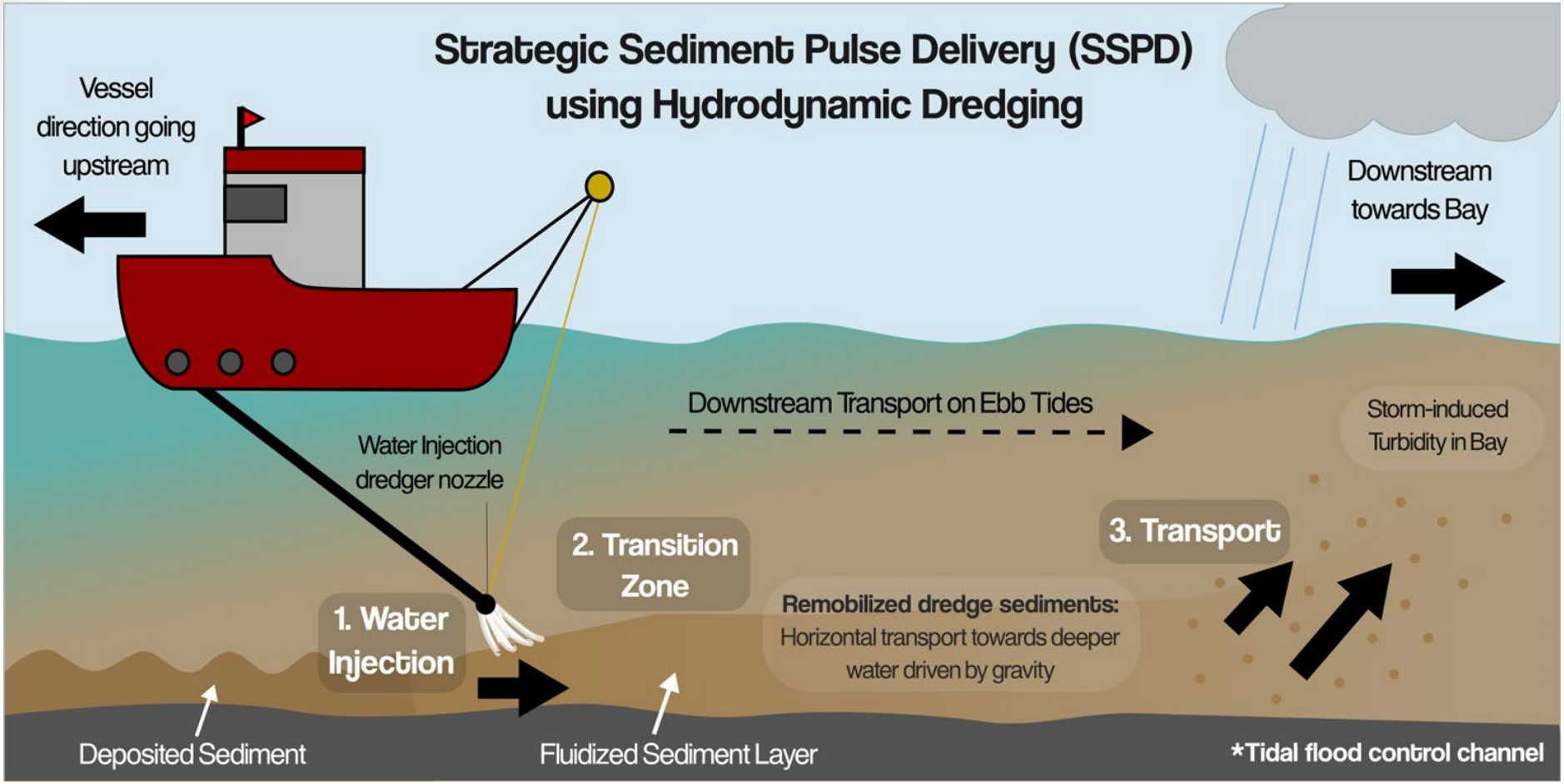
- Study Duration:
  - Summer 2023 – Summer 2024
  - 3 Technical Working Group (TWG) meetings

EWN Storm Driven Dredging - NSPD

- A proposal to naturally dredge tidal channels tied to episodic storm events when the Bay is naturally turbid – *a paradigm change in contracting*
- Limited to tidal channels
- Feeds the system with sediment when it's needed, that recent science shows does the most to sustain tidal marshes
- Low cost and low carbon

✓Very EWN, but difficult to permit in SF Bay

SF Bay in storm conditions



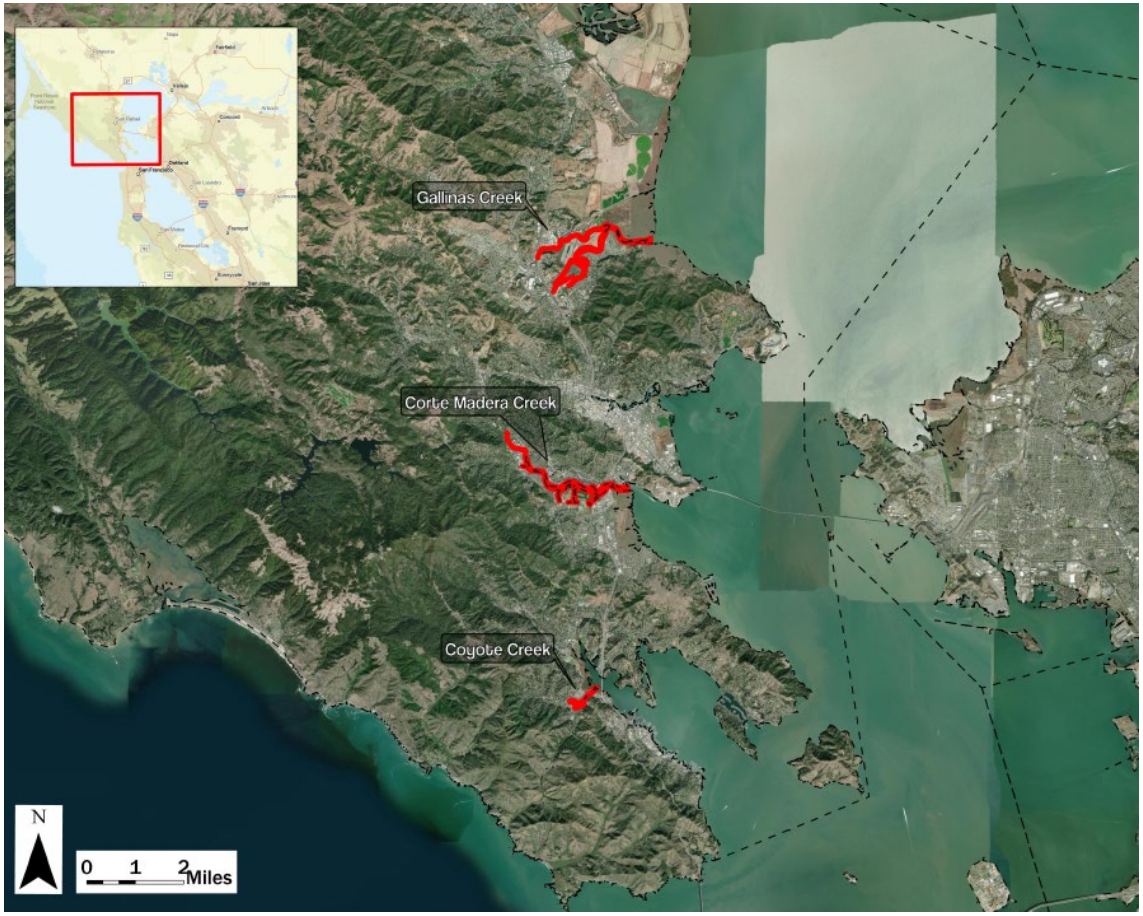
Note: Vertical scale in graphic is exaggerated

THREE POSSIBLE MARIN CREEKS - PILOT SITES

Gallinas Creek

Corte Madera Creek

Coyote Creek



Strategic Sediment Pulse Delivery Pilot

USACE Floodplain Management Services (FPMS)

Roger Leventhal, PE[1], Tiffany Cheng, PE[2], Julie Beagle[2], Jade Ishii[2], Jared McKnight[3]

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2. USACE San Francisco District (SPN), San Francisco, CA, PDT Contact: tiffany.k.cheng@usace.army.mil, julie.r.beagle@usace.army.mil
3. Engineer Research & Development Center (ERDC), Vicksburg, MS

I. Too much sediment in tidal channels, too little in marshes

This pilot project aims to **shift sediment from tidal channels** in Marin that are infrequently dredged and are in essence "mud locked" **to mudflats and marshes** that need sediment.

• Reduce Flood Risk by Tidal Channels

Many tidal flood control channels around San Francisco Bay naturally silt in and thus rely on the local flood risk manager to pay for dredging to achieve flood risk reduction goals. As dredging costs have increased substantially, most flood control channels are out of compliance with the initial design requirements and are not dredged (Sediment for Survival, SFEI 2021). This pilot approach proposes to incrementally meet these requirements at a lower cost and with a potentially lower carbon impact compared to traditional dredging by leveraging natural tidal and wave forces to redistribute sediments beneficially to adjacent mudflats and marshes.

Community members protest lack of dredging in the Petaluma River

• Support Regional Marsh/Mudflat Resiliency

Recent studies document the importance of episodic storm driven deposition on tidal marshes (Thorne et al 2022, Tognin et al 2021, Pannozzo et al 2023). Increasing the amount of sediment supply in the "erodible pool" can bolster sediment deposition on marsh and mudflat systems. This pilot approach would allow for keeping more sediment in the overall Bay system, rather than removing material in a traditional dredge approach. Approximately 5 to 10% of sediment in the Bay Area is trapped in tidal channels and could potentially be mobilized for beneficial re-use, without the expense or logistical burden of above-water handling/storage/transport of dredged material.

II. Strategic Sediment Pulse Delivery

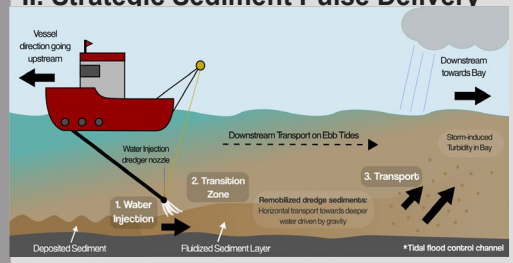


Figure 1. Conceptual schematic of hydrodynamic dredge approach and resultant downstream process.

This pilot study investigates **SSPD** as a Flood Risk Management/Engineering with Nature approach for coastal/fluvial flood risk management in tidal flood control channels around San Francisco Bay.

SSPD is proposed as an alternative to standard dredging, typically conducted under non-turbid conditions, to a specified design depth and mechanical piping and transport of sediment in barges for disposal. SSPD would achieve flood risk reduction in tidal channels by **disturbing and entraining sediments from the channel bottom using hydrodynamic dredge methods during conditions when turbidity levels are naturally elevated (e.g. prior to a storm) and allowing natural forces (e.g. ebb tidal currents) to transport sediment** to the Bay and thus support sediment supply to local marsh/mudflats. Hydrodynamic dredge techniques disrupt and suspend the sediment at the channel bottom temporarily in the water column and allowing natural forces to transport sediment downstream via a density-driven current. (**Figure 1**). Examples of hydrodynamic dredging approaches include agitation dredging, water injection dredging, and dredging with ploughs, beams and rakes (**Figures 2a, 2b**).

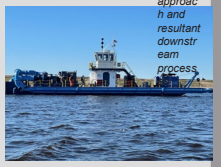


Figure 2a Example of water injection dredge

Figure 2b. Example plough dredge technology

Source: Joe Wagner

III. Adaptive Hydraulics (AdH) Modeling

Gallinas Creek by San Pablo Bay in Marin County, CA was selected as the pilot site (**Figures 3a, 3b**), based on discussion with the Technical Working Group (TWG) over Fall 2023. The tidal reach of Gallinas Creek is approximately 14,000 linear feet. The site was chosen due to the high potential to demonstrate benefits in both flood risk reduction and marsh resilience. The neighboring community of Santa Venetia is an area of high flood risk (**Figure 3c**). The site is located next to China Camp State Park in San Pablo Bay, which is a subject of much scientific study of marsh deposition and local wave energy.

The project team is working together with the U.S. Army Engineer Research and Development Center (ERDC) to apply Adaptive Hydraulics (AdH), a hydrodynamic and sediment transport model, to investigate the impacts of sediment pulse dredging on local morphology and sediment fluxes into the system. AdH is a modern, multi-dimensional modeling system for saturated and unsaturated groundwater, overland flow, three-dimensional Navier-Stokes flow, and two-dimensional or three-dimensional shallow water problems (CHL, 2023)

The modeling is intended to yield greater insight into depth-limited flow as a floodplain hazard and sediment fate as a proxy for the potential of this approach to contribute to marsh sustainability. Ultimately, the modeling results will evaluate effectiveness of sediment pulse dredging for a historic

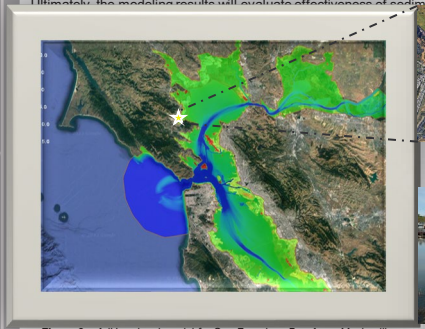


Figure 3a. AdH regional model for San Francisco Bay Area. Mesh will be Refined in the vicinity of Gallinas Creek to resolve tidal channel.

Figure 3b. Gallinas Creek tidal flood control channel (red polygon)

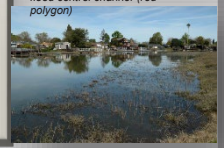


Figure 3c. Photo of Gallinas Creek and low-lying neighborhood, Santa Venetia

Research conducted by Thorne et al (2022) studies deposition in China Camp State Park, due to the 2017 Atmospheric River (AR) event in California. Marshes located within the riverine geomorphic setting were more influenced by storm flooding and exhibited greater elevation response. Figure 4 shows the gage height at a USGS-operated stream gage by Corte Madera Creek (closest gage location) during the atmospheric river.

As Winter 2017 was a historic water year for the state, this same time period will be used for modeling in this pilot effort. The team will model Gallinas Creek with/without the SSPD approach during this time range as well as for a summer king tide cycle, to assess performance under storm and non-storm conditions.

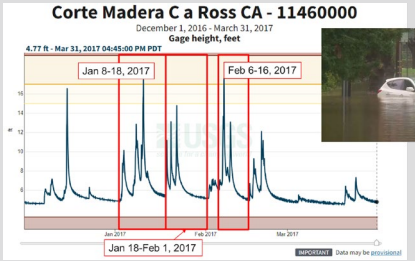


Figure 4. Back-to-back winter storms hit Northern and Central California during January and February 2017 with historic levels of precipitation, leading to widespread flooding (op right).

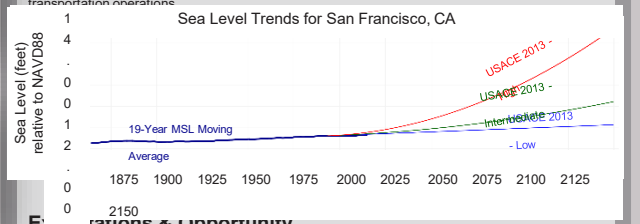
IV. Model Development and Calibration

An Adaptive Hydraulics (AdH) hydrodynamic and sediment model is currently under development. The model bathymetry was developed using an existing AdH model with multibeam surveys of Gallinas Creek and previously developed RAS model bathymetry of the surrounding flood plain. The projection is UTM Zone 10N and the vertical datum is NAVD88 meters. The model mesh consists of 3,868,282 elements and 1,936,876 nodes. The mesh spacing varies from 1000 meters on the ocean boundary to 5 meters along Gallinas Creek. NOAA Gage 9414290 San Francisco, CA is being used to develop the tidal elevation boundary condition as well as for wind forcing. NOAA Gages Redwood City, CA; Alameda, CA; Richmond, CA; Martinez Amorco Pier, CA; and Point Reyes, CA are also being utilized for wind forcing as well as for water surface elevation comparisons and model calibration.

V. Environmental Effects

Habitat Benefits & Emissions Reduction

Rather than removing sediment and transporting it to a disposal site, the SSPD approach could keep sediment within the Bay system and allow for natural transport to mudflats and marshes that need sediment to keep pace with sea level rise. SSPD would also reduce greenhouse gas emissions associated with dredging due to the elimination of sediment extraction and transportation operations.



E… tations & Opportunity

Pl… al. (2021) conducted one of the few studies on the effects of hydrodynamic dredging an… that the effect of hydrodynamic dredging operations could not be separated from ele… urbidity associated with tidal effects, but dissolved oxygen dropped substantially for a fe… Additionally, there were significant reductions in benthic macroinvertebrate abundance an… omic richness after five months, but for fish, effects to community composition, mortality, an… were minimal or insignificant. This pilot study presents an opportunity to understand the ne… and far-field impacts of hydrodynamic dredging at the top layer of a tidal channel bed, wh… oth the layer that is disturbed and the layer that most supports aquatic organisms.

V… eferences

Coa… ics Laboratory (CHL). Adaptive Hydraulics 2D Shallow Water (AdHSW2D) User Manual (Version 4.7.1) Guidelines for Solving Two -Dim… hallow Water Problems with the Adaptive Hydraulics Modeling System. 2023.

Dus… cKnight, K., Grenier, L., & Kauffman, N. (2021). Sediment for Survival: A Strategy for the Resilience of Bay Wetlands in the Lower San… Estuary. *A SFEI Resilient Landscape Program. A product of the Healthy Watersheds, Resilient Baylands project, funded by the San Francisco Bay … y Imp.*

Pan… eonardi, N., Camacina, I., & Smedley, R. (2021). Salt marsh resilience to sea-level rise and increased storm inte… *orphology, 389*, 107825.

Plec… win, P., Mathers, K., Phillips, J., Wood, P., & Yu, D. (2021). The effects of water injection dredging on low-salinity estuarine eco… plications for fish and macroinvertebrate communities. *Ecological Indicators, 122*, 107244.

Tho… s, S., Freeman, C., Buffington, K., Janousek, C., & Guntenspergen, G. (2022). Atmospheric river storm flooding influences tidal mar… building processes. *Journal of Geophysical Research: Biogeosciences, 127*(3), e2021JG006592.

Tog… paos, A., Marani, M., & Carniello, L. (2021). Marsh resilience to sea-level rise reduced by storm-surge barriers in the Venice Lag… *Geoscience, 14*(12), 906-911.

Wils… 007). Water injection dredging in US waterways, history and expectations. In *Proceedings of the 18th World Dredging Congress WO…* (pp. 397-412).

Caution…

- A feasibility study is not a permit
- Not funded
- Will be difficult to get approval and funding so this is still very uncertain

Questions…