moffatt & nichol

600 University Street, Suite 610
Seattle, WA 98101

(206) 622-0222 Fax: (206) 622-4764
www.moffattnichol.com

MEMORANDUM

To:	Rob Holmlund (Humboldt Bay Harbor, Recreation, and Conservation District)
From:	Shane Phillips and Michael Jokerst
Date:	April 25, 2024
Subject:	Bay Navigation Assessment
Project:	Redwood Marine Multipurpose Terminal Replacement Project
Location:	Humboldt Bay, California
M&N Job No.:	212991-03

Disclaimer: This draft technical memorandum is a work-in-progress and is intended to be an internal document for use by the Humboldt Bay Offshore Wind Heavy Lift Marine Terminal Project team as a part of the conceptual design process and the ongoing permitting process. This memorandum is meant to be read as a part of a comprehensive packet of technical analyses. It is not written to be a standalone document and it is assumed that the reader has substantial project knowledge and context to understand the memorandum's content. All aspects of this memorandum are subject to change and may become less accurate over time. To better understand the project, please review the more comprehensive and up to date documents posted to the Humboldt Bay Harbor District's website at https://humboldtbay.org/humboldt-bay-offshore-wind-heavy-lift-marine-terminal-project-3.

The purpose of this memorandum is to document Moffatt & Nichol's (M&N's) evaluation process of navigation for floating offshore wind turbines and vessels requiring access to the proposed Redwood Marine Multi-Purpose Terminal (RMMT). This memorandum is organized as follows:

1. Introduction
2. Design Criteria
3. Navigation Facility
4. Results & Next Steps
5. References

1. INTRODUCTION

Construction and delivery of Wind Turbine Generators (WTG) for floating offshore wind farm development is dependent on marine transportation and reliable access to navigation channels.

The RMMT facility is positioned directly adjacent to the northern limit of the Humboldt Navigation Channel managed by the US Army Corps of Engineers (USACE) San Francisco District. The purpose of the assessment is to evaluate at a conceptual level the navigation requirements to help outline more refined work to be conducted in a future phase of design and to help frame engagement with USACE, US Coast Guard, and other stakeholders on the topic of navigation.

The navigation assessment is focused on the federal navigation channel under existing conditions without modification. Vessel fleet and types will be substantially different than those currently using or have used the navigation channel in the past. Other components of the vessel fleet may not exist or have ever transited a west coast navigation channel. This will require advance planning to bring the most relevant industry knowledge and stakeholders to develop an understanding of the new navigation requirements and operational conditions. The work outlined in this memorandum is supplemental to the results outlined in the *Wet Storage Capacity Analysis* Technical Memorandum.

2. DESIGN CRITERIA

The particulars and dimensions for the vessel fleet and WTG were determined based on industry outreach, recent offshore floating wind (OFW) planning studies and literature review. The following were determined to be vessels critical for conducting navigation assessment work.

- Floating Wind Turbine Generator Device (Fully Integrated)
- Floating Wind Turbine Generator Device (Base Only)
- Break Bulk Deep Draft Vessel
- Semi-Submersible Barge and/or Heavy Lift Vessel
- Ocean Towing Tugs. Deeper draft larger vessels used for towing WTG from vertical integration port to the offshore wind farm
- Overall Vessel Fleet for Construction.

The overall vessel fleet is outlined in Appendix A. The vessel fleet information will frame the basis for a navigation channel impact assessment relative to increased vessel activity. Coordination with offshore wind developers will be needed on numbers and frequency as that relates directly to their construction operational plans. That will include the WTG, towing and support tugs, CTV vessels supporting the construction work, component delivery vessels, semi-submersible vessels and harbor tugs.

WTG and vessel particulars are outlined in Section 3 of the *Wet Storage Capacity Analysis* Technical Memorandum,9 with additional supplemental information outlined in Appendix A.

3. NAVIGATION FACILITY

Humboldt Harbor is the only deepwater port between San Francisco, 225 nautical miles to the south, and Coos Bay, Oregon, 156 nautical miles to the north (USACE, 2006). The entrance to Humboldt Bay is bordered by two stone mound jetties approximately one-half mile apart and extending perpendicularly from the ends of two long, narrow sand spits that separate the shallow bay from the ocean. Humboldt Bay has a 48-foot-deep Bar and Entrance channel, and Samoa Channel is 38-feet-deep. Both the South Bay and Eureka channels are 26-feet-deep (HBHSC, 2021). The project site is located adjacent to the Samoa Channel and the turning basin at the northern extent of the federal channel, see **Figure 1**.

As outlined in the Humboldt Harbor Safety Committee Harbor Safety Plan, shoaling conditions can exist in the bar and entrance channels. The conditions are unpredictable but occur more often in the winter months or upon the onset of inclement weather. Historically, moderate winter storms have created dangerous shoaling spots as streams of sand flow upward from the entrance of the ship channel. This shoaling not only creates shipping hazards but has forced the Humboldt Bay Bar Pilots to impose restrictions on vessel drafts. Emergency dredging has been necessary (HBHSC, 2021).

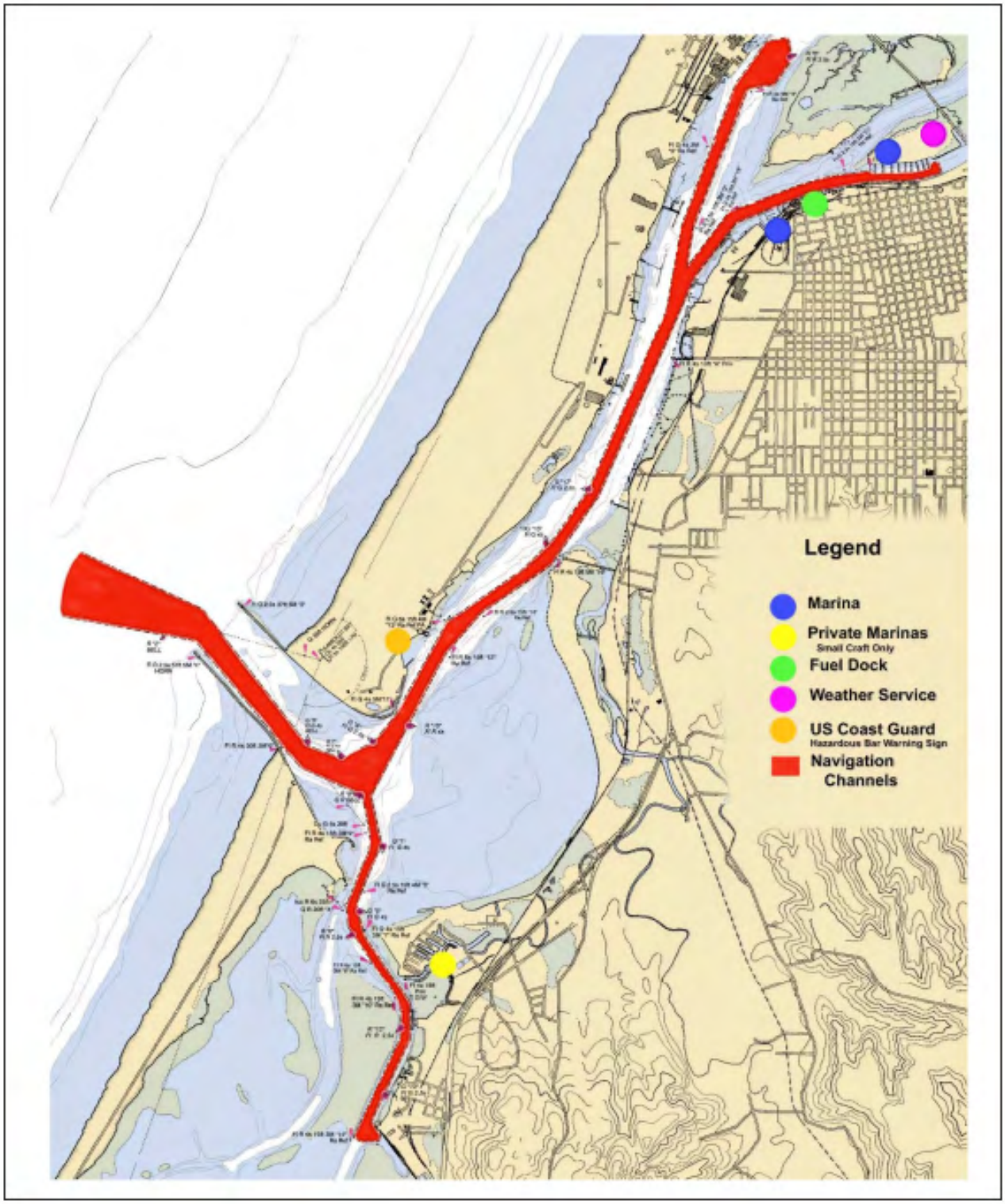


Figure 1 – Humboldt Harbor Facility (HBHSC, 2021)

4. RESULTS & NEXT STEPS

Vessel Maneuvering

Empirical analysis was conducted to assess maneuvering needs within the existing channel for both the WTG and vessel fleet. Results are outlined in the WTG and Vessel Fleet sections described below. More detailed vessel maneuvering analysis and vessel bridge simulation work is needed in the next phase of work to further refine the navigation requirements and size of device and support tug operational envelope required. That additional analysis would include utilizing some combination of desktop simulators to help conduct a range of scenarios to help narrow down critical conditions for more detailed assessment in the Humboldt Harbor simulator at Cal Maritime. The simulation work will require close coordination with the USCG, USACE and Pilots association.

WTG Device Size

Currently, 12 MW offshore wind turbine systems are commercially available; however, the anticipated size of turbine systems to be installed on the U.S. West Coast may be 15 – 20 MW or larger, which then require larger floating foundation systems. There are two main reasons for installing the largest capacity turbines available on the U.S. West Coast:

1. Risk - The risks in towing and installing these turbines out into the ocean are so high that developers want to go through the tow-out and installation process as few times as possible.
2. Cost - It is also very expensive to assemble and install floating OSW turbines, so developers want to make as few crane lifts and tow-outs as possible. The additional effort and cost to build and install a 20 MW versus a 15 MW turbine is not significant.

Therefore, to get the most MW installed with the least amount of risk and lowest cost, the developers will install the largest MW turbines available.

Based on the conceptual empirical analysis, discussions with the industry and marine towing companies, the following are sizes being used for navigation planning and terminal design work.

- Navigation Planning: WTG equal to or less than 350’ Width, 35’ Draft (most likely fits within channel for width, depth). Needs further evaluation.
- Terminal Design: WTG greater than 350’ width may require channel modification, relocation of navigation aids and/or other special operational considerations. WTG greater than ~35ft draft may require channel deepening. It is recommended to future proof structures for a larger WTG as outlined in the AB525 report or other most current relevant industry recommendations in the event a future channel modification project occurs.

Vessel Fleet

A vessel fleet that could utilize the proposed terminal facility and navigation channel was developed and based on empirical analysis; all appear to be within the parameters for utilizing the existing channel with the following exceptions:

- Larger class of semi-submersible WTG foundation delivery vessel. The largest sizes would be limited by the channel depth and width. A smaller to medium class vessel would be required.
- The sinking basin requirements need further refinement with offshore wind industry. A planned depth of -60’ MLLW was determined to be needed for a smaller to medium class of semi-submersible type vessel. Further confirmation of exact sinking basin operations is needed through discussion with the industry in the next phase of design. The sinking basin is proposed to be co-located with the north area wet storage and outside the limits of the navigation channel turning basin.
    - As discussed in the *Terminal Permitted and Future Operations Memo*, it is important to note that if assembled foundations or fully integrated turbines are utilizing the co-located

wet storage area when a semi-submersible barge/vessel needs to utilize the sinking basin, this may effective efficient operations depending on the type and size of semi-submersible barge/vessel. Therefore, both the sinking basin and wet storage locations need further analysis and refinement based on further industry outreach activities.

Channel Modification

Based on the conceptual level empirical analysis, discussions with the industry, and marine towing companies, it is currently anticipated the navigation channel would be used in a fully maintained state for the anticipated WTG size used for the navigation assessment. WTG sizes greater than the width and draft outlined may require a channel modification.

Channel modification would not be proposed or required for the proposed terminal operations. If the offshore wind industry were to shift to a larger size WTG in the future as more lease areas come onto the market, a channel modification project under a separate process may be needed. Those improvements could include a wide range of potential modifications from localized widening, deepening, relocation of navigation aids, or other factors to improve navigable area for safe operations and to improve efficiency for maintenance dredging requirements within the entrance and bar channel. It is recommended to initiate preliminary conversations with the USACE to outline potential reconnaissance level study costs and timelines for planning purposes.

Channel Maintenance Dredging

The USACE currently conducts maintenance dredging of the federal channel at varying intervals based on conditions and availability of dredge plant availability. A combination of the Dredge Essayons and Yaquina are used for the Bar/Entrance Channel and interior Samoa/North Channel, respectively. Continued maintenance dredging will be required and increased frequency and volumes of dredging should be anticipated to maintain the channel to the authorized depth and width for all season access to the maximum extent possible. It is recommended to coordinate vessel activity and fleet requirements with the USACE for their future dredge operational planning and budgeting process. Of particular interest is the shoaling that occurs within the entrance channel. Further evaluation and coordination with USACE and Harbor Safety committee is needed in the next phase. As part of longer-term planning, a section 216 study as outlined by the USACE in the early 2000's may be warranted and should be investigated with the Navigation Section of the San Francisco USACE.

Pilotage

The Humboldt Bay deep-draft harbor has pilotage requirements for deep-draft vessels entering the harbor and navigation channel (HBHSC, 2022). Harbor tugs are available for assistance for existing larger vessels that transit the channel. Further evaluation of type, size, number and location for homeporting the harbor and ocean tugs is needed. Pilotage requirements for the fully assembled WTG during tow out needs further evaluation and discussion. Additional questions that need to be addressed in the next phase of design are as follows:

- The WTG is classified by the Coast Guard as a dead ship tow. Will the primary towing tug require pilotage from Humboldt Harbor pilots?
- What other pilotage requirements will apply to the new towing operations for WTG's?
- Will portions of the vessel fleet require pilotage such as cargo delivery vessels, semi-submersible delivery vessels and towing of WTG substructures across the bar channel?

Further evaluation and discussions with USACE, Coast Guard, Pilots will be required to further develop a navigation operational plan (as an example, dead ship tow regulations can be found in other similar coastal harbors such as for the Lower Columbia River Entrance Channel outlined by the Harbor Safety Committee).

Navigation Aids

Navigation aids located adjacent to the proposed terminal will require relocation. Further discussion with USCG in the next phase will be required to determine an appropriate replacement location for the two navigation aids that will need some form of relocation. One is located at the terminal berth area and the other adjacent to the east side wet storage.

Navigation aids located adjacent to the navigation channel but south of the terminal may need relocation depending on the operating envelope for the tow out operational plan. The support tugs located port and starboard of the WTG during tow out may need to operate within the fairway in close proximity to the navigation aids. Further maneuvering analysis and discussions with USCG is needed to determine the need for any navigation aid relocation.

Sea State for Bar Crossing

The Harbor Safety Committee has imposed restrictions for crossing the bar under certain oceanographic and bathymetric conditions and vessel type. Those have been determined through a combination of experience, local knowledge, and simulator work at Cal Maritime.

Further vessel simulation work will be required in the next phase of design as well as close coordination with Harbor Safety Committee to outline those types of conditions that will be acceptable to transiting the entrance for both the WTG's and the vessel fleet. The results will have some influence on the need for wet storage of fully integrated WTGs and WTG foundations.

5. REFERENCES

Humboldt Bay Harbor Safety Committee (HBHSC). (2022). *Harbor Safety Plan of Humboldt Bay*. humboldtharborsafety.org.

United States Coast Guard. (Aug 2019). Navigation and Vessel Inspection Circular No. 01-19. *Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations*. winston.com.

Lower Columbia Region Harbor Safety Committee Dead Ship Tow Guidelines. (2017).

USACE. San Francisco District. SECTION 905(b) (WRDA 86) ANALYSIS HUMBOLDT BAY LONG-TERM SEDIMENT MANAGEMENT STUDY (CWIS #081540; P2 Project #105098. Proposed Section 206 Study. (2006))

APPENDIX A

Humboldt Bay Harbor, Recreation, and Conservation District

moffatt & nichol

REDWOOD MARINE MULTIPURPOSE TERMINAL REPLACEMENT PROJECT

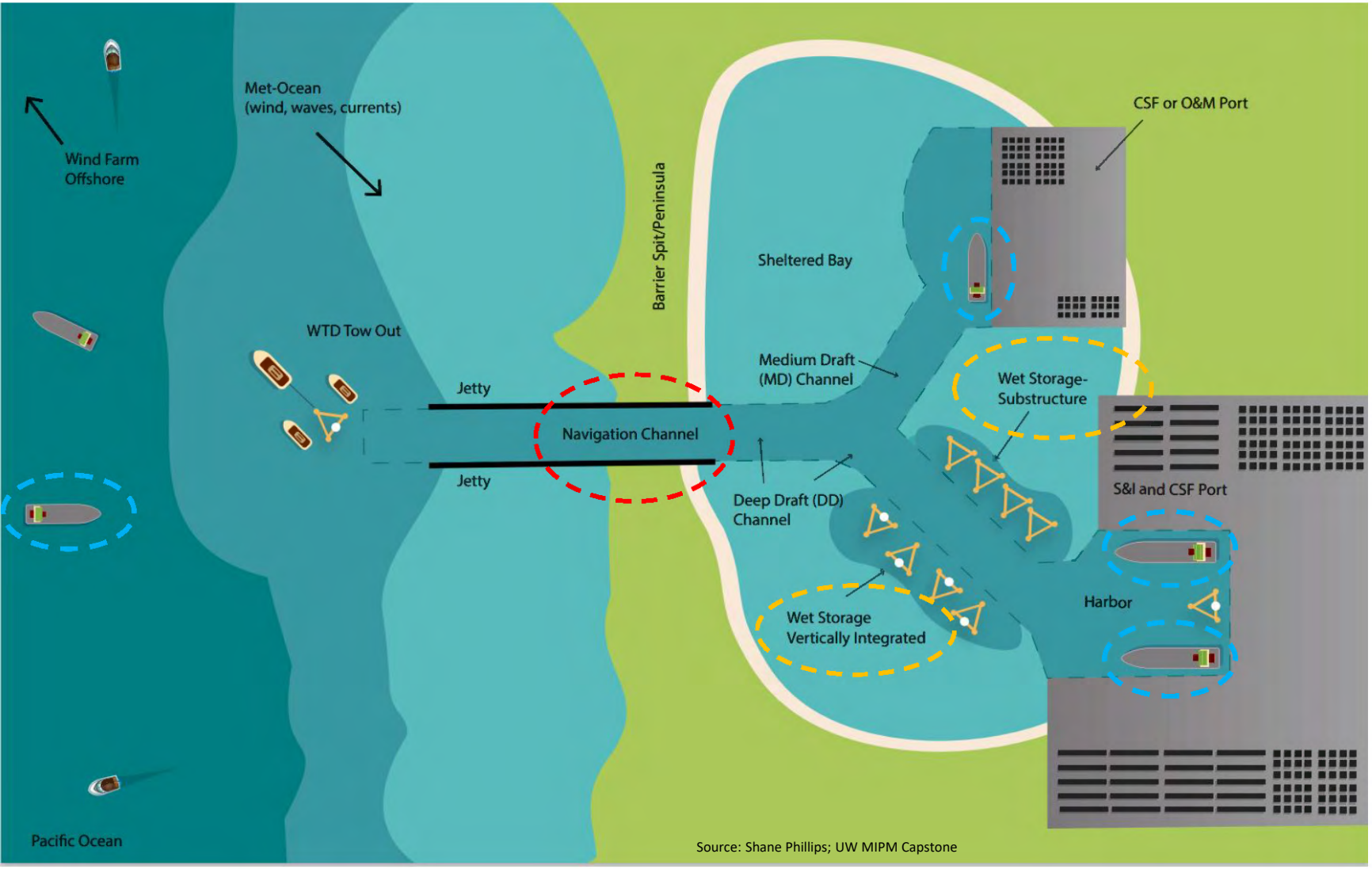
NAVIGATION ASSESSMENT UPDATE

December 7, 2023

Navigation Assessment

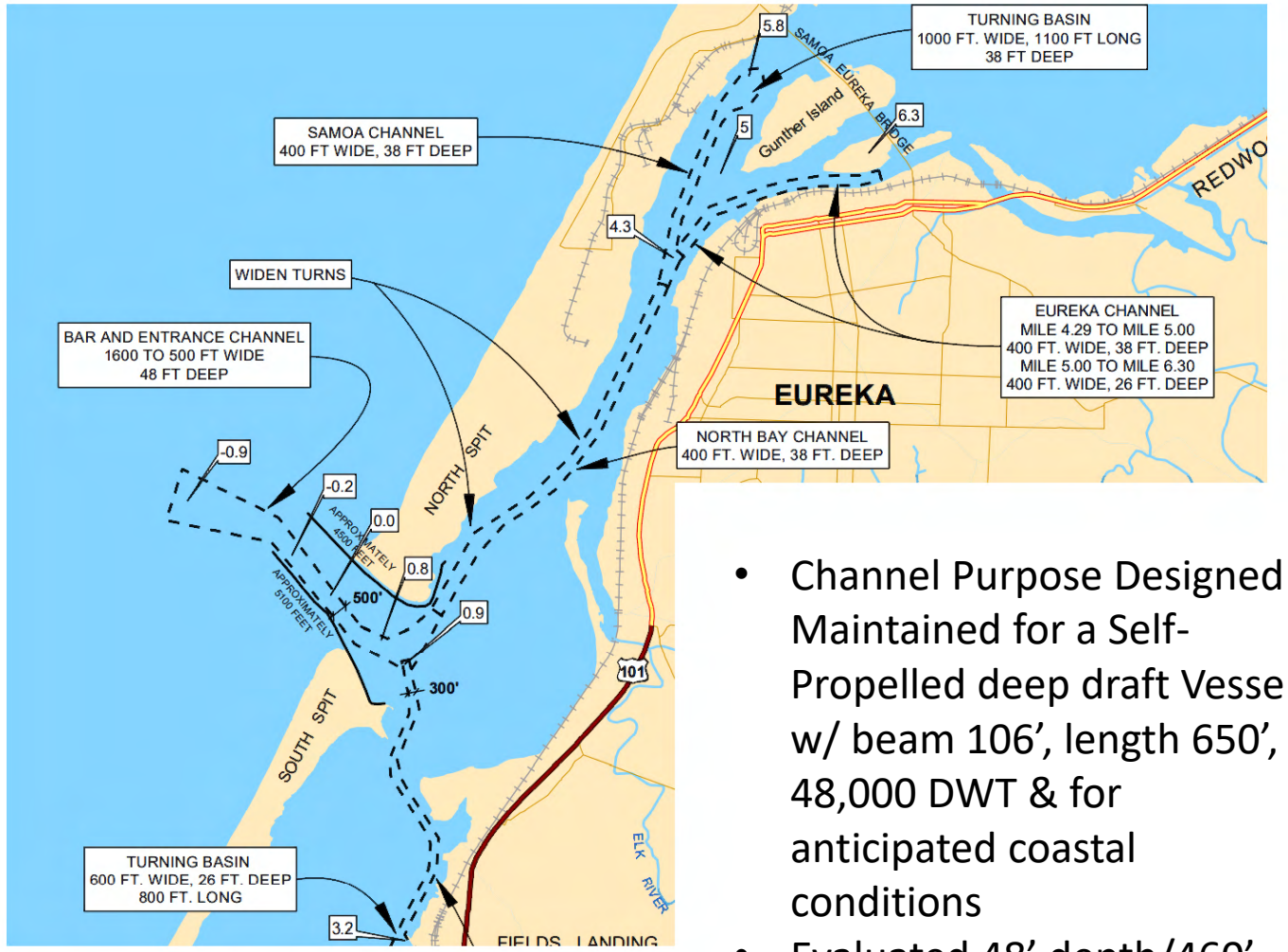
- Desktop Review to help inform narrative for navigation plan and help inform more detailed analysis' that may be needed
- Review historic USACE hydrographic condition survey data to look at shoaling patterns, areas of potential concerns and post maintenance dredging changes
- Outline the vessel fleet type, size and operating envelope to assist with the assessment
- Define the maximum WTD for channel operations (maximum beam and draft). There will be two criteria; A. Channel Operations under existing Navigation Channel conditions and B. Future proofing scenario for designing infrastructure relative to a possible future channel modification (width or depth) condition.

Ports & Waterways – How & Where

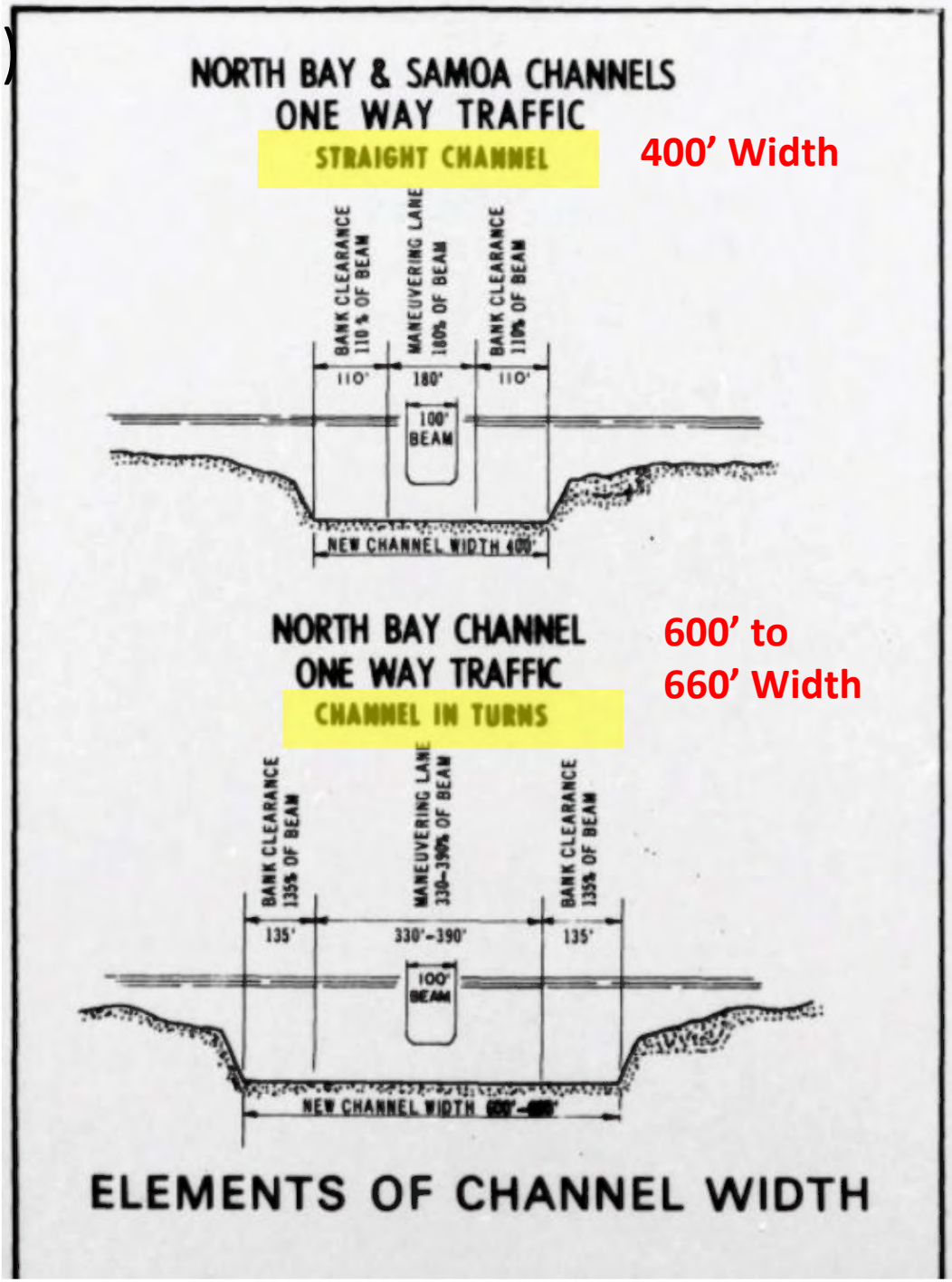


Source: Shane Phillips; UW MIPM Capstone

Navigation Channel – Existing Channel (Width)

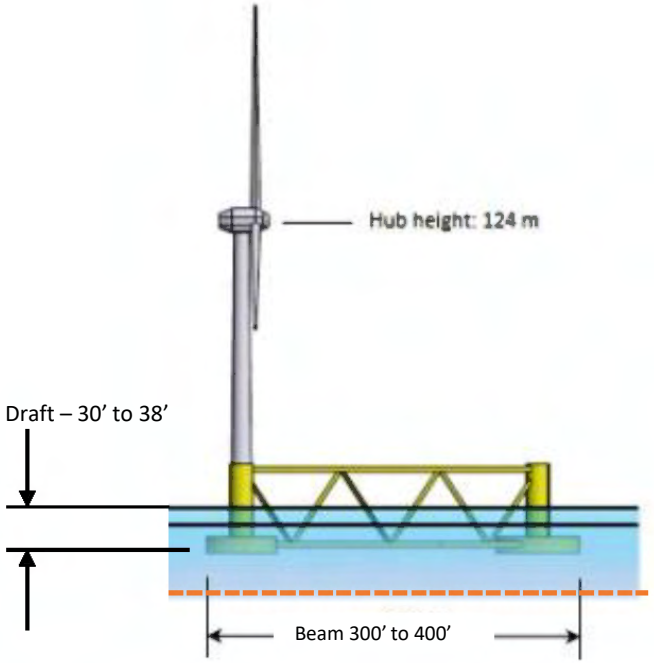


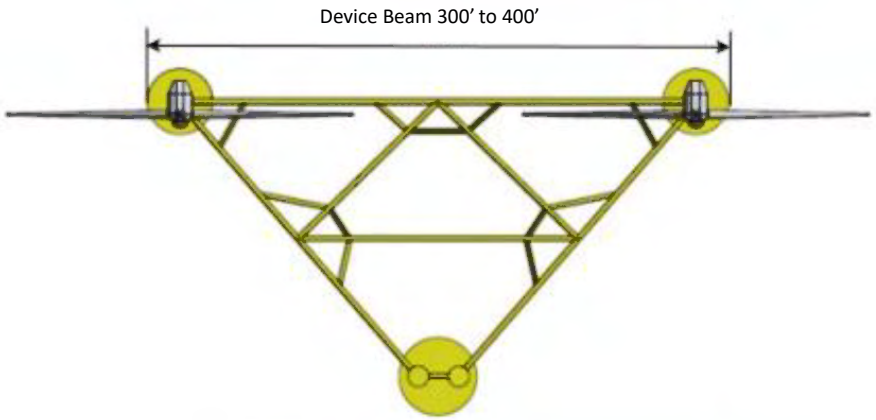
- Channel Purpose Designed & Maintained for a Self-Propelled deep draft Vessel w/ beam 106', length 650', 48,000 DWT & for anticipated coastal conditions
- Evaluated 48' depth/460' width in Samoa Channel; *not carried forward*



Source: USACE Deepening Study

Navigation Channel – Tow Out Operations





Source: 3 Gorges Offshore Floating Wind Farm Project

- USCG Classification = Dead Ship Tow
- Maneuvering Requirements – Multiple Tugs (3 to 4 depending on conditions)

- Width Greatly Varies w/ Technology = 300’ to 400’; Utilize 350’ for permitting
- Draft Greatly Varies w/ Technology = 30’ to 38’; Utilize 35’ for permitting

Industry Outreach Summary

Note: 3 Gorges Device; Beam = 300’, Installed Draft 44’

Navigation Channel – Example Tow Vessels

Crowley Marine – Ocean Wind/Ocean Wave

- LOA = 146’
- Beam = 46’
- Draft 25’
- Bollard Pull = 147 ton

Crowley Marine – Ocean Wind/Ocean Wave

- LOA = 250’
- Beam = 60’
- Draft 26’
- Bollard Pull = 205 ton

Prototype 300’ Example – 3 Gorges 300’ width WTD

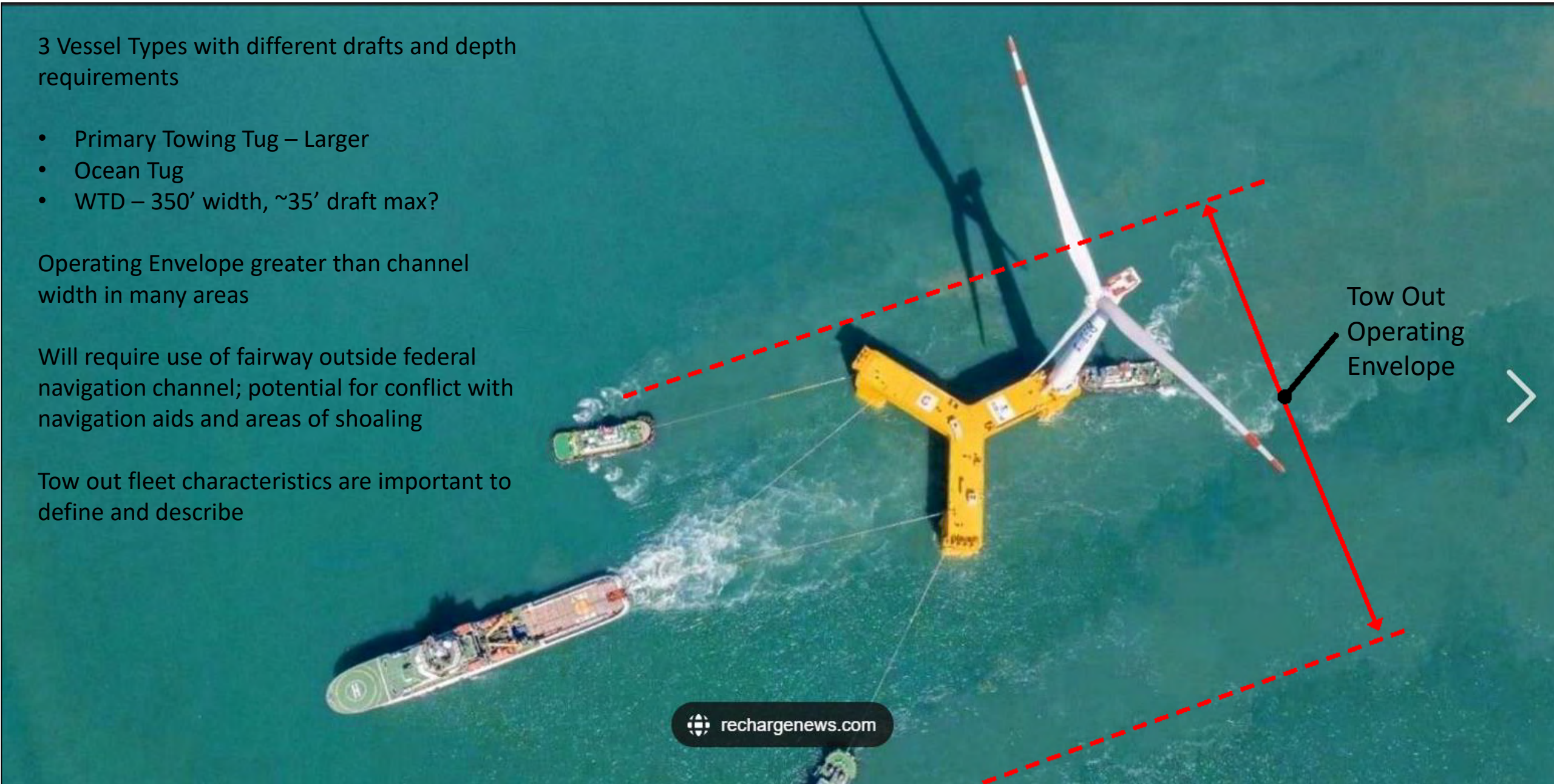
3 Vessel Types with different drafts and depth requirements

- Primary Towing Tug – Larger
- Ocean Tug
- WTD – 350’ width, ~35’ draft max?

Operating Envelope greater than channel width in many areas

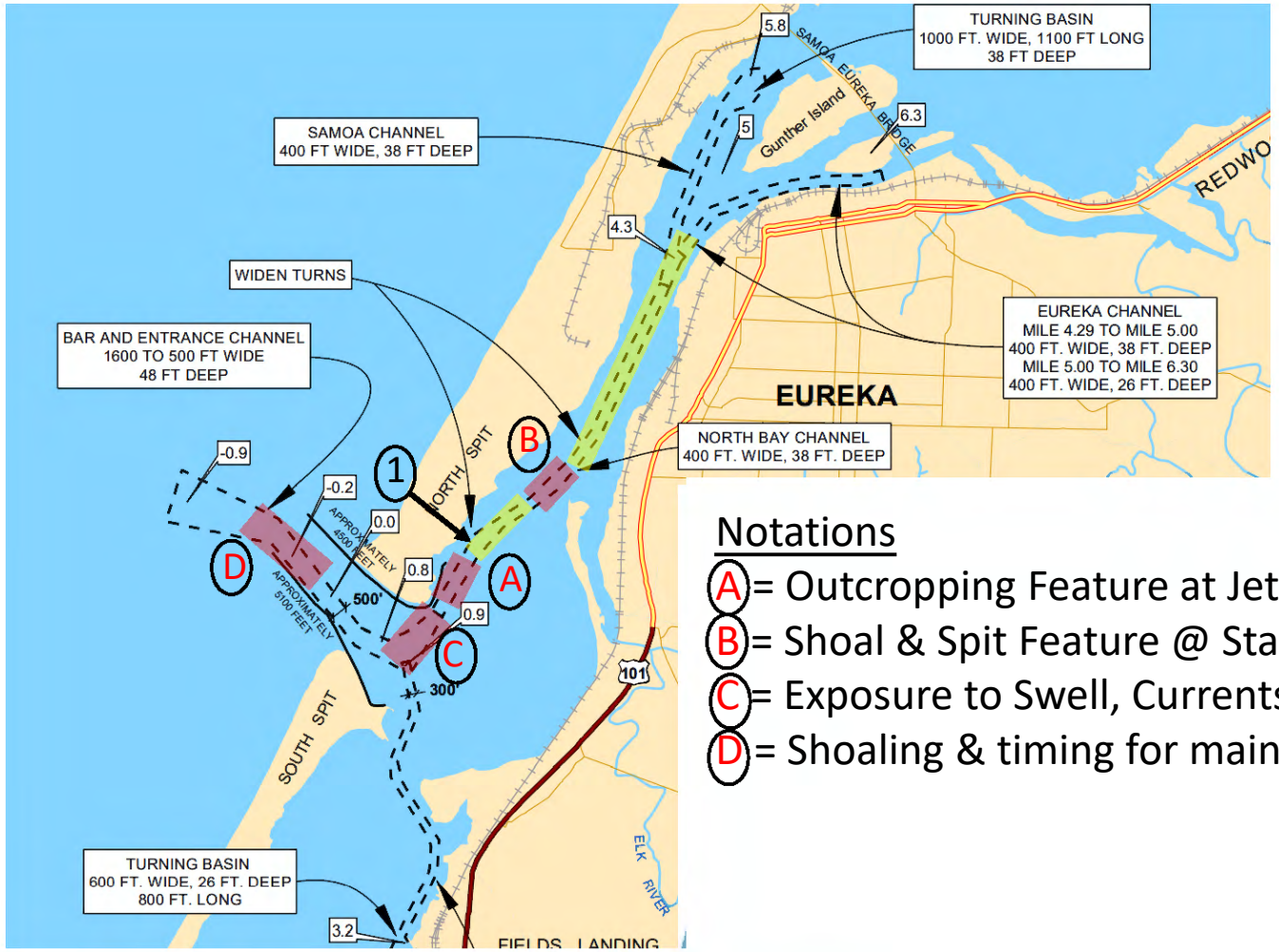
Will require use of fairway outside federal navigation channel; potential for conflict with navigation aids and areas of shoaling

Tow out fleet characteristics are important to define and describe



Prototype 300’ Example – Tow-out to Ocean (Samoa Channel Superimposed; approx. scale)

Navigation Channel – Width/Depth & Maneuvering



= Area of Higher Concern

= Area of Medium Concern

= Area of Lower Concern

Notations

(A) = Outcropping Feature at Jetty (Stone?) @ Sta 140+00 & Shoaling on east side

(B) = Shoal & Spit Feature @ Sta 186+00 to 216+00 on east side

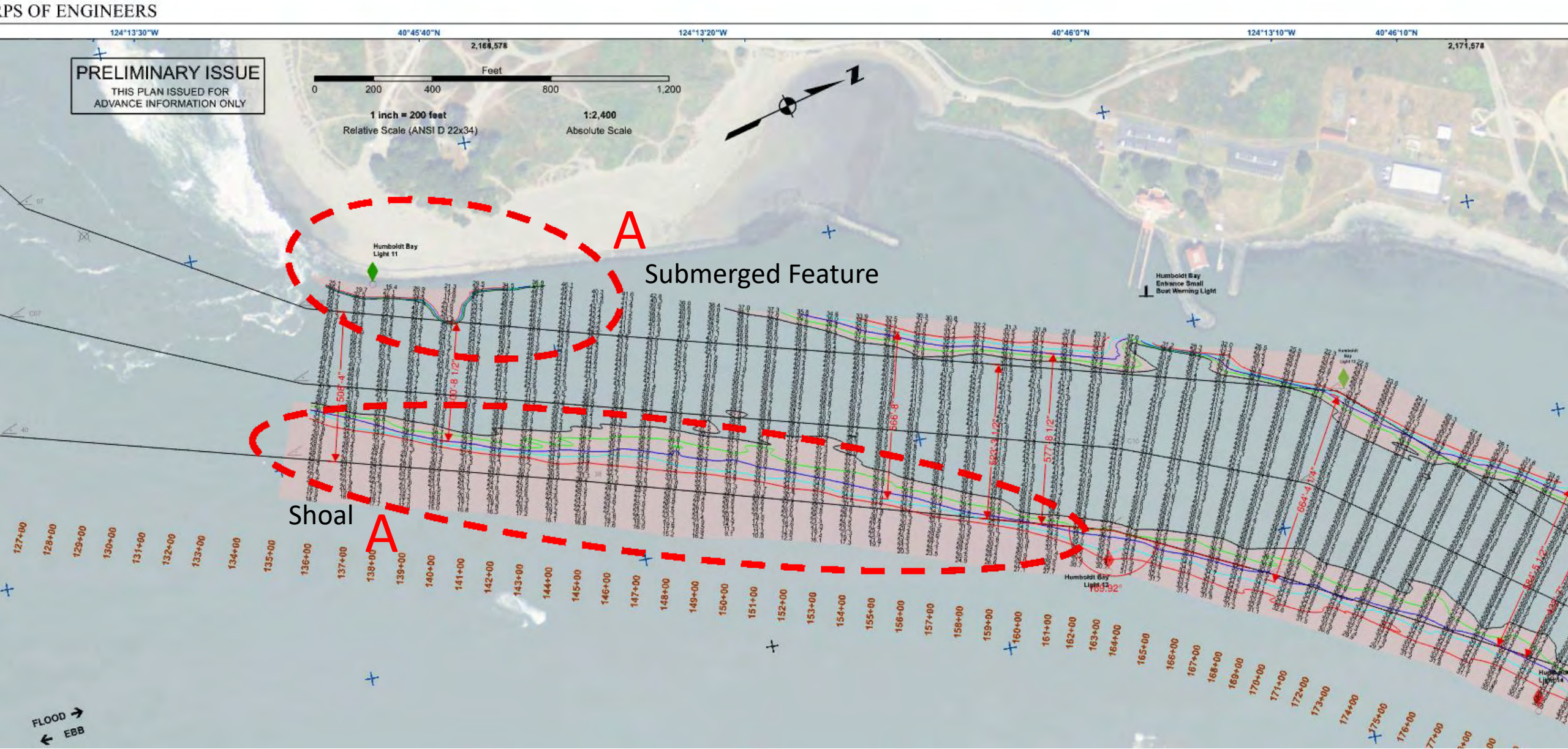
(C) = Exposure to Swell, Currents, Wind at transition to entrance channel (beam seas)

(D) = Shoaling & timing for maintenance dredging

Details:

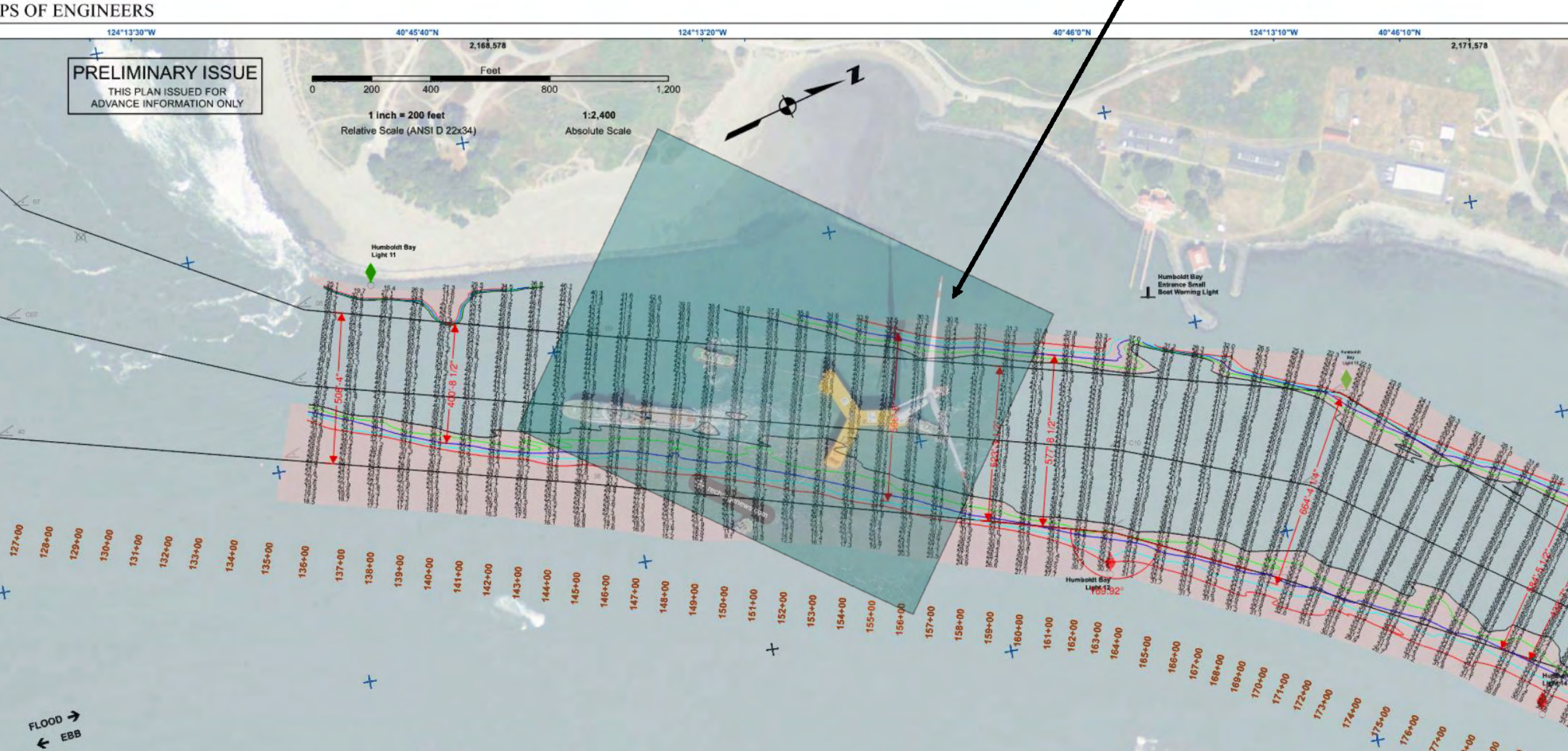
1. Samoa Channel 400’ width starts @ Sta 181+00; bends are wider
2. Width @35’ Depth – Varies 440’ to 650’+; majority of channel is >500’ when USACE conducts maintenance dredging to authorized depth
3. Navigation Aids are generally 75’ min off edge of channel; >500’ width possible

Navigation Channel – Notation A

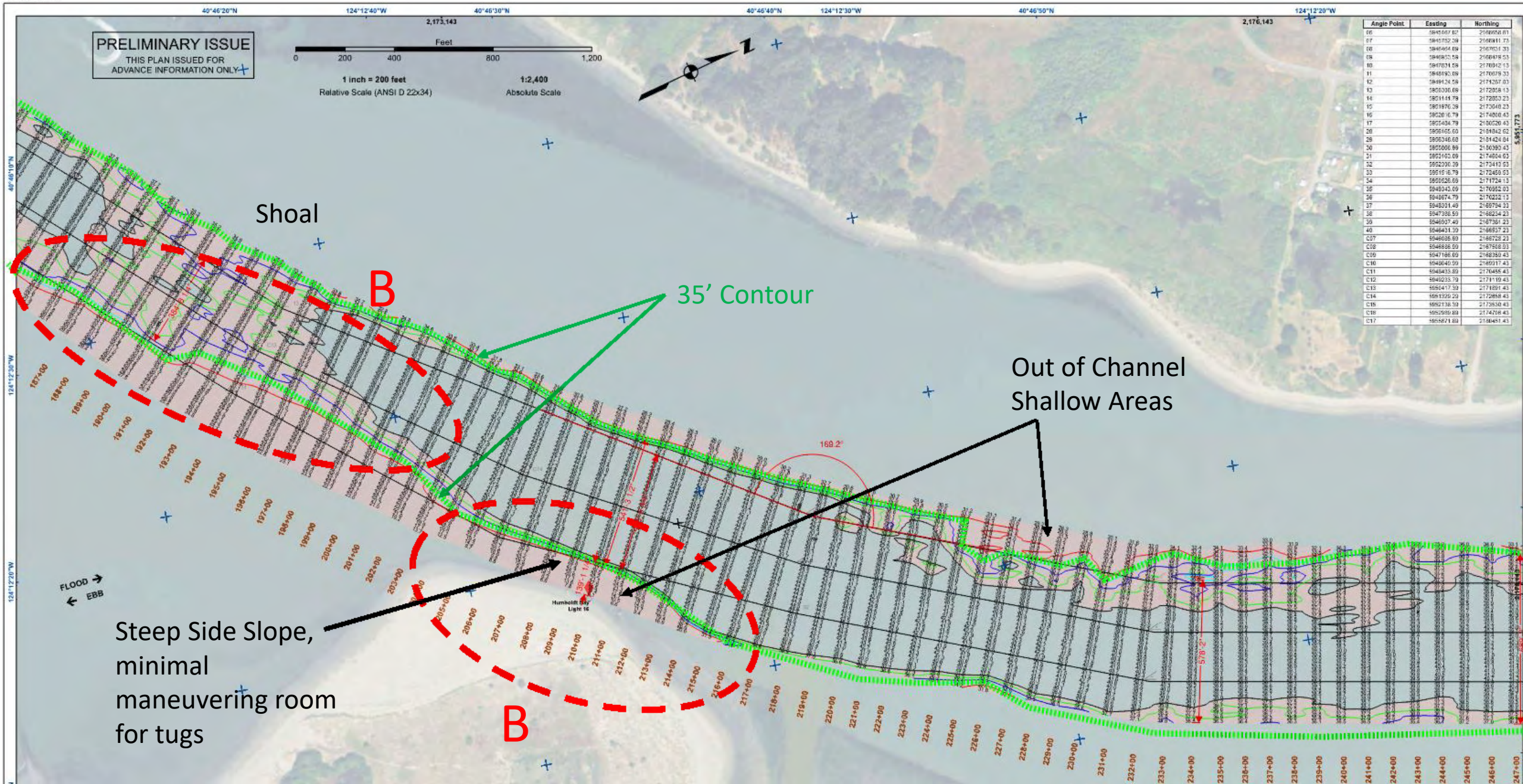


Navigation Channel – Notation A

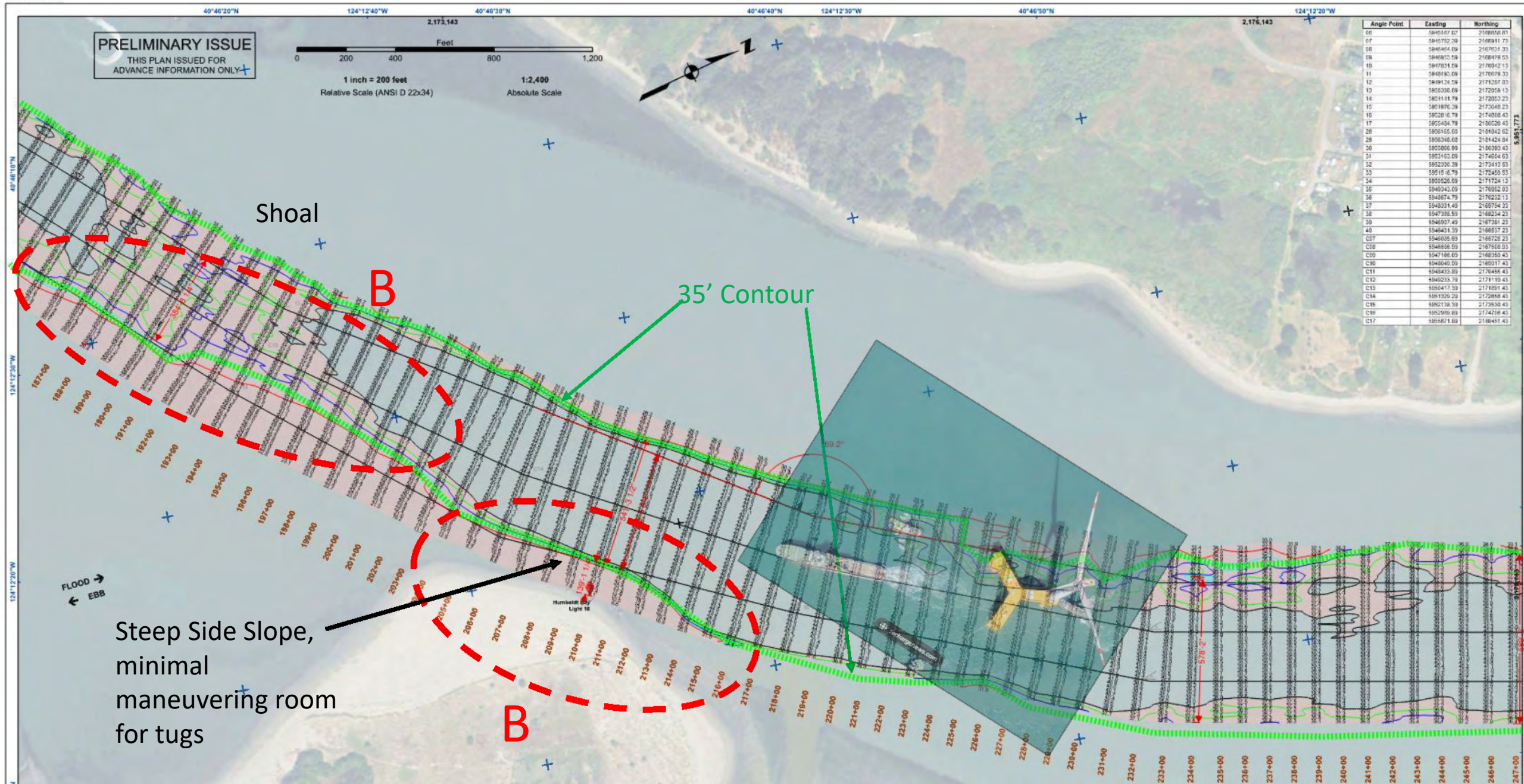
3 Gorges Project Floater Scaled to ~300’ Beam



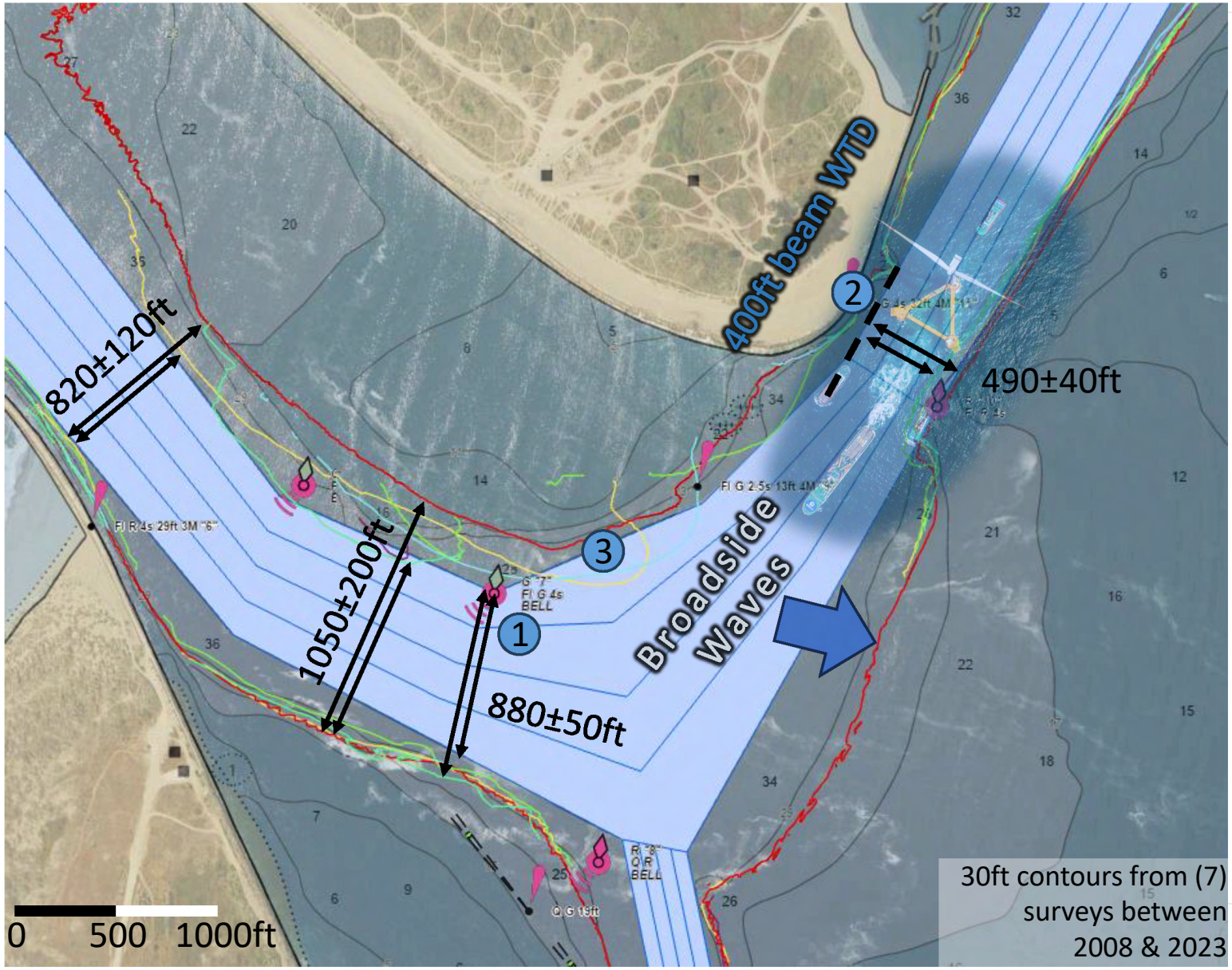
Navigation Channel – Notation B



Navigation Channel – Notation B



Maneuvering – 30ft Contour – Entrance & Turn

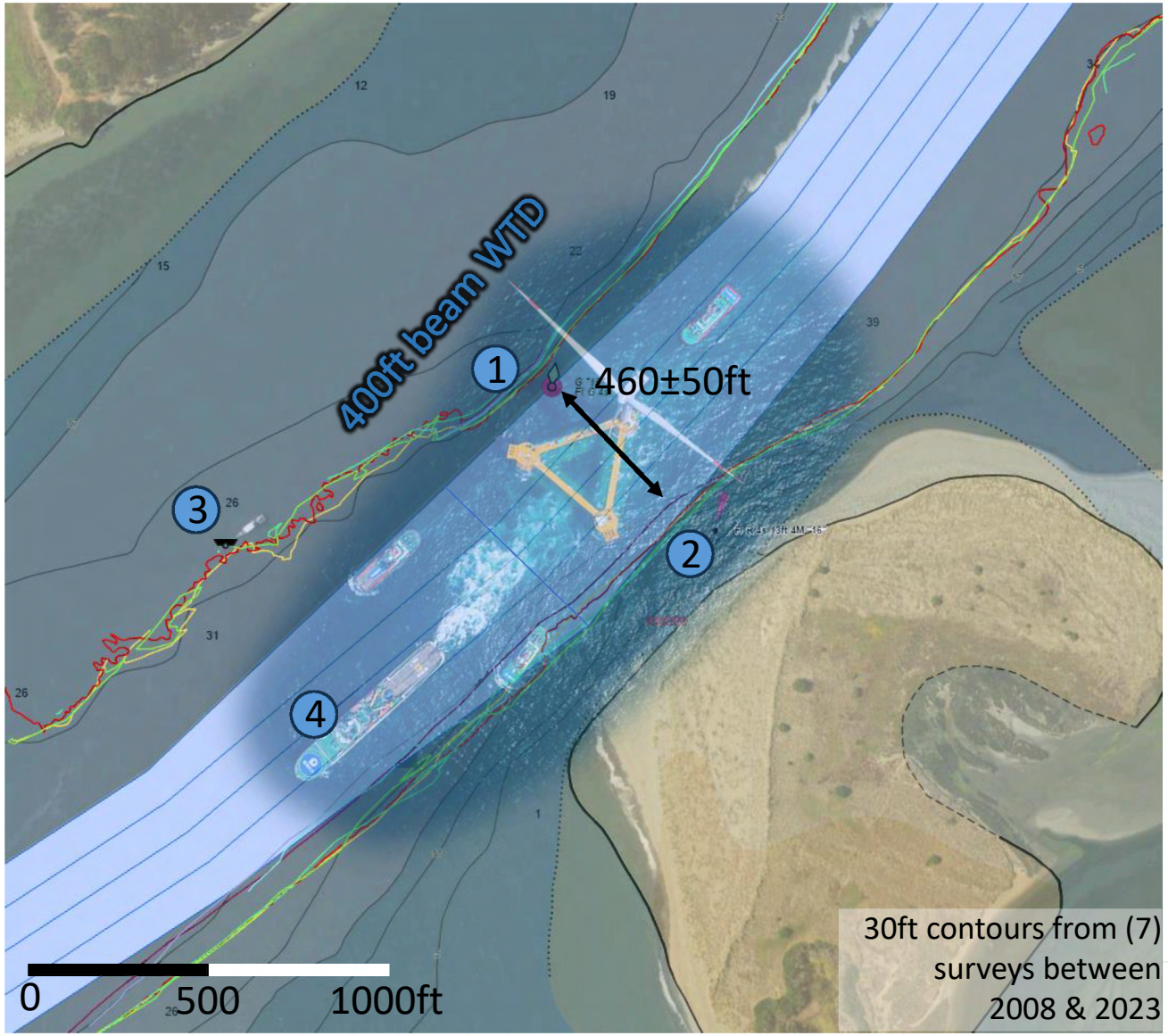


1. BUOY 7 restricts channel, however, shoal immediately downstream will constrict width a similar amount. Without the buoy present effective width could be up to 1000ft.

2. Channel restricted to the North by jetty root structure and to the South by a buoy and shallow water.

3. Presence of shoal may require a more difficult, sharper turn out to sea. Broadside waves may be significant depending on ocean conditions.

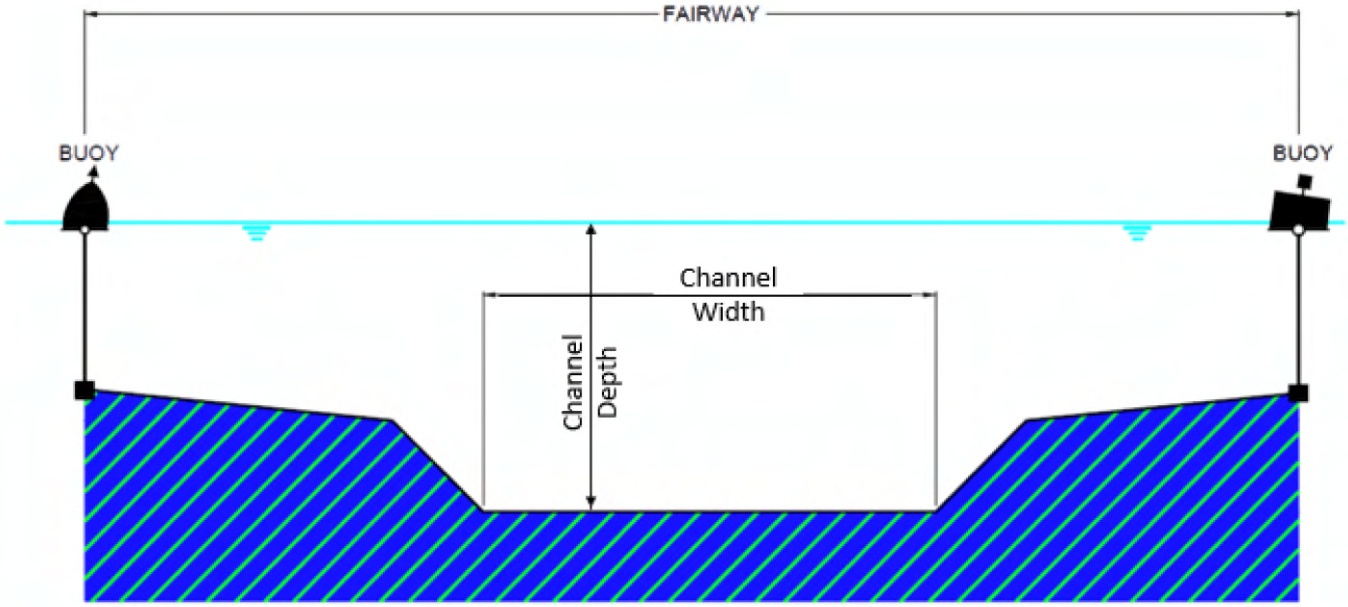
Maneuvering – 30ft Contour – Bucksport Bend



1. BUOY 15 and shoal restrict usable width
2. LIGHT 16 and variable shoal restricts usable width
3. Navigation Aid buoy
4. Can become restricted due to shoaling for depths greater than ~40ft.

Vessel Fleet & Channel Use

Note: Not all associated with Wind Terminal Operations. Source S. Phillips Capstone



Navigation Channel (deep draft) vs. Fairway

Assessment of both deep draft channel use and non-deep draft for new channel usage. Investigate options for safe passage of commercial fishing and recreational vessels along the edge of the navigation channel as a mitigation consideration – currently occurs in some locations.

Vessel Fleet Particulars

Table - Vessel Fleet Requirements (Offshore Floating Wind Activity)

Vessel Particulars and Channel Use Classification

Activity Phase	# (Fig)	Vessel Type	Beam (ft)	Draft (ft)	Length (ft)
Construction					
	4	Component Transport (CT)[2,12]	66 - 105	24 - 44	387 - 670
	5	Semi-Submersible Heavy Transport (SSHT)[8]	140 - 258	33 - 70	700 - 900
	6	Anchor Handling Tug (AHT)[9]	46 - 72	15 - 26	180 - 305
	7	Ocean Towing Tugs (OT)[2,7]	40 - 46	18 - 22	100 - 146
	8	Harbor Tugs (HT) [11]	35 - 40	12 - 18	75 - 150
	9	Construction Support Heavy Lift Vessel (CSV)[9]	62 - 104	18 - 30	295 - 492
	10	Cable Laying (CLV)[9]	60 - 145	16 - 26	265 - 455
	12	Crew Transfer (CTV)[6]	16- 35	4 - 8	55 - 91
	13	Service Operation (SOV)[9]	52 - 72	18 - 23	285 - 390

Notes:

A. Vessel Dimensions will be a range that could be +/- 10% from those shown

References

1. American Clean Energy - Offshore Wind Vessel Needs. Tow Out Calculations for Floating Wind Turbines Thies, Crowle, Oct 2022.
2. Wind Ireland National Ports Study. https://windenergyireland.com/images/files/final-national-ports-study.pdf
3. USACE Portland District. Yaquina & Essayons. https://www.nwp.usace.army.mil/Media/Images/igphoto/2000754769/.
4. Maersk Supply Service. https://www.maersksupplyservice.com/wp-content/uploads/2020/06/HTML-Maersk-Installer-1782.pdf
5. Ulstein. https://ulstein.com/ship-design/offshore-wind
6. REACH. https://reachcentralcoast.org/wp-content/uploads/Waterfront-Infrastructure-Report-121522.pdf
7. Crowley Marine. https://www.crowley.com/wp-content/uploads/sites/7/2021/06/Apollo-web.pdf
8. Boskalis. https://boskalis.com/media/ydukdsci/boka_polaris.pdf
9. GRS Group Offshore Renewable Vessel Leasing. https://grs.group/grs-offshore-renewables/charter/offshore-vessels-by-type/
10. FUGRO. https://www.fugro.com/about-fugro/our-expertise/vessels-and-jack-up-barges/geotechnical-vessels
11. Foss Maritime. https://www.foss.com/fleet/tugboats/
12. G2Ocean. https://www.g2ocean.com/vessels-and-equipment/fleet-list/

Navigation Channel – Discussion

Relevance to Project Description?

- Stakeholder Feedback (Fisherman), USACE, USCG, Pilots
- Terminal vs. Offshore Wind Project Area = ~Ocean Boundary of Navigation Channel
  - Navigation Effects for CEQA/NEPA – Vessel Traffic, Shoreline Erosion
  - Maintenance Dredging Needs? Will Increase as part of the terminal development; need for more frequency by USACE.
  - Need to relocate Navigation Aids? TBD
  - Dead Ship Tow & Channel Closure Requirements; closure to deep draft only and not shallow draft vessels. Evaluate navigation of vessels in fairway outside of USACE channel limits
  - Existing obstructions may exist in new fairway operating areas and edge of existing channel

WTD Maneuvering Simulations

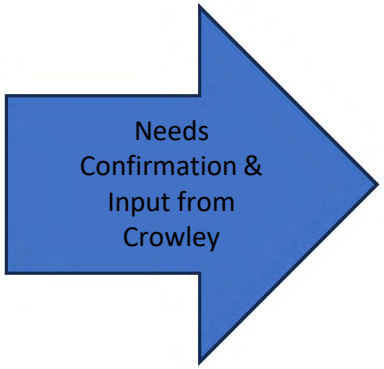
- Multi step process
- Current phase – empirical based on experience, industry guidance and discussions with Crowley
- Vessel Simulation next phase likely needed – desktop analysis then full bridge simulation in the future

Follow Up Discussion With USACE and USCG

- USACE – Areas of concerns, need for maintenance dredging, Section 408 (1st meeting completed)
- USCG – Planned operations, navigation aid relocations at terminal, change in navigation

Navigation Channel – Discussion

- Need a consistent operational narrative
  - WTD size
  - Tow Out Operations
  - In Harbor Operations – Movement of tugs and WTD substructures
  - Semi-Submersible Operations – Type of operation, required depth (-45’ or deeper)
  - Number and Type of Vessels during vertical integration operations
  - Location of navigation for commercial traffic to marine terminal and then for recreational, fishing and other non-terminal commercial activity
  - Impacts Assessment



What is needed? Topic Meeting follow up, information from Crowley and then confirmation on BOD.

CEQA/Permitting Marine Operations Criteria

Future Proofing Infrastructure Criteria

Operational Narrative

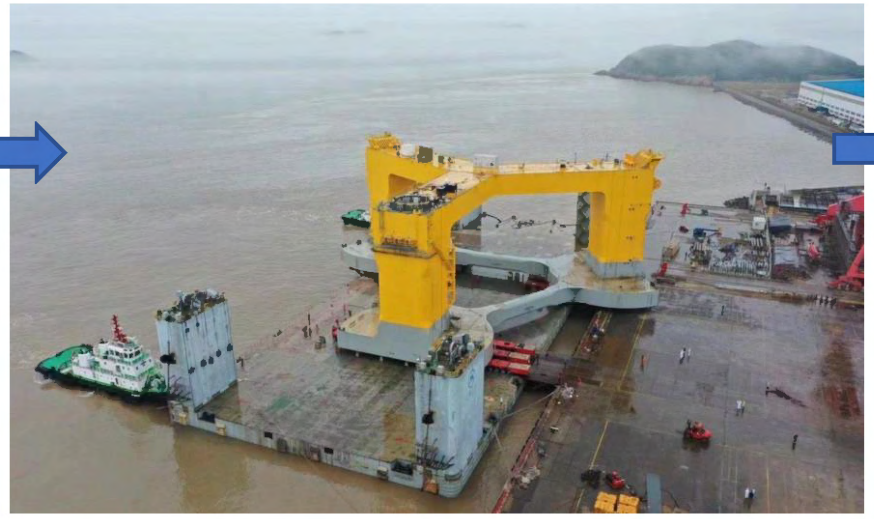
Needs to align on overall narrative between wharf, berth, wet storage, tow out, float off of semi-submersible for substructures.

WTD = 350’ Width, 35’ Draft (fits within channel for width, depth.

WTD >350’ future proofing of structures in the event a future channel modification project occurs

Semisubmersible Roll On Float Off Operations

Prototype Example – Foundation Fabrication & Transfer to Semi-Submersible – (Chinese Three Gorges Guangdong Floating Offshore Wind Power Project)



Foundation Details

Width = 300’

Installed Draft = 44’

Installed Turbine Capacity = 5.5 MW

Semi Submersible – Float off @ Sinking Basin

Industry Ask?

- Varies: 40’ to 80’ depending on device type, size and methods and type of vessel being used
- 60’ for mid size range of vessel

Sinking Basin Considerations

- USACE Navigation Channel
  - Navigation Safety – compatibility with commercial and non-commercial vessels activity
  - Section 408 – Review of alterations to ensure no impact on Civil Works program (Navigation Channel); in this case could be use of channel, environmental, change in hydrodynamics, navigation safety, maintenance dredging, etc…
- Dredging Needs – Capital and Maintenance
  - Location relative to bay tidal channel morphological processes – don't locate at high potential shoaling areas
  - Good location is north of and adjacent to the turning basin.
- Proximity to shore
  - Potential for impact on intertidal habitat, nearshore structures
- Maximum Existing Depth Locations?
  - Navigation Channel – Entrance Channel (~ -65')
  - Outside Navigation Channel – Fairhaven Marine Terminal Berth (~ -52')
- Required Depth?
  - Varies by developer based on technology
  - Industry outreach indicates anywhere from -40' to -80'
  - What's practicable? Likely ~ -50' to -60'; beyond that is a deepening of natural depths in the bay