Quantitative Approach to Navigation Channels Asset Management

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WEDA
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US Army Corps of Engineers
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Overview

- Channels are considered assets to both US commerce and national security.
- Effective asset management requires:
  - identifying the assets
    - Where are the channels?
  - establishing their current condition, and
  - determining their expected future performance
- Objectively manage increasing dredging requirements w/ decreasing funds
- Provide roll-up capability to develop work packages
  - Channels in system and spatial component

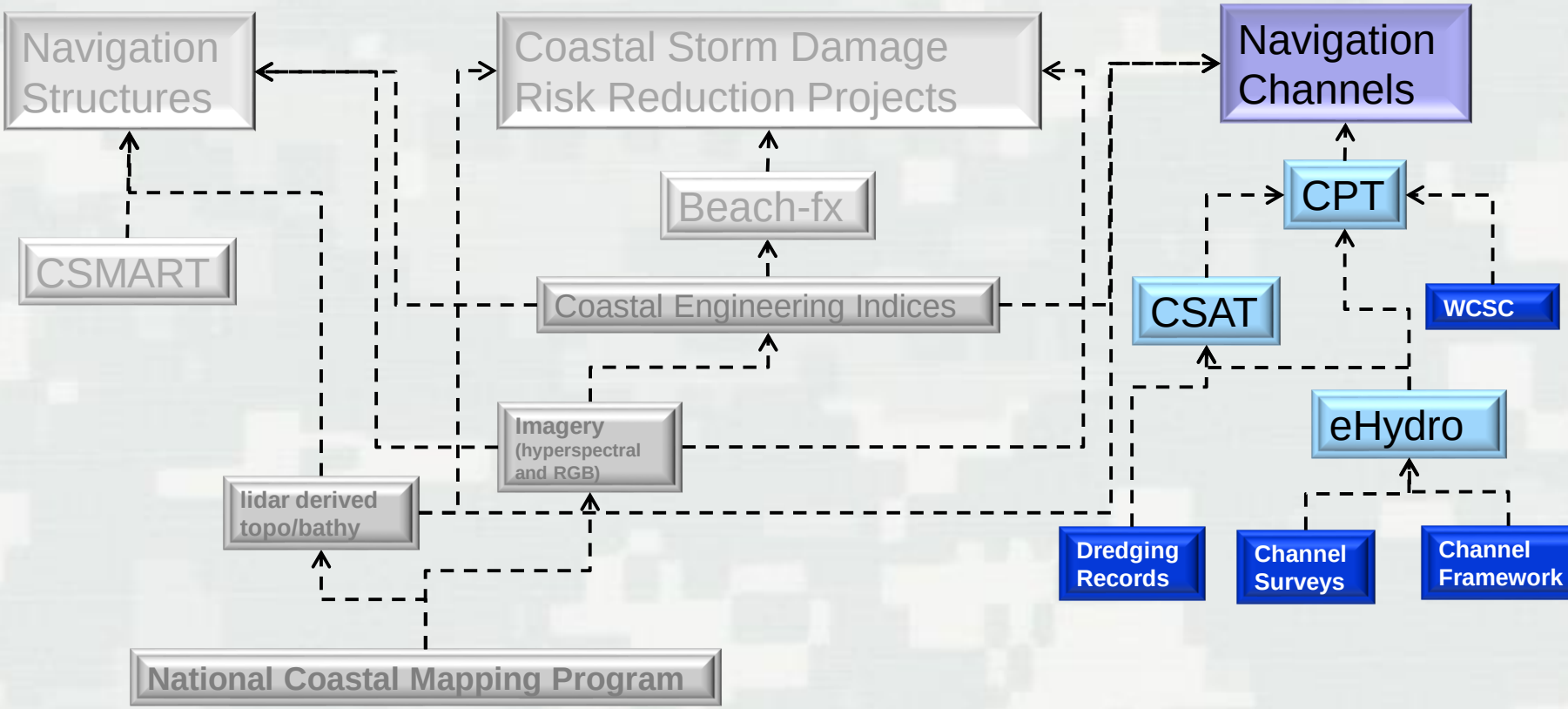
Tools/Data

- National Channel Framework – **NCF** – GIS database for USACE-maintained channels
- **eHydro** – desktop hydro-survey application showing present channel conditions
- Corps Shoaling Analysis Tool – **CSAT**
  - Leverage eHydro and National Channel Framework
- Channel Portfolio Tool – **CPT** - web application used to quantify the various channel depths that are used by maritime vessels and the tonnage supported
  - Waterborne commerce data – cargo/tonnage/draft

Coastal Systems Asset Management

Coastal Asset
Tool
Data
Product
Program

Risk Informed Decisions



- Spatial and economic datasets provide input for tools used to quantify value of maintaining channels as function of tonnage and depth.

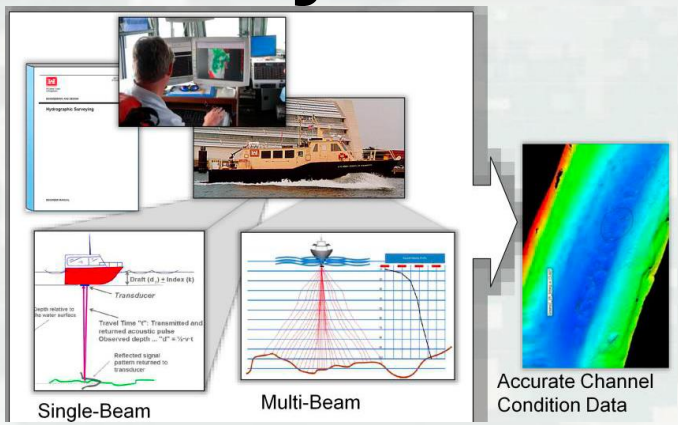
National Channel Framework

- *Where are the channels?*
- Channels divided by reaches and quartered

Galveston Channel

eHydro: Enterprise Hydrosurvey Processing

- *What is the present channel condition?*
- Geo-process hydrosurveys using automated GIS scripts
- Reports/Products generated
  - Channel Condition Report (CCR)
  - Channel Condition Index (CCI)
  - Channel Availability Reports
  - Condition plots
- Coastal districts using eHydro
  - National Channel Framework
  - Uploading surveys



REPORT OF CHANNEL CONDITIONS
400 FEET WIDE OR GREATER

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Date 3/3/2015

To: Navigation Interests

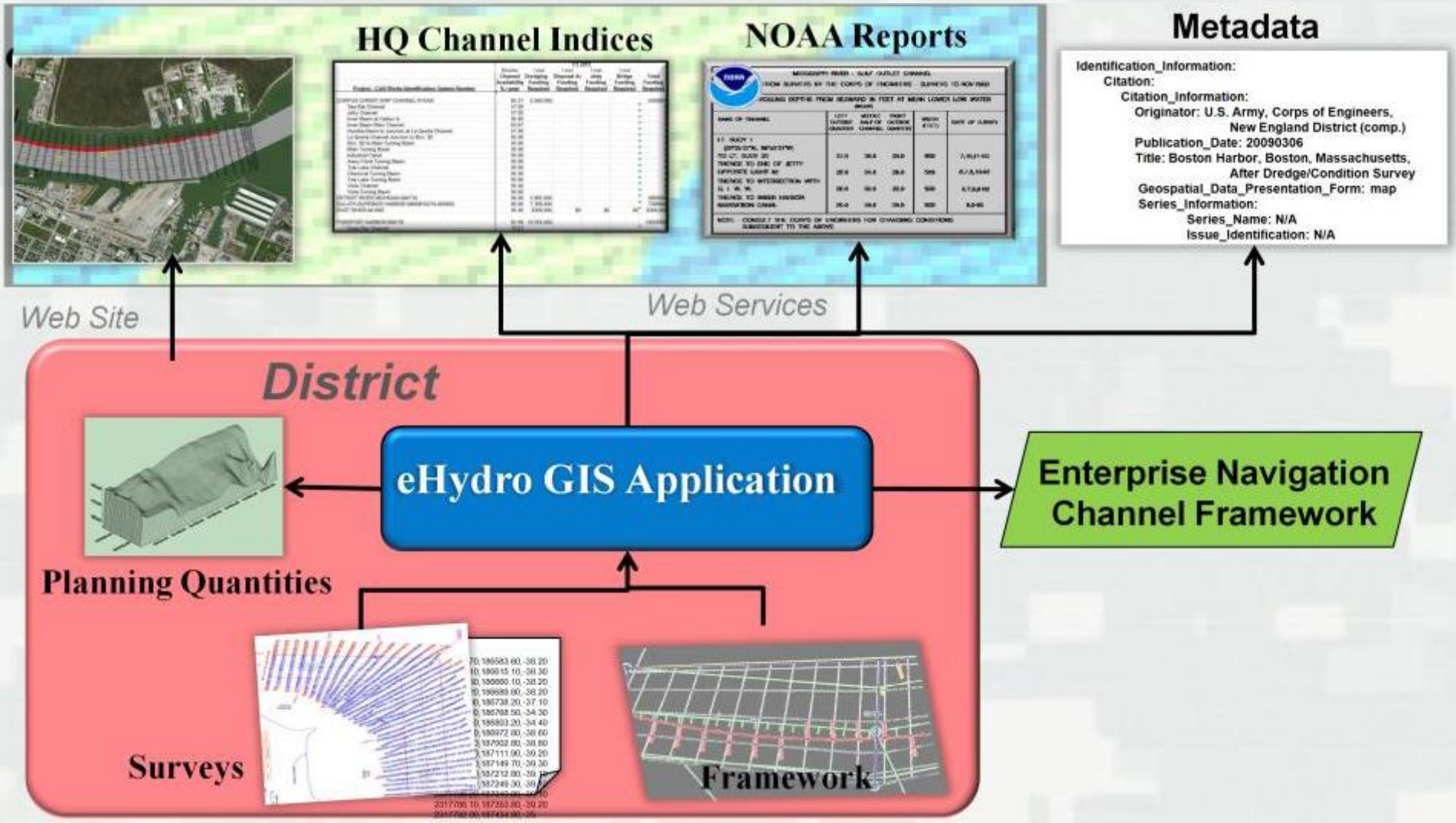
From: US Army Engineer District, Portland
333 SW First Avenue
Portland, OR 97204-3495

RIVER/HARBOR NAME AND STATE
COLUMBIA RIVER
OREGON & WASHINGTON

MINIMUM DEPTHS IN EACH 1/4 WIDTH OF CHANNEL ENTERING FROM SEAWARD

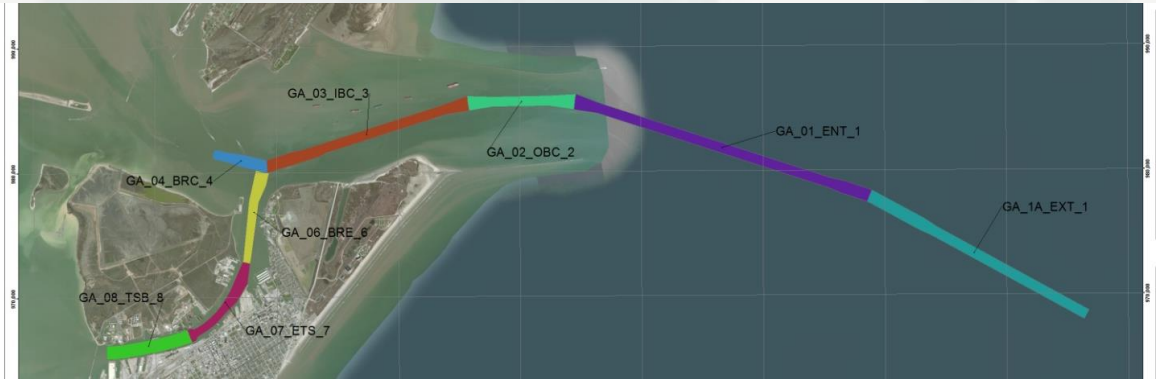
NAME OF CHANNEL	DATE OF SURVEY	AUTHORIZED PROJECT			LEFT OUTSIDE QUARTER (feet)	LEFT INSIDE QUARTER (feet)	RIGHT INSIDE QUARTER (feet)	RIGHT OUTSIDE QUARTER (feet)
		WIDTH (feet)	LENGTH (miles)	DEPTH (feet)				
MOUTH OF COLUMBIA RIVER Entrance Range	11-07-2014	2000	3.30	55	51	51	52	
MOUTH OF COLUMBIA RIVER Entrance Range	11-07-2014	640	3.30	48				41
MOUTH OF COLUMBIA RIVER Sand Island Range	11-07-2014	2000	2.20	55	50	52	53	
MOUTH OF COLUMBIA RIVER Sand Island Range	11-07-2014	640	2.20	48				42
LOWER DESDEMONA SHOAL Lower Desdemona Shoal	02-18-2015	600	3.40	43	46	47	49	50
UPPER DESDEMONA SHOAL Upper Desdemona Shoal	01-22-2015	600	3.60	43	42	44	43	41

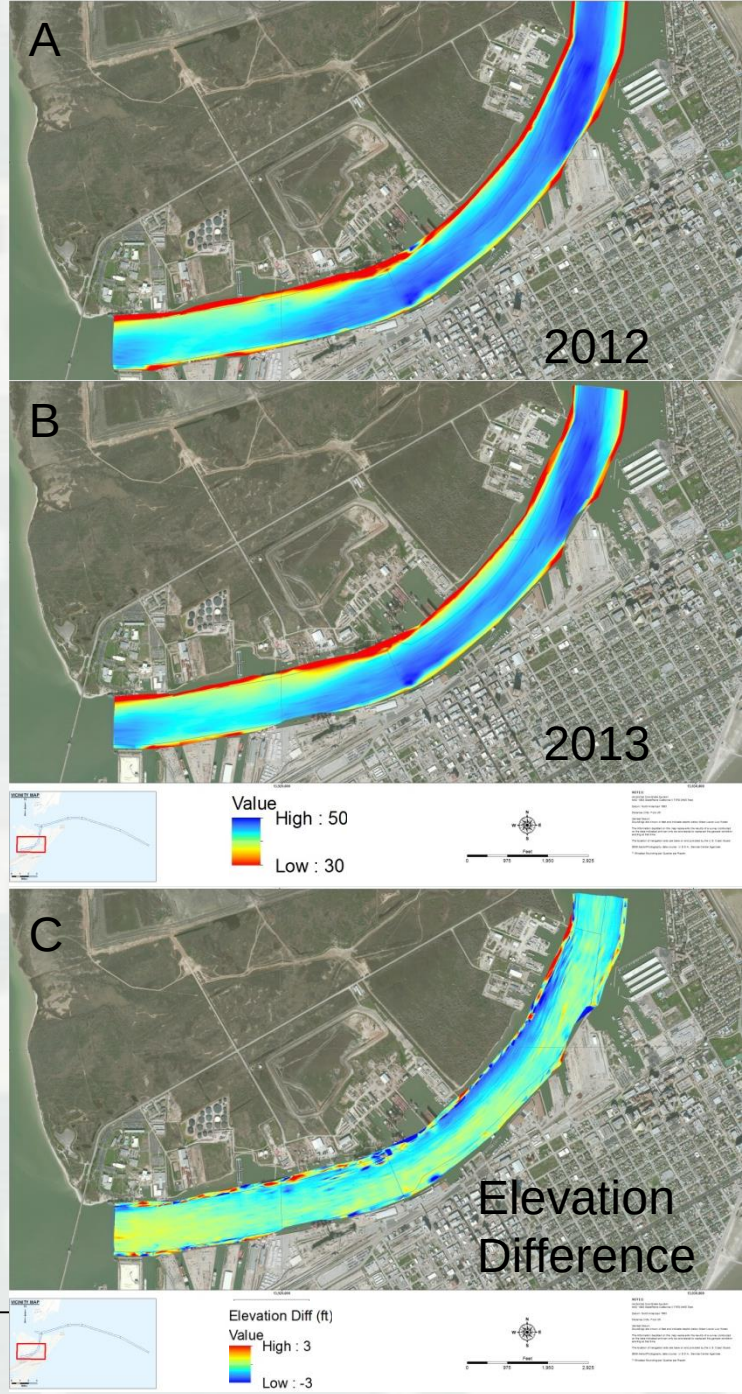
eHydro: Application and Reporting Process



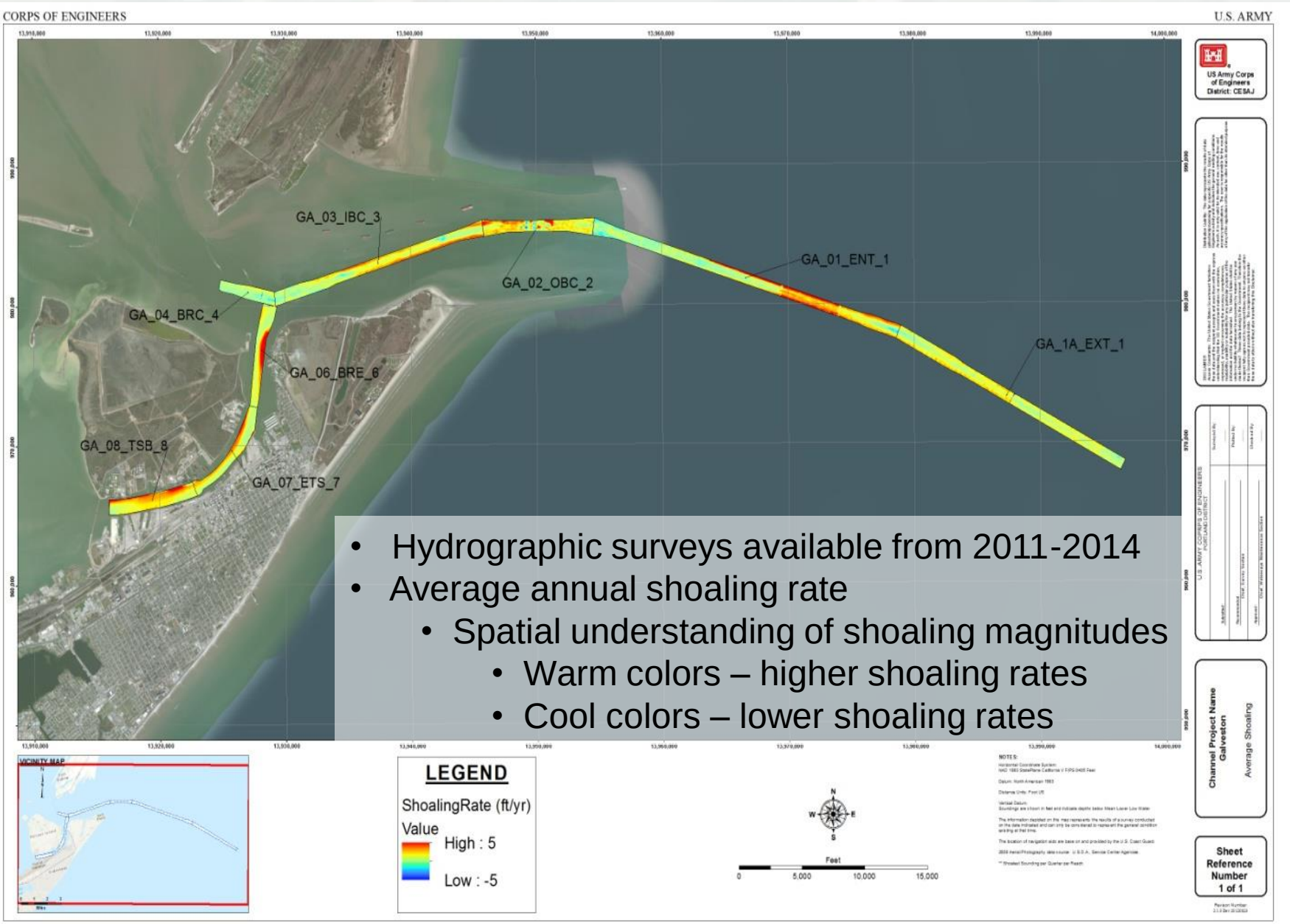
Corps Shoaling Analysis Tool

- *What will the channels look like in the future?*
- Use historical survey data from eHydro and generate difference grid sets between dredging events
- Predict average shoaling rates and dredging requirements per channel reach
- Report volumes at different depth/time intervals and shoaling rates
- *Efficiently process large spatial datasets*



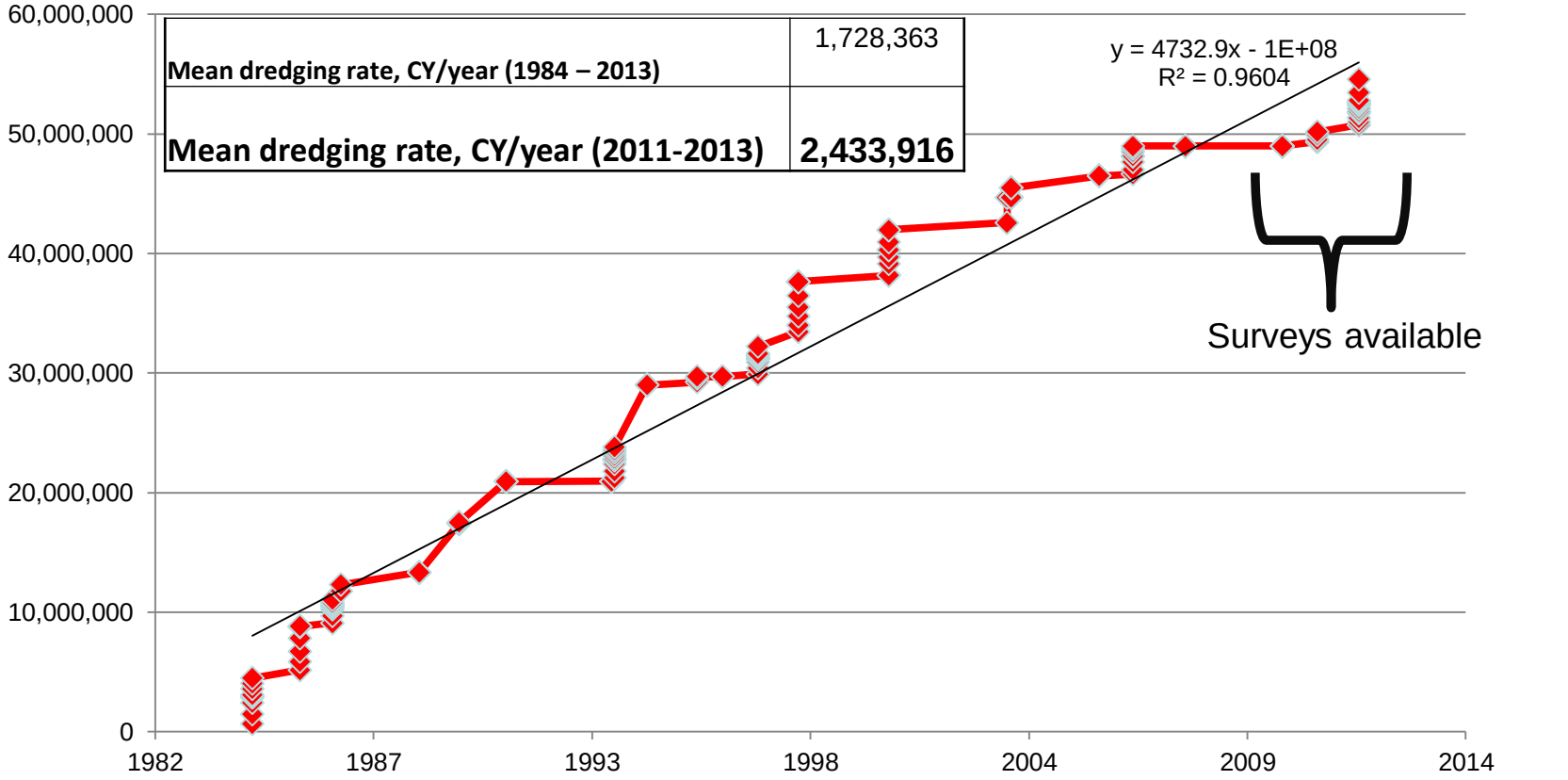


Shoaling Rate



- Hydrographic surveys available from 2011-2014
- Average annual shoaling rate
  - Spatial understanding of shoaling magnitudes
    - Warm colors – higher shoaling rates
    - Cool colors – lower shoaling rates

Cumulative Dredging Requirements



Mean dredging rate, CY/year (1984 – 2013)	1,728,363
Mean dredging rate, CY/year (2011-2013)	2,433,916

CSAT: Average Volume (CY/yr)
2,320,358

Reach_ID	Average Rate (ft/yr)	Average Volume (CY/yr)	Dredge Interval, yrs
GA_01_ENT_1	0.29	224,569	-
GA_02_OBC_2	1.41	410,411	0.97
GA_03_IBC_3	0.77	424,394	0.66
GA_04_BRC_4	0.23	35,537	-
GA_06_BRE_6	1.80	401,986	-
GA_07_ETS_7	1.03	236,065	-
GA_08_TSB_8	2.13	587,395	-
GA_1A_EXT_1*	0.84	537,825	1.31

* Average volume not included in total average volume.

Volume Tables

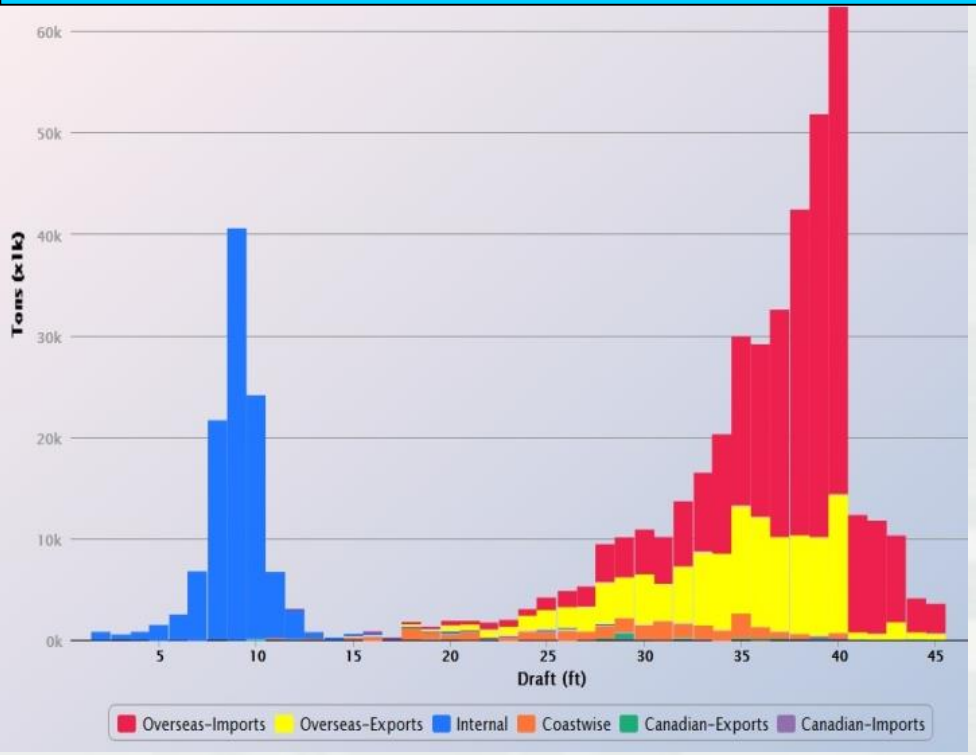
Shoaling rate w/ last survey

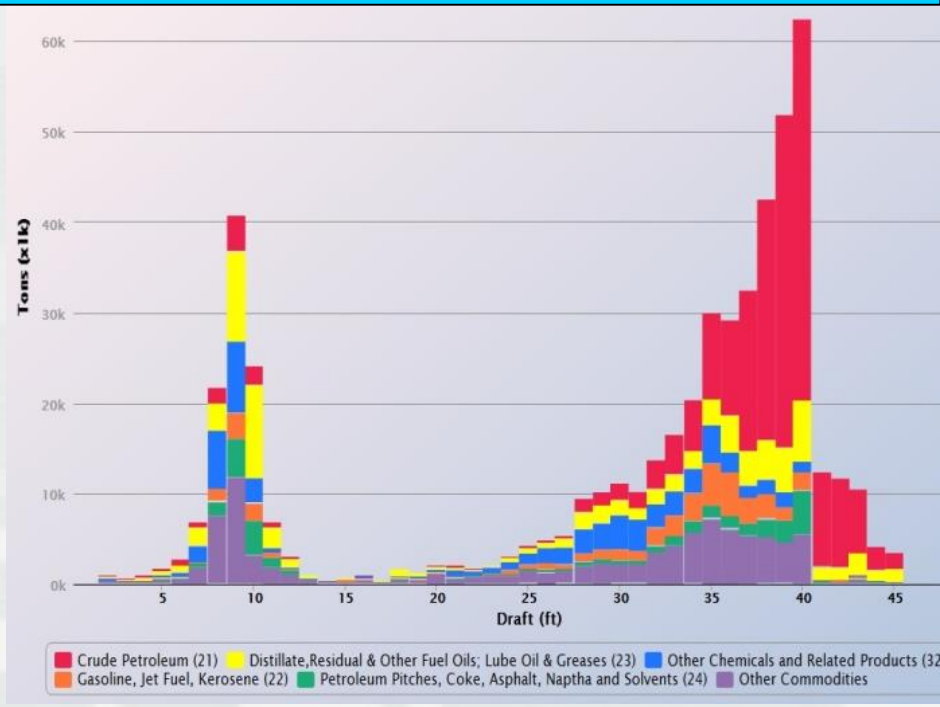
Dredge Cut (ft)	Now (CY)	6 months (CY)	12 months (CY)	18 months (CY)	24 months (CY)	30 months (CY)	36 months (CY)
-45	195,320	271,020	373,070	492,200	624,890	771,020	931,220
-44	125,140	173,140	238,620	331,710	444,910	572,680	713,450
-43	76,249	109,860	153,260	210,570	293,080	399,730	522,310
-42	43,628	65,655	95,990	135,350	186,480	258,070	356,920
-41	24,409	37,093	56,313	83,402	119,100	165,270	227,370
-40	14,958	21,022	31,470	48,147	72,041	104,370	146,170
-39	10,060	13,343	18,250	26,832	41,017	61,922	91,020
-38	7,083	9,092	11,945	16,084	23,035	34,823	53,059
-37	5,194	6,480	8,241	10,728	14,312	19,888	29,576
-36	3,865	4,787	5,944	7,496	9,673	12,784	17,358
-35	2,806	3,555	4,412	5,465	6,843	8,751	11,457

Draft Utilization

➢ *What's the optimum depth/time to dredge with relative cost-effectiveness?*

Via Waterborne Commerce data, CPT can generate depth-utilization profiles showing the distribution of cargo across the range of maintained depths for any system of navigation channels.





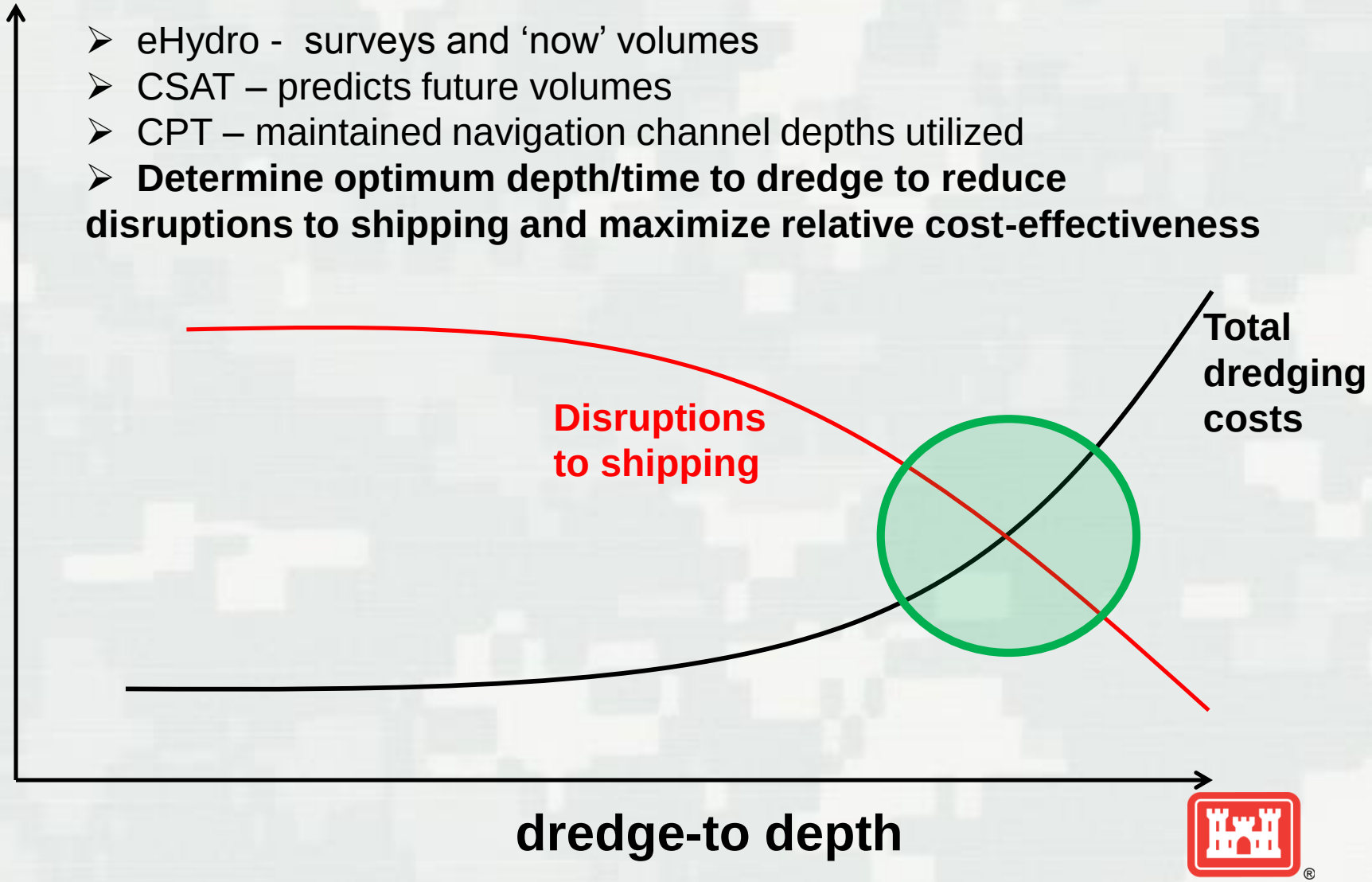
Draft utilization charts for the Louisiana and Texas coasts showing traffic type (left) and top-5 commodity (right) breakdowns, FY09-FY13.

Annualized Tonnage

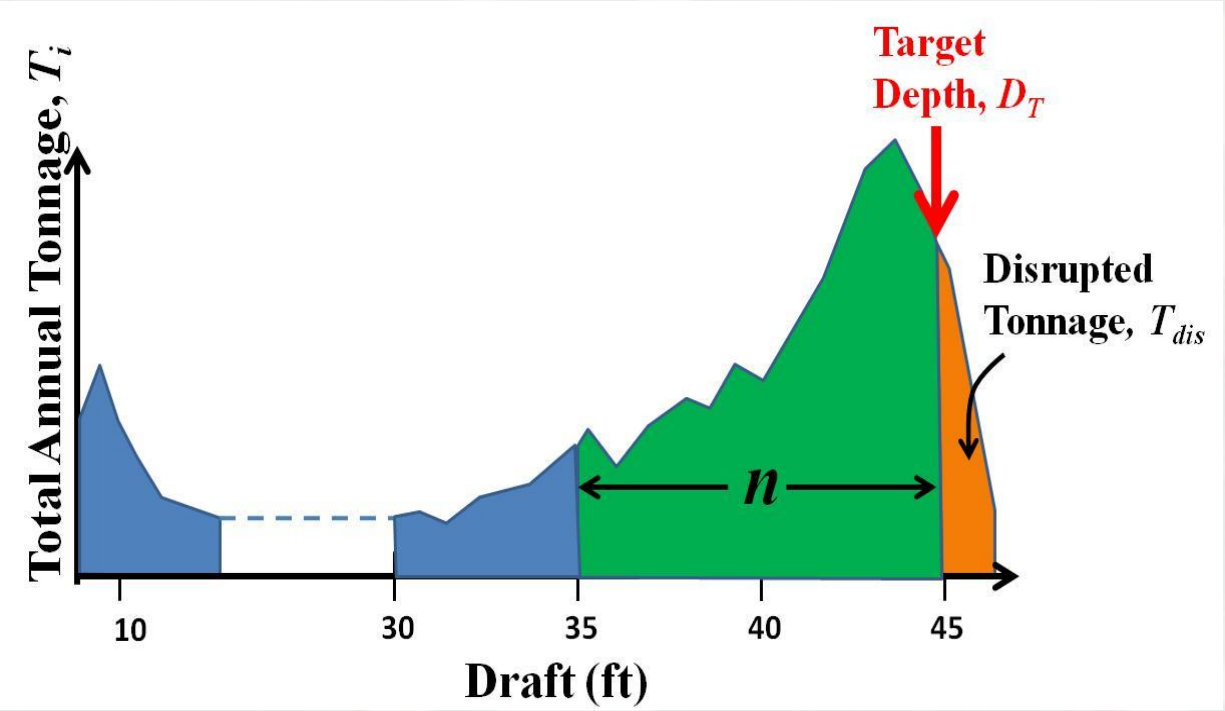
CPT Reach Name	Maintained Depth (ft)	Average Annual Tonnage (x1M)	Average Annual Tonnage (x1M), Deepest 10-ft
01a Extended Entrance Channel (GA_1A_EXT_1)	45	212.0	126.0
001 Entrance Channel (GA_01_ENT_1)	45	212.0	126.0
002 Outer Bar Channel (GA_02_OBC_2)	45	212.0	126.0
003 Inner Bar Channel (GA_03_IBC_3)	45	212.0	126.0
004 Bolivar Roads Channel (GA_04_BRC_4)	45	209.1	123.6
006 Bolivar Roads to Exxon Oil Dock (Mile 0.0 To Mile 1.5) - (GA_06_BRE_6)	40	11.8	5.6
007 Exxon Oil Dock to Todd Shipyards (Mile 1.5 To Mile 3.0) - (GA_07_ETS_7)	40	11.6	5.5
008 Todd Shipyards to Pier B (Mile 3.0 To Mile 4.2) - (GA_08_TSB_8)	40	10.4	5.0

CPT/e-Hydro/CSAT Integration

- eHydro - surveys and 'now' volumes
- CSAT – predicts future volumes
- CPT – maintained navigation channel depths utilized
- **Determine optimum depth/time to dredge to reduce disruptions to shipping and maximize relative cost-effectiveness**



Depth Utilization Data



- Depth-utilization profile showing various approaches to tallying supported waterborne cargo.

- Optimize dredging work packages
  - Time/depth to dredge

Proxy Benefit to Cost Ratio equation:

$$BCR_{D_T,k} = \frac{\left(1+\frac{k}{2}\right)\left[\left(\sum_{i=(D_T-n)}^{D_T} T_i\right)-T_{dis}\right]}{C_{MB}+C_{CY}V_{D_T,k}}$$

Work Package Formulator

https://cptdev.erdc.dren.mil/Protected/Data?g=Reach — CPT

Edit View Favorites Tools Help

Reach - Click Tab Below for Desired Analysis

Rankings | Rollup | Flow | Work Package

Dredge Cost/Benefit By:	(•) Tons ( ) Dollars
Color Scale:	(•) Linear ( ) Logarithmic
Mob\De-Mob Cost:	1,000,000
Cost\yd^3:	3.00
[ ] Update Reach Dredging Cost	Update

Reach Work Package

Rollup

	Parent Name	Name	Under Keel Buffer	Addl. Mob\De-Mob Cost	Cost Per Cubic Yard	Recommendation	
⊞	Galveston Harbor and Channel	Galveston, Tx - 001 Entrance Channel (325901)	0	50000	4	30 Months (39 ft.) => 272.0933	Update / Cancel
⊞	Galveston Harbor and Channel	Galveston, Tx - 002 Outer Bar Channel (325902)	0	$0.000	$3.000	36 Months (41 ft.) => 442.0620	Edit
⊞	Galveston Harbor and Channel	Galveston, Tx - 003 Inner Bar Channel (325903)	0	$0.000	$3.000	18 Months (39 ft.) => 239.0665	Edit
⊞	Galveston Harbor and Channel	Galveston, Tx - 004 Bolivar Roads Channel (268400)	0	$0.000	$3.000	36 Months (41 ft.) => 510.1814	Edit
	Galveston Harbor and	Galveston, Tx - 01a	0	$0.000	$3.000	36 Months (39 ft.) =>	

Work Package Formulator

- Sensitivity of dredging work plans to unit costs, CCY, ($/CY) and mobilization-demobilization costs, CMB, ($M); CCY/CMB ratio value is, clockwise from top left, 0.5, 1.5, 3.0, and 5.0

Mob/demob costs

Target Elev, ft (MLLW)	Years between Dredging Events						
	1	1.5	2	2.5	3	3.5	4
45	16.16	21.71	25.15	27.35	29.03	30.70	33.17
44	16.46	22.52	26.36	28.78	30.64	32.47	35.19
43	16.71	23.30	27.58	30.27	32.32	34.34	37.34
42	15.94	22.60	27.11	29.91	32.00	34.03	37.04
41	15.75	22.73	27.65	30.68	32.92	35.04	38.17
40	15.19	22.14	27.33	30.56	32.89	35.07	38.21
39	14.48	21.32	26.71	30.12	32.52	34.73	37.87
38	13.14	19.42	24.65	28.12	30.47	32.60	35.57
37	11.96	17.76	22.82	26.35	28.68	30.74	33.57
36	10.51	15.64	20.28	23.69	25.96	27.89	30.47
35	8.92	13.30	17.39	20.57	22.71	24.44	26.72
34	7.28	10.87	14.28	17.05	19.02	20.54	22.45
33	5.93	8.86	11.69	14.11	15.89	17.23	18.84
32	4.88	7.31	9.66	11.75	13.36	14.57	15.95
31	4.13	6.19	8.20	10.04	11.53	12.65	13.86
30	3.31	4.97	6.59	8.11	9.39	10.38	11.40
29	2.47	3.70	4.92	6.08	7.10	7.91	8.71
28	1.92	2.88	3.83	4.75	5.58	6.27	6.92

Target Elev, ft (MLLW)	Years between Dredging Events						
	1	1.5	2	2.5	3	3.5	4
45	13.95	16.09	16.05	15.60	15.31	15.35	16.15
44	14.81	17.62	17.71	17.14	16.76	16.77	17.68
43	15.72	19.42	19.68	18.96	18.45	18.43	19.47
42	15.22	19.58	20.24	19.49	18.91	18.82	19.85
41	15.29	20.56	21.75	20.94	20.22	20.05	21.12
40	14.86	20.52	22.38	21.69	20.90	20.68	21.75
39	14.27	20.27	22.86	22.35	21.48	21.19	22.26
38	13.01	18.70	21.74	21.68	20.84	20.51	21.52
37	11.89	17.30	20.80	21.22	20.40	20.02	20.98
36	10.48	15.35	18.87	19.74	19.14	18.75	19.61
35	8.91	13.14	16.54	17.79	17.42	17.03	17.77
34	7.28	10.78	13.74	15.14	15.10	14.79	15.40
33	5.93	8.82	11.39	12.88	13.12	12.87	13.36
32	4.88	7.29	9.47	10.93	11.37	11.26	11.67
31	4.13	6.18	8.09	9.53	10.14	10.14	10.50
30	3.31	4.96	6.53	7.79	8.46	8.59	8.92
29	2.47	3.70	4.89	5.91	6.56	6.78	7.05
28	1.92	2.88	3.82	4.65	5.25	5.52	5.78

Target Elev, ft (MLLW)	Years between Dredging Events						
	1	1.5	2	2.5	3	3.5	4
45	9.44	8.44	7.09	6.23	5.77	5.58	5.77
44	10.95	10.00	8.24	7.09	6.48	6.23	6.45
43	13.02	12.27	9.82	8.21	7.38	7.03	7.28
42	13.16	13.35	10.73	8.79	7.77	7.34	7.57
41	13.86	15.40	12.45	9.91	8.60	8.02	8.24
40	13.80	16.34	13.69	10.76	9.19	8.49	8.68
39	13.59	17.31	15.19	11.74	9.82	8.96	9.11
38	12.56	16.54	15.39	12.04	9.90	8.93	9.03
37	11.66	15.89	15.88	12.61	10.14	9.02	9.07
36	10.35	14.39	15.18	12.46	9.97	8.74	8.73
35	8.88	12.58	14.11	12.07	9.59	8.26	8.18
34	7.26	10.45	12.13	10.88	8.78	7.47	7.33
33	5.93	8.66	10.43	9.88	8.14	6.83	6.62
32	4.88	7.21	8.86	8.80	7.47	6.27	6.02
31	4.13	6.16	7.72	8.09	7.13	5.99	5.68
30	3.31	4.96	6.31	6.84	6.28	5.36	5.06
29	2.47	3.70	4.79	5.38	5.18	4.51	4.23
28	1.92	2.88	3.77	4.32	4.34	3.90	3.66

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40	14.38	18.49	17.59	15.11	13.52	12.80	13.22
39	13.97	18.89	18.79	16.11	14.23	13.37	13.75
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29	2.47	3.70	4.85	5.67	5.89	5.58	5.49
28	1.92	2.88	3.80	4.50	4.82	4.68	4.63

- tons of cargo supported per dollar spent dredging
- relative values are more important than the absolute figures

Project Value

- Leverage existing datasets/tools
- Relate metrics of economic significance via CPT to shoaling conditions and dredging requirements obtained from CSAT
  - Spatial component to predicted dredging requirements
- Develop work packages that quantify the value of maintaining Navigation channels as a function of cost & depth