Refinements in STFATE Modeling Allowing for Greater Dredge Volume Per Load

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Introduction

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Photo of Panama Canal
Courtesy of Nadia Lombardero
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- Panama Canal Expansion from 2007 to 2016
- Due to the increase in size of cargo ships traveling through the canal, several ports along the east coast were expanded, both in depth and channel width
- This also increased the amount of dredge material needed to be removed at each port
- Cruise ships have also increased in size, with passenger capacity well over 5,000 for the largest ships

Environmental Evaluations

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- ANAMAR has performed environmental evaluations in accordance with EPA requirements for multiple USACE districts across the country.
- Several criteria are required to meet EPA concurrence, including water quality, suspended and solid phase toxicology, and bioaccumulation.
- Even if dredge material passes all evaluation criteria, limited release volumes of dredge material can impact the overall effectiveness of dredging operations.
- Higher release volumes allow for more flexibility when contracting dredges and more efficient operations on site.

STFATE

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STFATE Purpose

- STFATE stands for Short-Term FATE of dredged material placed in open water
- To model the effects of dredge material on the water column over a period of 4 hours following disposal
- Water column effects may not exceed the limiting permissible criteria (LPC) inside the ODMDS after 4 hours
- Chemical or toxicological effects on the water column may not exceed LPC outside the ODMDS at any time

Running the STFATE Model

- Computer software developed from late 1970s, updated in late 1990s for a Windows interface
- ODMDS inputs from SMMP, regional guidance documents, or regulatory agencies
- Dredge operations from USACE or use standard inputs from past models
- Laboratory results for elutriate chemistry and toxicology

Example Graphic of Sediment Release in ODMDS

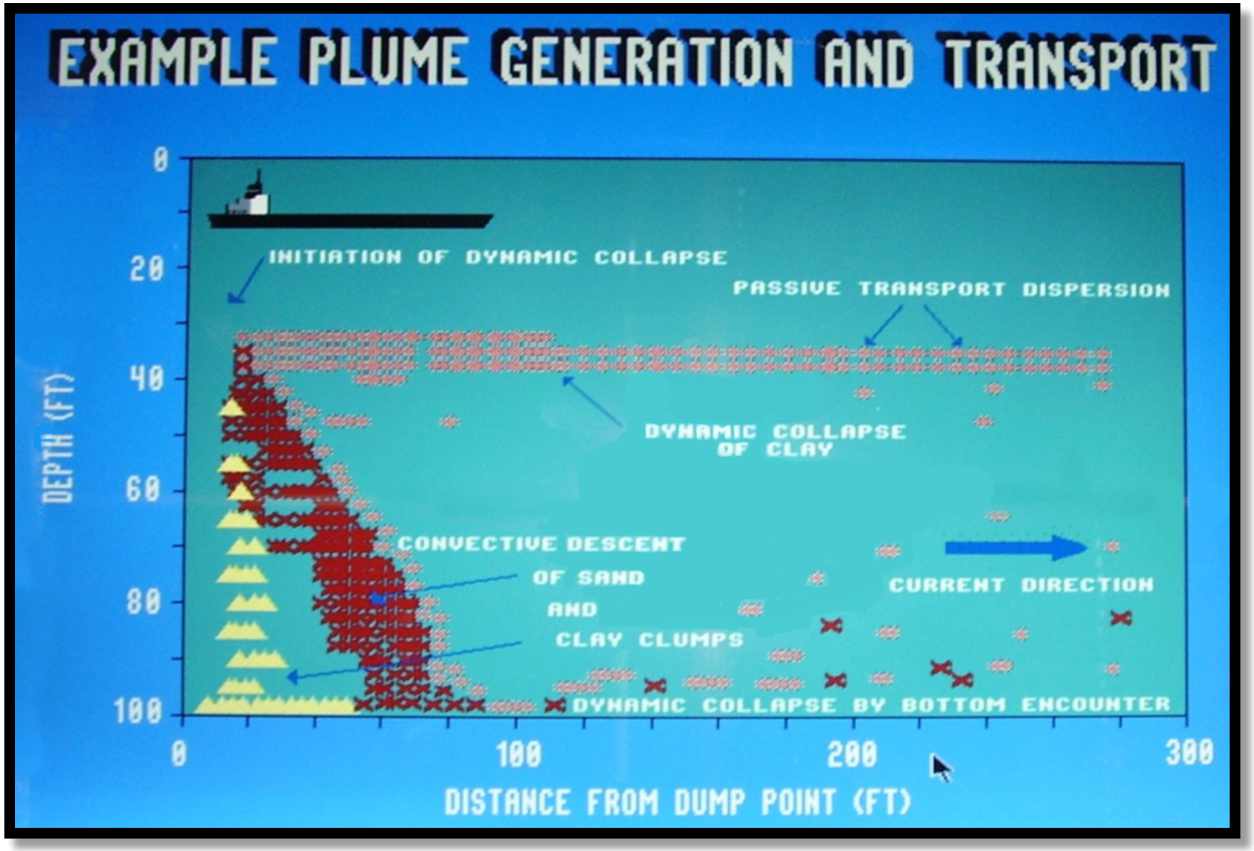

Image from USACE-ERDC

Refinements in Volumetric Fractions

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- Volumetric fractions estimate how much material at a given range of grain sizes is present in the dredge.
- Older methods did not include calculations for different types of dredges or sediment transports.
- Updated calculations were developed over time by EPA and USACE with the guidance shown in the paper appendix.
- An example calculation is shown on the next slide.

Example Calculations for Volumetric Fractions

Physical Characteristics	Test Sample
% Coarse (gravel and sand)	45.7
% Silt	18.4
% Clay	35.9
Free Water	20
%Sediment by volume	80
Specific Gravity	2.625
Water Density	1.025
Liquid Limit, % (from Atterberg Limits)	71
w, % (water content)	81.488
Volumetric Fractions (vf)	
vf clumps	0.65228
vf coarse	0.02187
vf silt	0.00881
vf clay	0.01718
vf water	0.29987

Ammonia Amelioration

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- Ammonia is produced in silty sediment, which is fairly common for dredge material.
- Ammonia is considered to be a non-persistent toxicant to local marine organisms.
- Toxicology testing is often affected by ammonia, resulting in higher mortality or abnormal development.

Ammonia Amelioration continued

- Ammonia can be ameliorated in the sediment by contact with air. Toxicology testing should be performed with both the ameliorated and unameliorated samples.
- If the mortality or abnormal development can be shown to be entirely due to ammonia, then a higher limiting permissible concentration may be used for STFATE.
- This process has allowed release volumes to increase significantly, in some cases by several thousand cubic yards.

Mytilus edulis
(common bay mussel or blue mussel)

Image from NewFields Northwest

Alternate Release Locations

- Modeling at different locations within the ODMDS can have a significant impact on dredge release volumes.
- The revised release location is opposite the prevailing current for modeling, allowing for the material to remain within the ODMDS for as long as possible.
- This decreases the chance of material failing outside the ODMDS.

Example Model

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- The example Harbor was evaluated in 2009 and 2016.
- The evaluation in 2009 did not take into account the refinements listed above, but were included for the 2016 evaluation.
- The dredge volumes from both evaluations are shown in the table below. The release volumes calculated are modeled at the same location in the ODMDS, and have incorporated refinements for ammonia amelioration and volumetric fractions only.
- They also include modeling for the hopper/cutter dredges vs. mechanical dredges for the 2016 evaluation.

Dredging Unit	2009 Dredge Volume (cubic yards/cubic meters)	2016 Dredge volume (cubic yards/cubic meters)	
		Hopper/Cutter	Mechanical
DU-1	6,500/4,970	12,500/9,560	15,000/11,500
DU-2	5,500/4,200	8,860/6,770	9,000/6,880
DU-3	6,500/4,970	7,000/5350	10,000/7640

Alternate Location Volumes

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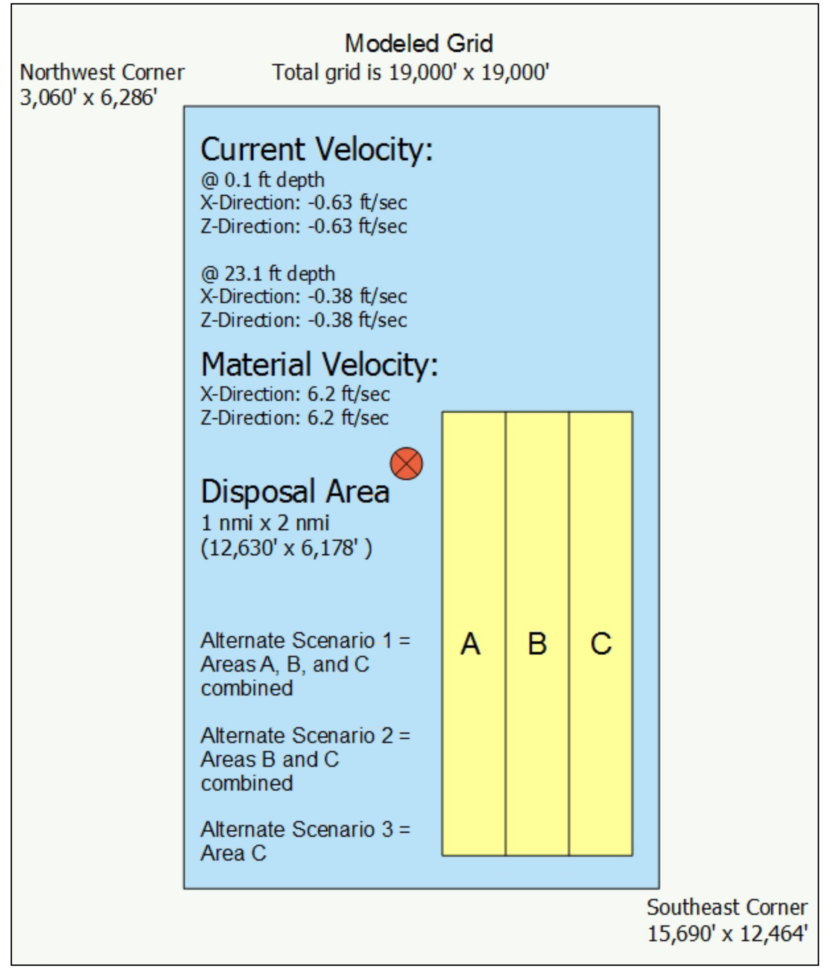
- In the previous example model, the two evaluations were compared using an unrestricted release location.
- Modeling at a point within the ODMDS farther from the boundary can increase the disposal volume substantially.
- Three additional scenarios were modeled using alternate scenarios, as shown in the figure to the right.



Alternate Location Volumes, continued

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- The alternate locations were modeled in 2016 only.
- The table below shows the changes in release volume between the standard release location and the three alternate release locations shown on the previous slide.
- The volumes shown are for hopper/cutter dredges only, but mechanical dredge volumes showed similar increases.

Dredging Unit	2016 Unrestricted Disposal Volumes (cubic yards/cubic meters)	Alternate Disposal Areas (cubic yards)		
		Scenario 1	Scenario 2	Scenario 3
DU-1	12,500/9,560	16,000/12,200	NA*	20,000/15,300
DU-2	8,860/6,770	12,300/9,400	15,800/12,100	20,000/15,300
DU-3	7,000/5350	13,200/10,100	18,000/13,800	19,000/14,500

* For DU-1, the volume determined in Scenario 1 exceeded the requirements requested by the client for Scenario 2, so no additional modeling was required.

Conclusions

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- The refinements shown can result in cost savings to the port through more efficient dredging.
- Modeling needs to be evaluated on a case-by-case basis, and not all of the refinements will necessarily apply.
- Questions?

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