CONNECTING THE DOTS TO INNOVATION

CONOWINGO RESERVOIR MODELING STUDY

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OVERVIEW

Background

- Objectives of the effort
- Team and Partnerships

Modeling approach

- Hydrodynamics
- Nutrient water quality
- Sediment transport

Model applications

- Dredging scenarios
- Extreme event scenarios

Project and reporting schedule

Questions

Regional View of Conowingo Reservoir

BACKGROUND

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SITE OVERVIEW

Conowingo Reservoir:
Lowest impoundment on the Susquehanna
94’ tall dam (owned by Constellation Corp.)
9000 acre impoundment

Concern:
Increased risk of intense summer and winter season storms leading to increased risk of sediment and nutrient releases to Chesapeake Bay

Previous Models:
-proprietary
-lack of spatial sediment capability
-not integratable (as is) to CBP models

OBJECTIVES

1. Develop a non-proprietary, 3D water quality modeling system of Conowingo Reservoir for the purpose stated above. The modeling system should be capable of simulating hydrodynamics, biogeochemical, and sediment transport processes within CR. Modeling package output will be consistent with requirements of the CBP modeling suite.

2. Application of the modeling system to current and future dredging scenarios, specifically the evaluation of sediment and associated nutrient reductions from different dredging scenarios. It must leverage the additional CR sediment characterization work done and lessons learned through Maryland's innovative and beneficial reuse pilot.

3. Application of the modeling system to future hydrologic-climate scenarios. This information will help various Chesapeake Bay partnerships better understand and institutionalize the resiliency and response of CR to extreme weather events, flows, future climate change hydrology, and determine CR scour and sediment resuspension and associated nutrient/contaminant increases within the reservoir and transport downstream.

TEAM AND PARTNERSHIPS

ERDC

Maryland
Department of the Environment

Matt Rowe
Christina Lyerly

Cost Share →

US Army Corps of Engineers

Baltimore District (NAB)
Planning Assistance to States Program
Karl Kerr – Program manager
Vanessa C. Campbell – Project manager

Chesapeake Bay Program
Science. Restoration. Partnership.

Data Share →

Conowingo Reservoir Model

Dredging scenarios

Extreme event scenarios

← Data Share

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Dr. Jodi L. Ryder – Technical manager
Dr. Earl J. Hayter – Technical lead

MODEL REQUIREMENTS

- Continuous simulation of the reservoir pool including selected hydrometeorological events; (1991-2000)
- Change in hydrodynamics from reservoir infill of sediments from the CR watershed, and removal of material through dredging
- Biogeochemistry in the reservoir pool, responding to the amount and speciation of nitrogen, phosphorus, and sediment inputs from upstream and bottom sediment
- Biogeochemical changes in sediments, including burial, species changes, and water column exchanges
- Physical changes in sediment characteristics due to erosion, bed armoring, and deposition of sediment and the resulting morphological changes in the reservoir
- Dredging of the reservoir.

MODELING APPROACH

MODELING APPROACH – DATA ACQUISITION

- Bathymetry in the model domain, i.e., the CR.

- Meteorological data time series
  - wind speed and direction
  - atmospheric pressure
  - incident solar radiation
  - air temperature (both wet and dry bulb)
  - precipitation

- Hydrologic data time series for watershed
  - CBP will provide Phase 6 → Phase 7
  - Constellation Energy for dam operations (Muddy Run)

- Water quality in-situ
  - water temperature, DO, SOD, nitrogen, phosphorus, and other

- Sediment characteristics
  - grain size distributions (including percentage of organic matter)
  - historical cores and new collection for erodibility

Description	**FY25**			
	Q1	Q2	Q3	Q4
DATA ACQUISISTION	X			

MODELING APPROACH

Modeling approach

- Hydrodynamics
- Nutrient water quality
- Sediment transport
- Baseline calibration

Description	FY25			
	Q1	Q2	Q3	Q4
DEVELOPMENT OF CRMS				
Hydrodynamics	X	X		
Nutrient Water Quality		X	X	X
Sediment Transport		X	X	X

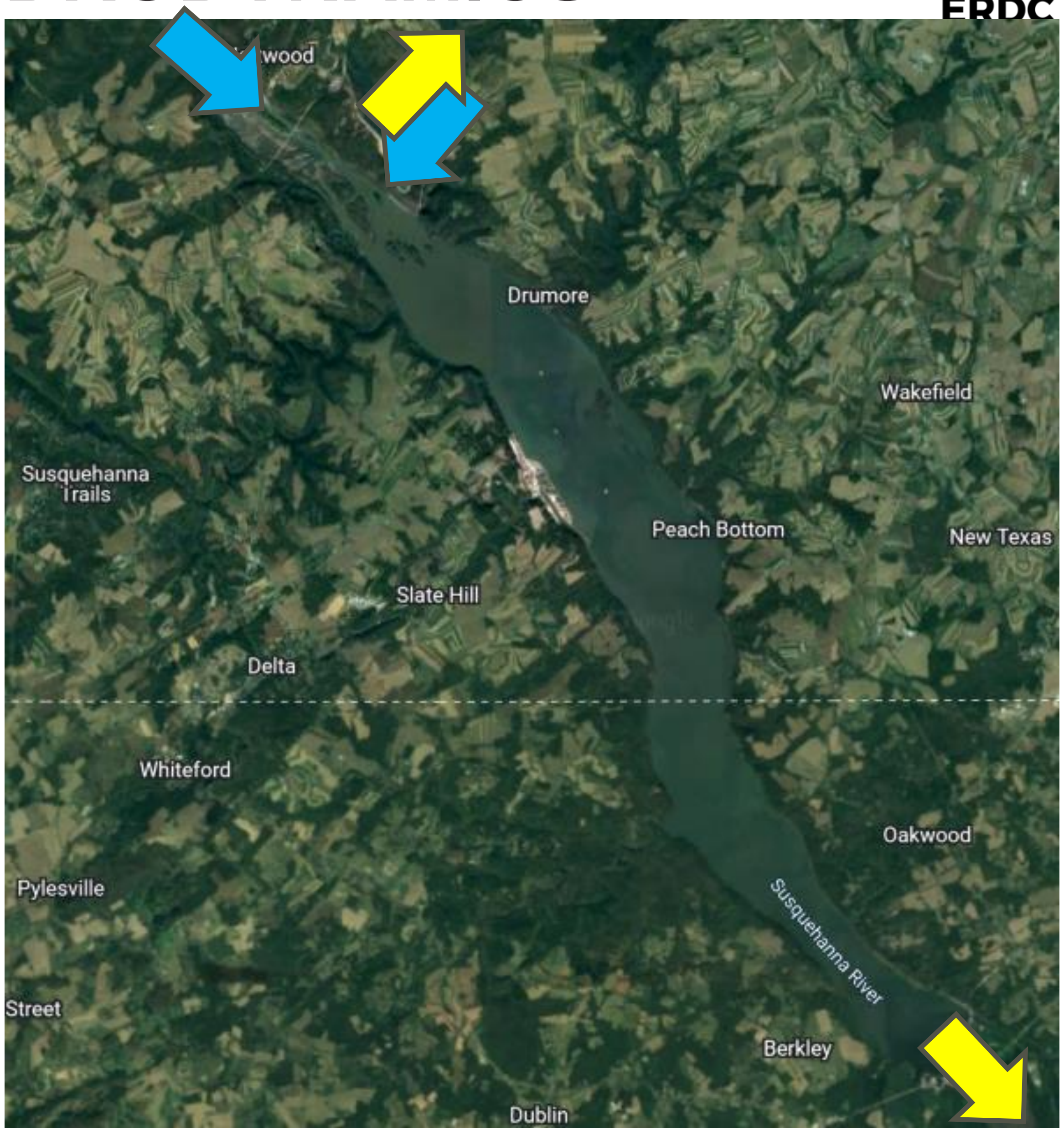
Model Selection

- Environmental Fluid Dynamics Code+ (EFDC+)
- Based on EFDC (originally developed by John Hamrick @ EPA)
- Refined by DSI
- Open source
- 3D hydrodynamics
- Fully coupled hydrodynamics, sediments, water quality

MODELING APPROACH - HYDRODYNAMICS

Major Inflows
Holtwood Dam (Upstream)
Muddy Run Power Reservoir
  Operational boundary
Watershed Direct runoff
  Initiate with Phase 6 HSPF
  Upgrade to Phase 7

Major Outflows
Muddy Run Power Reservoir
Conowingo Dam (Downstream)
  outlet grid constructed to
  mesh with CBP model



MODELING – NUTRIENT WATER QUALITY

Based in CE-QUAL-ICM kinetics

Unlimited algae and macrophyte groups
- mostly defined through half-saturation and uptake rates
- utilizes temperature effects on coefficients

Carbon treatment
- DOC
- Labile G1
- Refractory G2+G3

Processes
- reaeration
- benthic mass fluxes\sediment diagenesis (DiToro kinetics)
  - can be spatially varying

Boundaries
- point sources
- wet/dry deposition

ID	Description
1	Refractory Particulate Organic Carbon
2	Labile Particulate Organic Carbon
3	Dissolved Organic Carbon
4	Refractory Particulate Organic Phosphorus
5	Labile Particulate Organic Phosphorus
6	Dissolved Organic Phosphorus
7	Total Phosphate
8	Refractory Particulate Organic Nitrogen
9	Labile Particulate Organic Nitrogen
10	Dissolved Organic Nitrogen
11	Ammonia Nitrogen
12	Nitrate Nitrogen
13	Particulate Biogenic Silica
14	Dissolved Available Silica
15	Chemical Oxygen Demand
16	Dissolved Oxygen
17	Total Active Metal
18	Fecal Coliform
19	Carbon Dioxide
20	Cyanobacteria
21	Diatoms
22	Green Algae
23	Macrophytes
24	MesoZooplankton

MODELING APPROACH – SEDIMENT TRANSPORT

- Model will represent the different bed layer sources as scour occurs during different limbs of the hydrograph
- Will simulate the different classes and composition of sediment as well what's eroded into the water column
- Use field observations to set up the sediment bed model vertical variation of the different components - with spatial variation in the vertical composition in different parts of the reservoir

Data development:

- Historical cores with chemical analysis
- Additional data collection for erosion rates with SEDFLUME
  - Facilitated through MDE
  - 30 sediment grabs
  - 4x5 gal buckets

Model runtime:

1 week for EFDC+

Model emulation may be used for linkage to Bay model

MODEL APPLICATIONS

APPLICATIONS – DREDGING SCENARIOS

- Continuous simulation period (of 1991-2000)

Dredging 1 & 2: Different dredging scenarios in different locations in the CR to determine associated nutrients reduction within the CR and transported to Chesapeake Bay

Infill 1& 2: Different infill scenarios based on availably of bathymetry (e.g., 1995 and 2010 conditions or other years depending on data availability).

Reduced loading: A scenario that simulates watershed BMPs and in-reservoir dredging to reduce sediment loading from CR to Chesapeake Bay.

Description	**FY25**				**FY26**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DEVELOPMENT AND SIMULATION OF DREDGING SCENARIOS								
dredging 1				X	X	X	X	
dredging 2				X	X	X	X	
Infill 1				X	X	X	X	
Infill 2				X	X	X	X	
Reduce sediment loading to ChesBay				X	X	X	X	

APPLICATIONS – EXTREME EVENT SCENARIOS

Scenario selection Q1 FY25

Initial loads:

Based on 1991-2000 hindcast

Critical period:

1993-1995

Scenario characteristics:

Two back-to-back extreme storms (probably in excess of 400,000 cfs) during the warm season (April-September) in close succession

Description	FY25				FY26			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DEVELOPMENT AND SIMULATION OF EXTREME EVENT SCENARIOS				X	X	X	X	

TIMELINES

PROJECT AND REPORTING SCHEDULE

ERDC

Description	FY25				FY26				FY27			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
DATA ACQUISISTION	X											
DEVELOPMENT OF CRMS												
Hydrodynamics	X	X										
Nutrient Water Quality		X	X	X								
Sediment Transport		X	X	X								
DEVELOPMENT AND SIMULATION OF DREDGING SCENARIOS												
dredging 1				X	X	X	X					
dredging 2				X	X	X	X					
Infill 1				X	X	X	X					
Infill 2				X	X	X	X					
Reduce sediment loading to ChesBay				X	X	X	X					
DEVELOPMENT AND SIMULATION OF EXTREME EVENT SCENARIOS				X	X	X	X					

CBP phase 7

PROJECT AND REPORTING SCHEDULE

	FY25				FY26				FY27			
Description	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
PROJECT DELIVERABLES												
Tech Note – CRMS				X								
CRMS Presentation					X							
CRMS User Manual					X							
Tech Note – Dredging scenarios								X				
Tech Note – Extreme event scenarios								X				
Model code & Input file delivery				X				X				
CRMS user workshop									X			
Tech Report							X	X	X	X		

CBP phase 7

CONNECT WITH US

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