Marine Board Spring Meeting

April 2026

Under Keel Clearance at Port of Long Beach and the Future of Navigation at NOAA

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CA Navigation Manager

NOAA Coast Survey

OVERVIEW of Dynamic Under Keel Clearance Project

The Challenge:
Get VLCCs & ULCCs safely to the berth at POLB

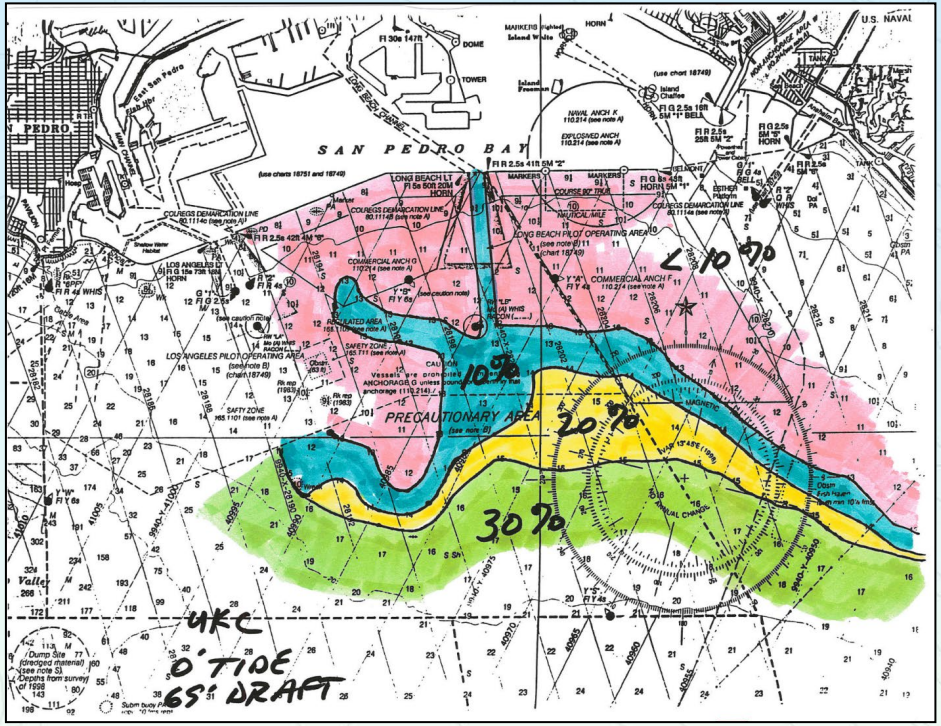
M/V ***Solana*** passing Jacobsen Pilot Station enroute pier 121, Tuesday 23 September 2014

History of the 76 foot channel into the Port of Long Beach

In 1998, after years of study, the Port of Long Beach, ACOE, and ARCO Marine partnered to dredge the Long Beach Approach Channel to 76'.

The goal was to allow ARCO's largest tankers at the time, 265,000 DWT (single hull) to transit to berth 121 with a full load which was 69' draft.

UKC + 10% of draft per Harbor Safety Plan



10% UKC Math: 69' draft + 10% of 69' = 76' channel depth 69' + 6.9' = 75.9' ~ 76'

Final dredging of a 76' deep channel from the LB Sea Buoy to Berth T-121 was completed in 2014.

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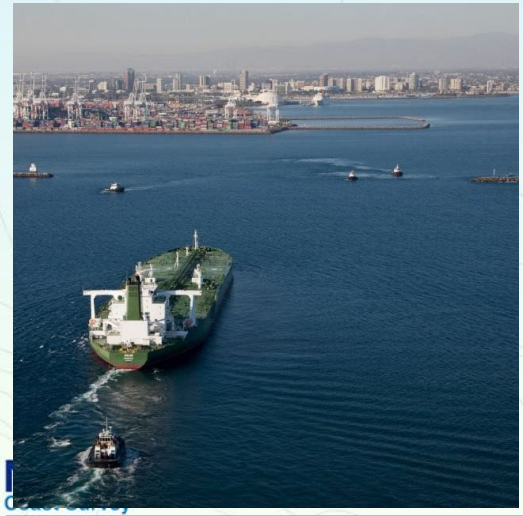
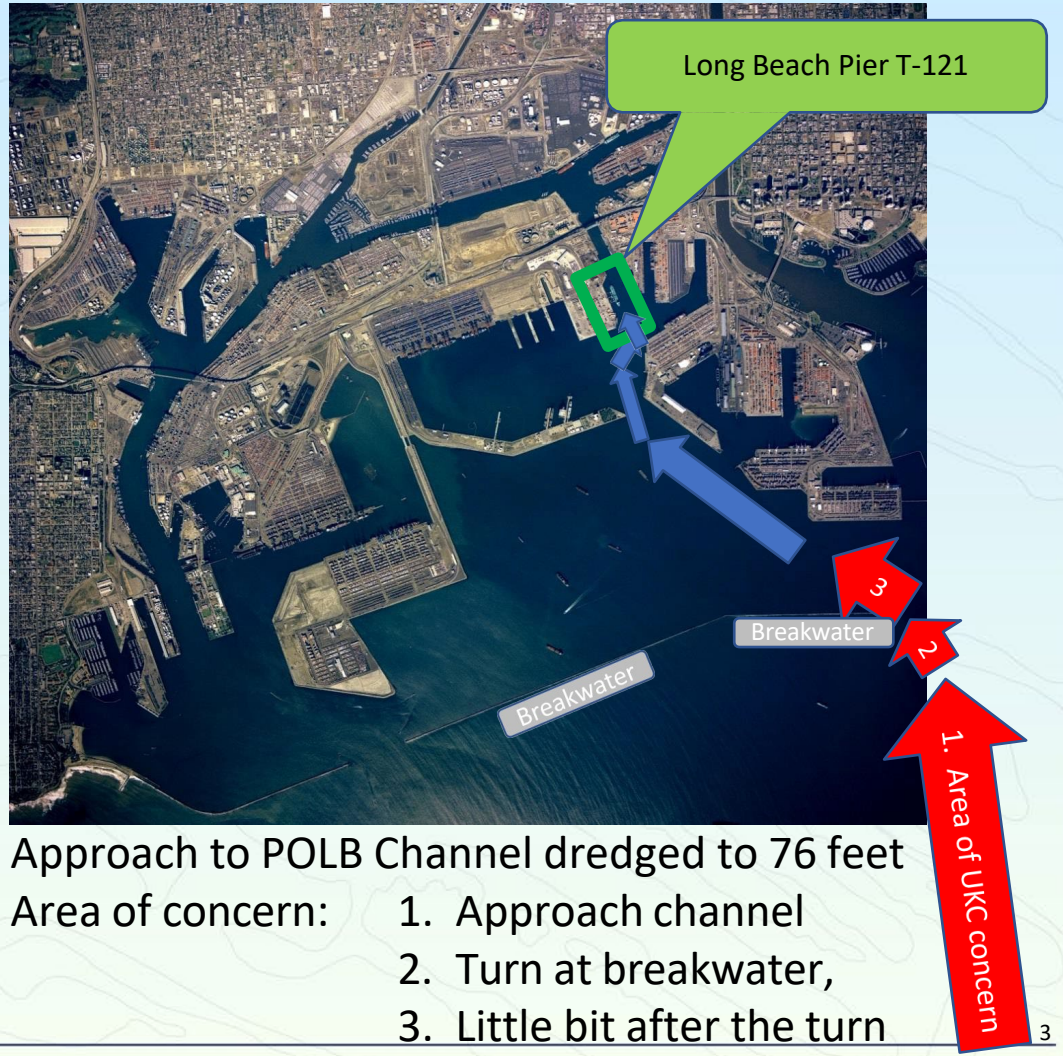
Ports of LA & Long Beach

- 50% of California's oil
- Only 5 day supply of oil ashore
- Pier T-121 is the only VLCC berth on the West Coast





- Approach to POLB Channel dredged to 76 feet
- Area of concern:
  1. Approach channel
  2. Turn at breakwater,
  3. Little bit after the turn

Before:

GO/NO GO decision made using:

- ✓CDIP Swell Warnings
- ✓CDIP Buoy Reports
- ✓Experience
- ✓Seaman's Eye
- ✓Observed pitch & roll far enough offshore to permit "bail-out" before committing to channel

Tue 9/20/2016 9:06 AM
CDIP Processing <uproc@model.cdip.ucsd.edu>
Swell Warning - WW3 forecast
To nine_trk@cdip.ucsd.edu; Kip Louttit; Swell-alert@jacobsenpilot.com

Prediction site: SP018

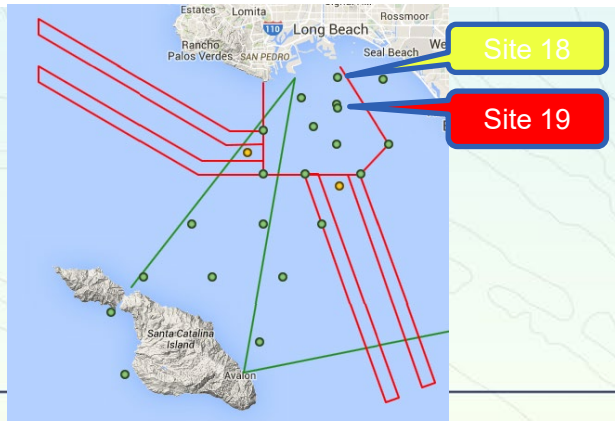
Date (PST)	14+ Hs (ft)	14+ Tp (secs)	14+ Dp (deg T)	Tot Hs (ft)	Tot Tp (secs)	Tot Dp (deg T)
2016-09-20 04:00 pm	3.15	15.38	172	3.97	15.38	172
2016-09-20 07:00 pm	2.79	14.29	172	4.20	14.29	172

Link:
http://www.sccoos.org/data/harbors/lalb/mop_site.php?mop=SP018&page=fc_swell_plot&xperiod=14&tz=PST&units=english

Prediction site: SP019

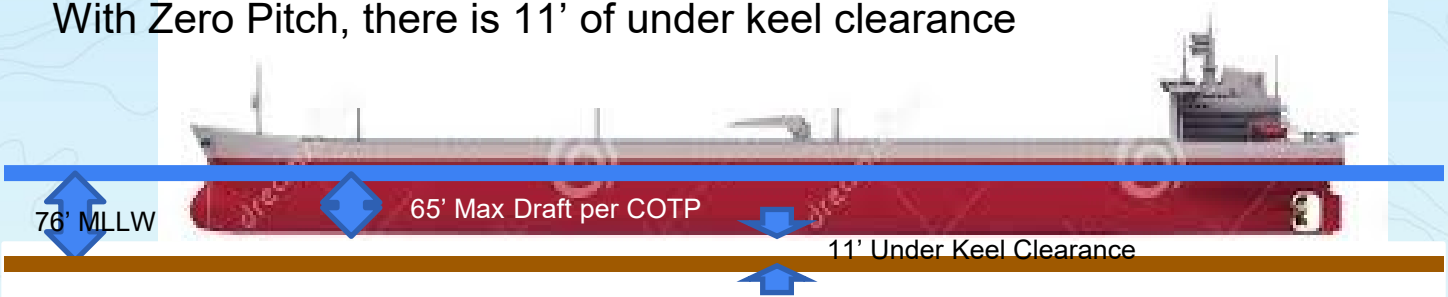
Date (PST)	14+ Hs (ft)	14+ Tp (secs)	14+ Dp (deg T)	Tot Hs (ft)	Tot Tp (secs)	Tot Dp (deg T)
2016-09-20 04:00 pm	3.22	14.29	171	4.30	14.29	171
2016-09-20 07:00 pm	2.79	14.29	173	4.59	13.33	169

Link:
http://www.sccoos.org/data/harbors/lalb/mop_site.php?mop=SP019&page=fc_swell_plot&xperiod=14&tz=PST&units=english

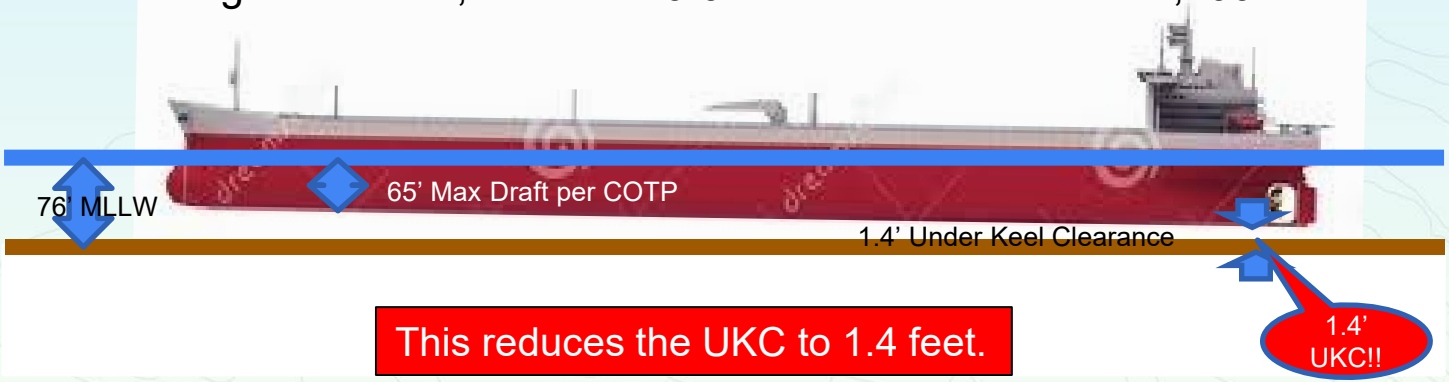


The Pitch Problem in a Long Period Southerly Swell

With Zero Pitch, there is 11’ of under keel clearance



With 1 degree of Pitch, there is a 9.6’ increase in draft for a 1,100 foot tanker:



This reduces the UKC to 1.4 feet.

POLB dredged to 76 feet from approach channel to Pier T121 (Tesoro and Pier T121 Users)

Moving to the Future… UKC Program:

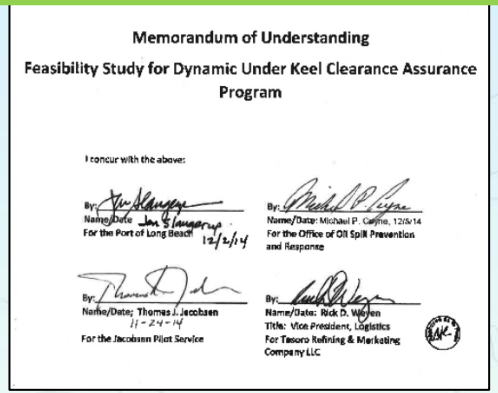
Feasibility Study *Memorandum of Understanding*
Signed Nov-Dec 2014

Interested Parties and Advisors

- NOAA (National Oceanic and Atmospheric Administration, U.S. Department of Commerce)
- IOOS® Integrated Ocean Observing System
- Southern California Coastal Ocean Observing System
- CDIP coastal data information program

Participants:

- The Port of Long Beach
- Jacobsen Pilot Service — Long Beach Pilots Since 1924
- California Department of Fish & Wildlife
- OSPR Office of Spill Prevention and Response
- TESORO
- & Pier 121 Users



Memorandum of Understanding

Feasibility Study for Dynamic Under Keel Clearance Assurance Program

I concur with the above:

By: Name/Date: Jon Stenger 12/2/14 For the Port of Long Beach

By: Name/Date: Michael P. Cayne, 12/5/14 For the Office of Oil Spill Prevention and Response

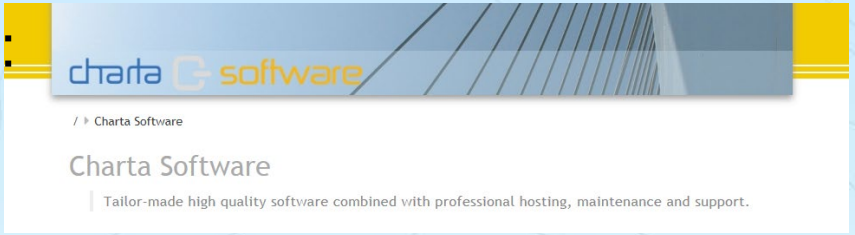
By: Name/Date: Thomas J. Jacobsen 11-24-14 For the Jacobsen Pilot Service

By: Name/Date: Rick D. Wilcox Title: Vice President, Logistics For Tesoro Refining & Marketing Company LLC

- ✓ Purpose, Goals, Definitions
- ✓ Study, Evaluation, Pilot, & Implementation Phases
- ✓ Desired Outcomes & Measures of Success
- ✓ Roles and Responsibilities
- ✓ $$ flows

Project Manager: Marine Exchange of Southern California VTS

The Potential Future:



PROTIDE takes predicted:

- ✓water levels (NOAA)
- ✓Currents (not sig in LA/LB)
- ✓wave conditions (CDIP/NOAA)
- ✓channel depth (NOAA)
- ✓ship course and speed (Pilots)
- ✓ship dimensions (ship)

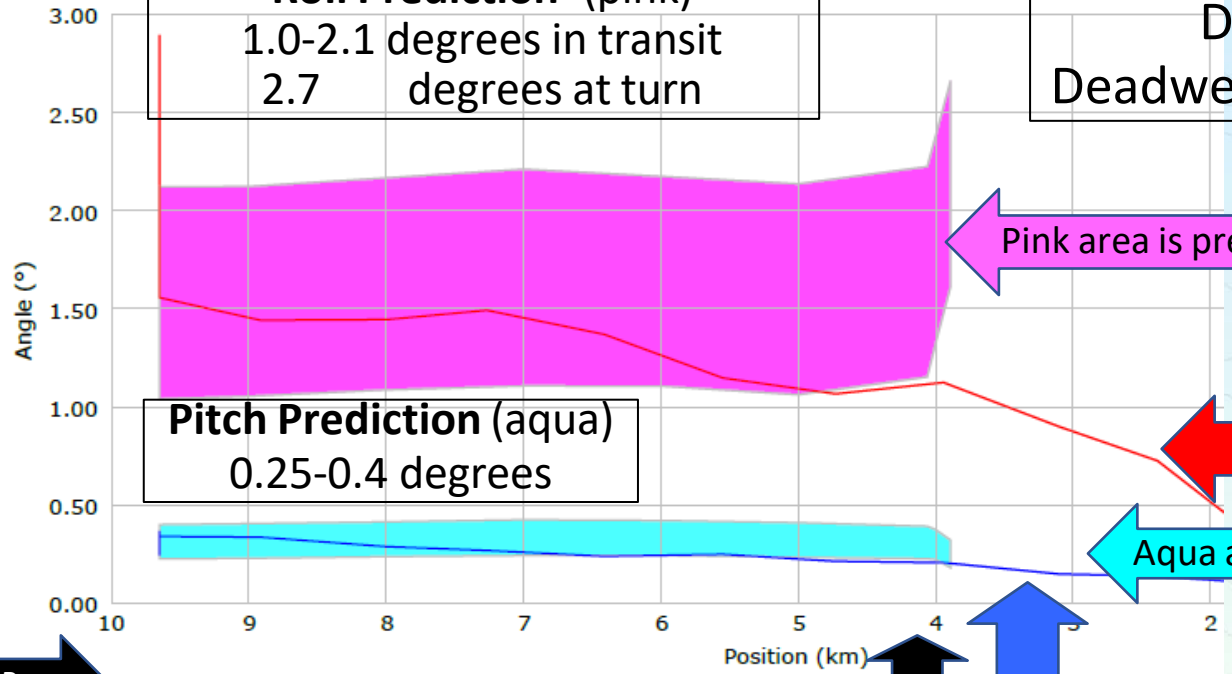
- ❑ Calculates vertical ship motion (Pitch, Roll, and Squat)…
- ❑ And then calculates predicted under keel clearance & bottom touch probability.

PROTIDE is now used in three harbors in the Netherlands to support the operational process:
Port of Rotterdam, Port of Amsterdam & Eemshaven

Roll and pitch angles diagram

Cosjade Lake
14 April 2017
Draft: 66 feet
Deadweight Tons: 298,000

Roll Prediction (pink)
1.0-2.1 degrees in transit
2.7 degrees at turn



Pitch Prediction (aqua)
0.25-0.4 degrees

Pink area is predicted roll

Red line is actual roll

Aqua area is predicted pitch

Start of Run

Turn at Breakwater

Blue line is actual pitch

Roll angle (°)
Roll angle (°) (Octopus Online)
Pitch angle (°)
Pitch angle (°) (Octopus Online)

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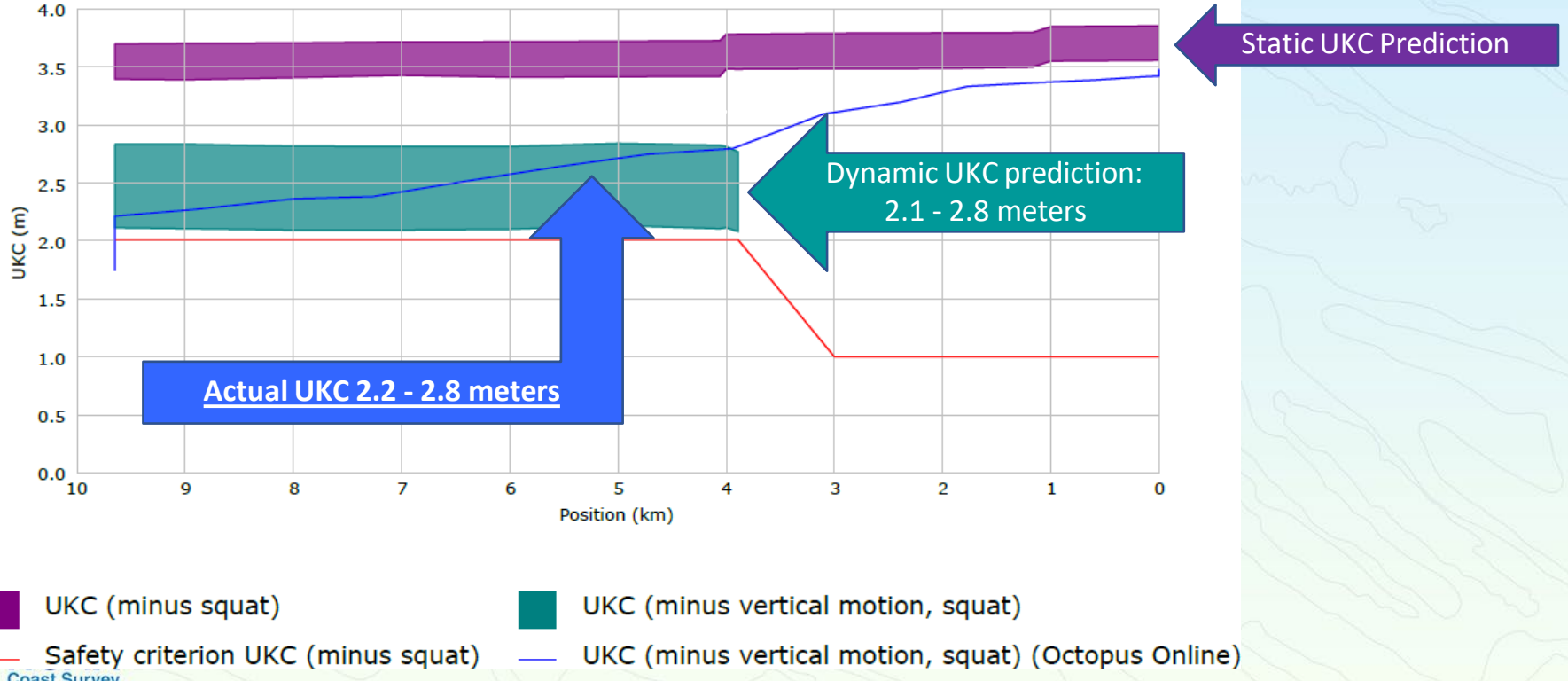
Resulting UKC:

Resulting Under Keel Clearance Predictions
Static: About 3.5 meters
Dynamic: 2.1 to 2.8 meters

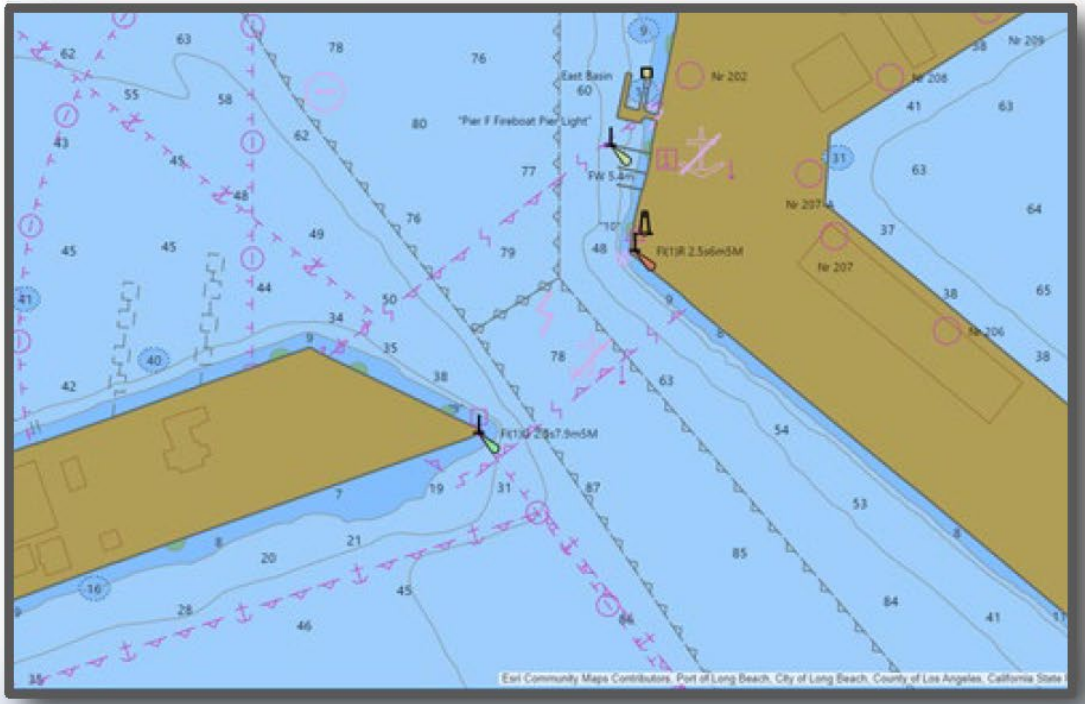
Under keel clearance curve diagram



Moving beyond 65 foot drafts

- November 2016, meeting between Pilots, Industry, USCG and other stakeholders discuss results of the project.
- COTP statement, “After a long, joint, and comprehensive review by Federal, State, and Local Port Partners, and key stakeholders, it has been determined that operations to bring in deeper draft tank vessels… in Long Beach can be done so safely and effectively.“
- April 2017, first tanker deeper than 65’ enters (66’ draft).
- May 2018, first tanker of 69’ draft enters port.

ENC of Transit to Port of Long Beach



ENC for the entrance to the Port of Long Beach, CA

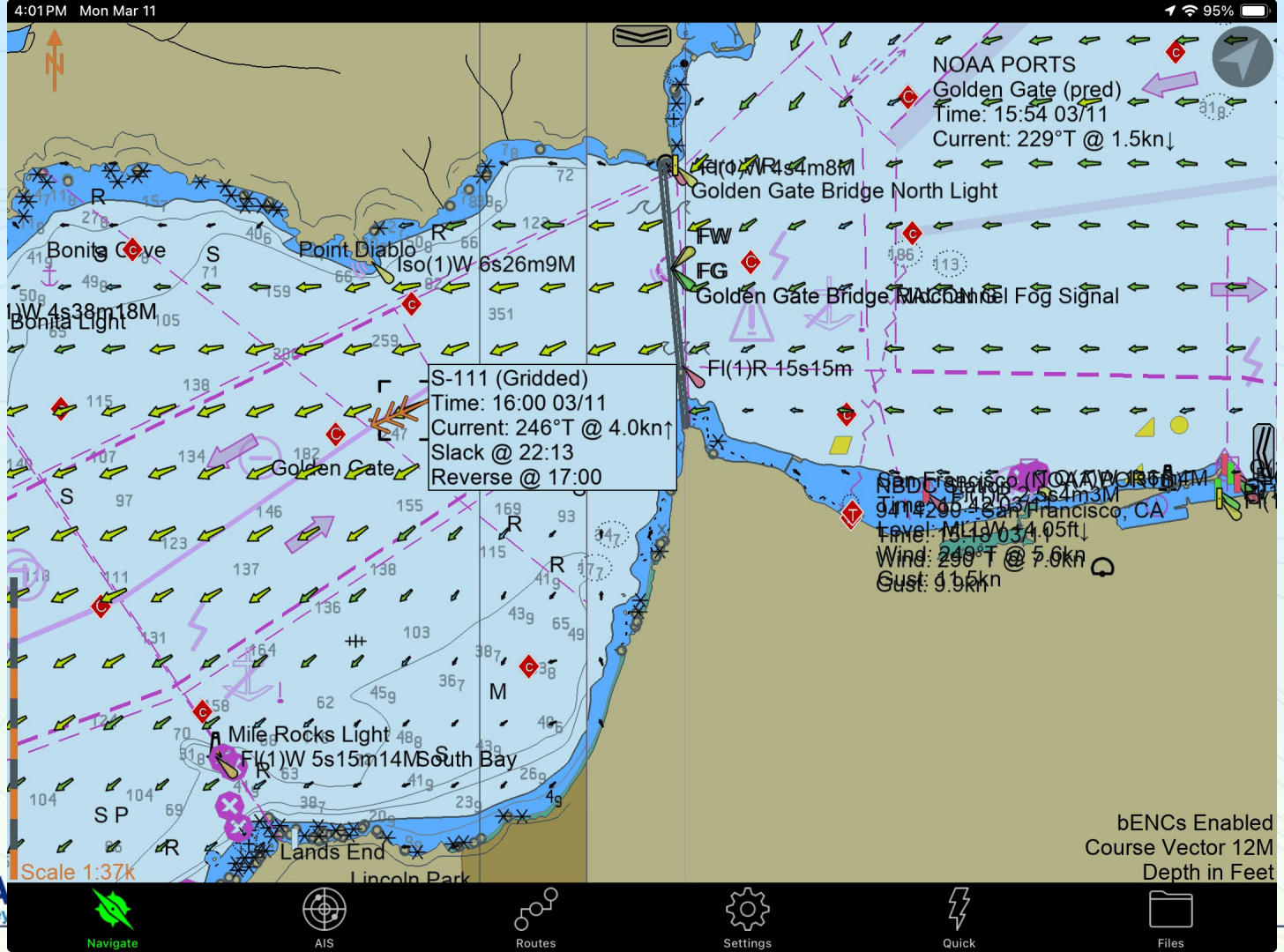
Same view taken from the bridge of the vessel's deck in transit into the Port of Long Beach, California.
Credit: Jacobsen Pilot Service.

S-102 Bathymetry Data Overlay

Jacobsen Pilot's portable pilot unit screen using the navigation system SEAiq Pilot, and S-102 data to draw custom safety contours. Credit: Jacobsen Pilot Service.

Same view taken from the bridge of the vessel's deck in transit into the Port of Long Beach, California. Credit: Jacobsen Pilot Service.

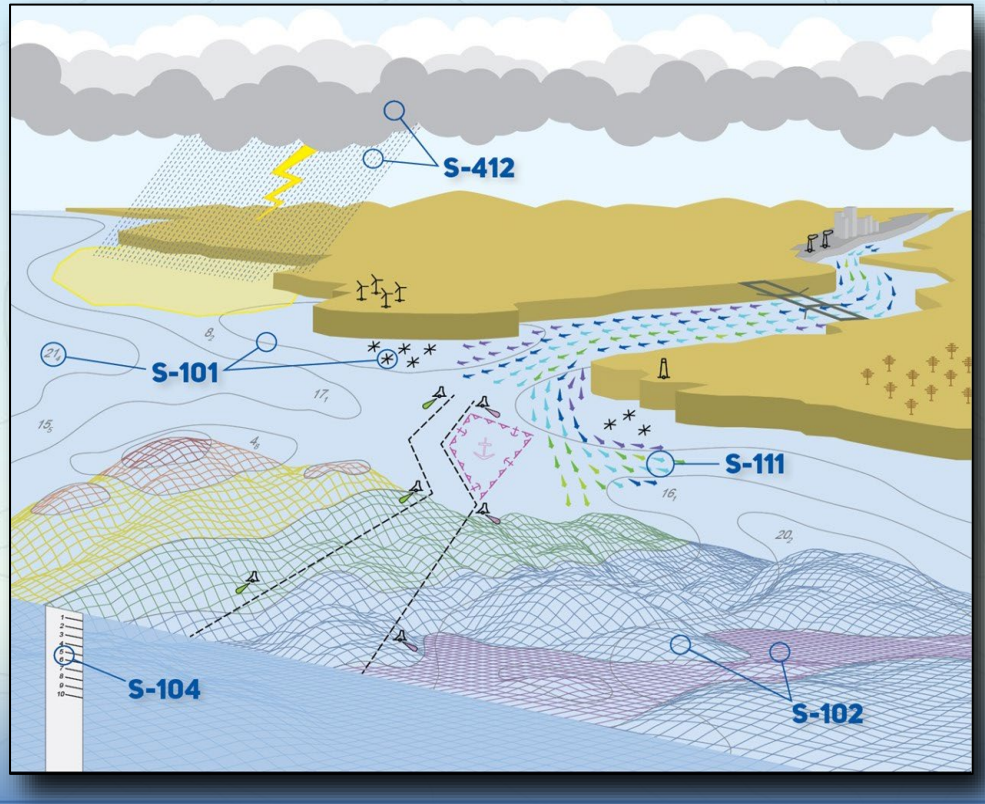
- S-102 Bathymetry Overlayed on ENC
- Safety Contour (red)

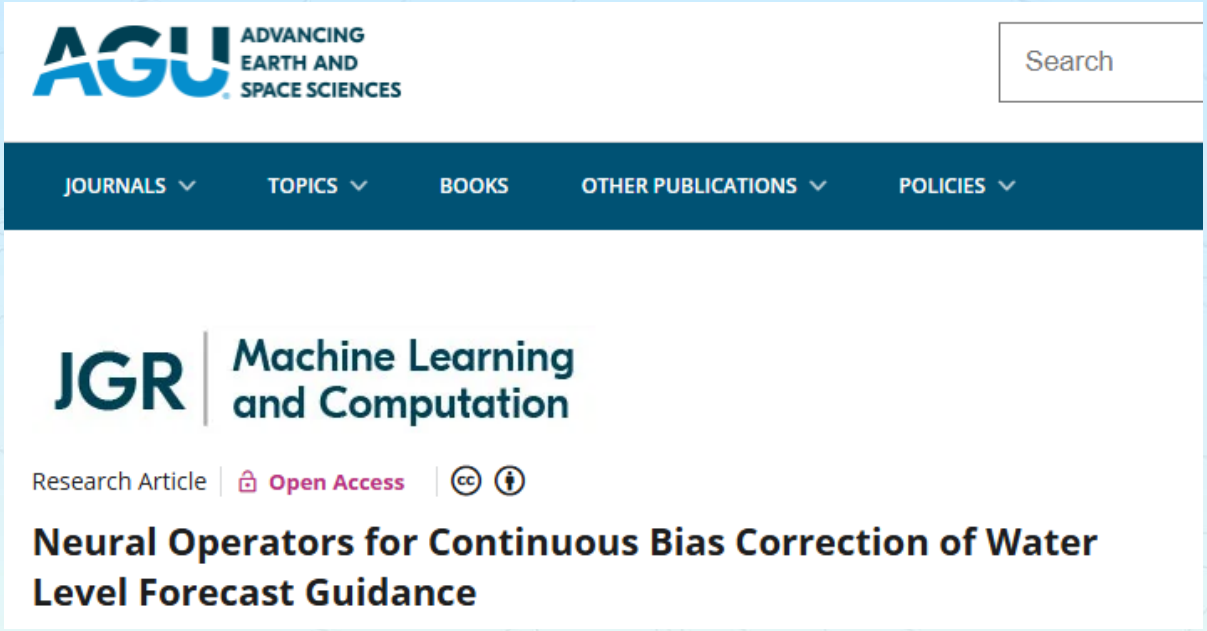

4:01PM Mon Mar 11
95%
NOAA PORTS
Golden Gate (pred)
Time: 15:54 03/11
Current: 229°T @ 1.5kn↓
Golden Gate Bridge North Light
FW
FG
Golden Gate Bridge Main Channel Fog Signal
Fl(1)R 15s15m
Bonita Cove
Point Diablo
Iso(1)W 6s26m9M
Bonita Light
S-111 (Gridded)
Time: 16:00 03/11
Current: 246°T @ 4.0kn↑
Slack @ 22:13
Reverse @ 17:00
Golden Gate
Mile Rocks Light
Fl(1)W 5s15m14M
South Bay
Lands End
Lincoln Park
Scale 1:37k
bENCs Enabled
Course Vector 12M
Depth in Feet
Navigate
AIS
Routes
Settings
Quick
Files

S-100 Data Framework

S-100 Data Products

- **S-101**: Electronic Navigational Charts (ENC)
- **S-102:** Bathymetric Surface
- **S-104:** Water Level Information
- **S-111:** Surface Currents
- **S-41X:** Weather Overlays



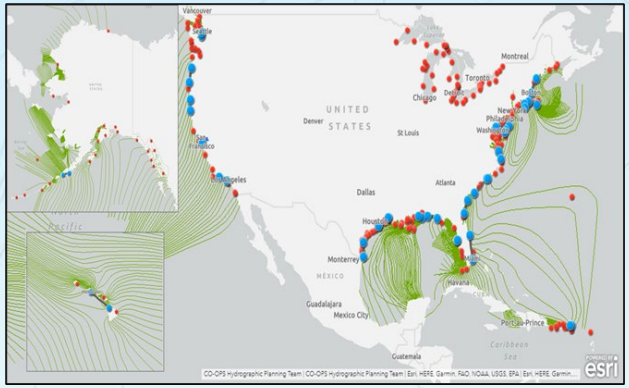


https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2025JH000853 published Feb 2026

The National Oceanic and Atmospheric Administration's (NOAA) Global Two-Dimensional Surge and Tide Operational Forecast System (STOFS-2D-Global) provides global operational tidal, subtidal, and total water level forecast guidance with a 7.5-day horizon.

To the best of our knowledge, this study represents the first application of a neural operator-based model for improving oceanic forecast guidance using limited observational data.

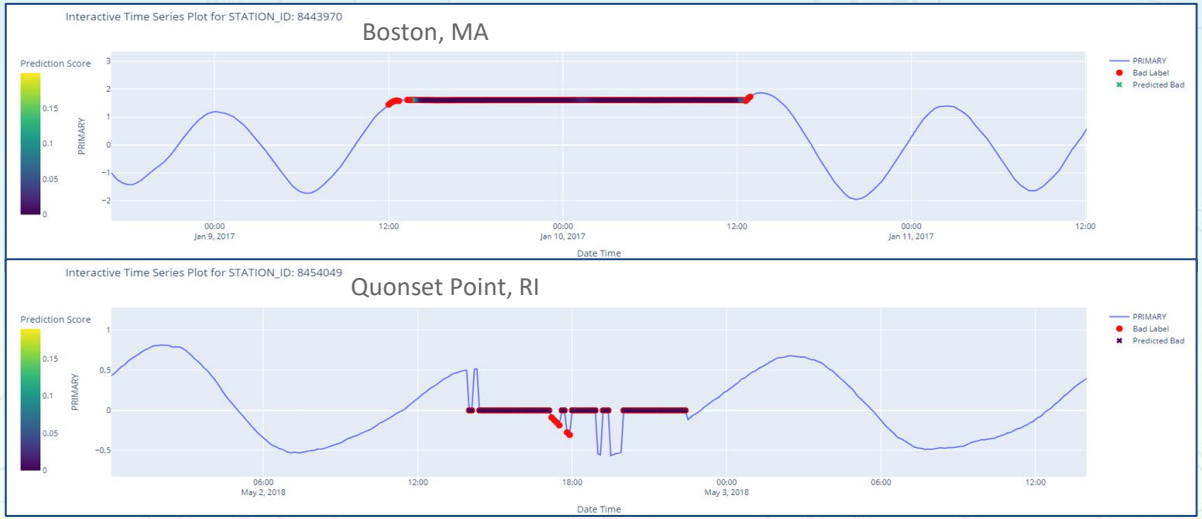
AI-Enabled Water Level Data Quality Control



Red: NOAA tide gauge stations
Blue: Stations for training dataset
Green: The green lines are cotidal lines.

AI Model Validation Results for All Stations (57)	
Overall Accuracy	**99.1%**
Accuracy for Bad Points	**84.9%**

- Goal is to dramatically improve efficiency of QC of NOAA tide gauge observations
- Initial prototype yielded encouraging results
- Partnering with Texas A&M Corpus Christi to complete R&D and then work toward operational transition



NOAA Coast Survey

NOAA
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