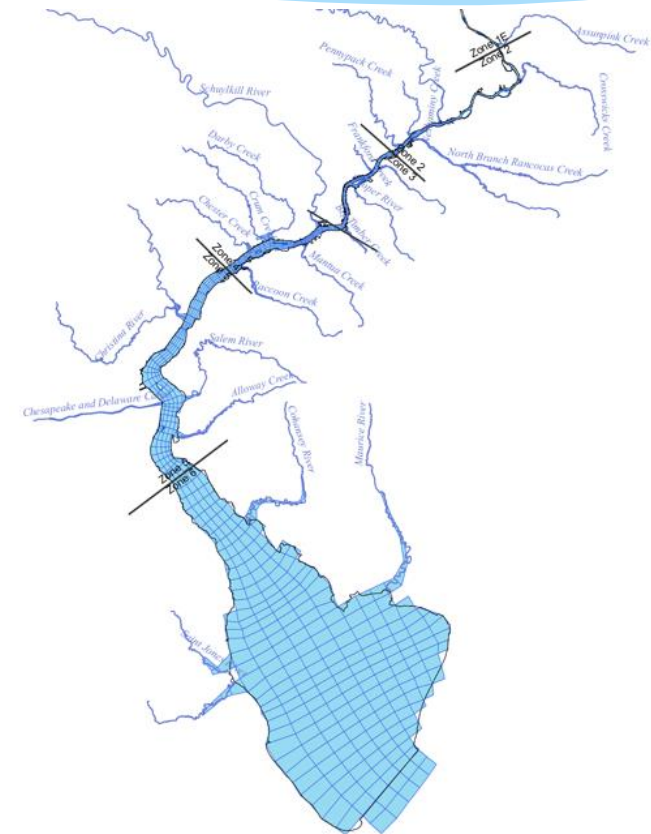# Modeling Eutrophication Processes in the Delaware Estuary to Link Watershed Efforts to Control Nutrient Impacts

Delaware Watershed Research Conference

Philadelphia, PA
November 19, 2019

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Delaware River Basin Commission
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Delaware Watershed Research Fund

Presentation Outline

- Goal of the Project

- Background

- Model Development
  - Approach
  - Hydrodynamic Model
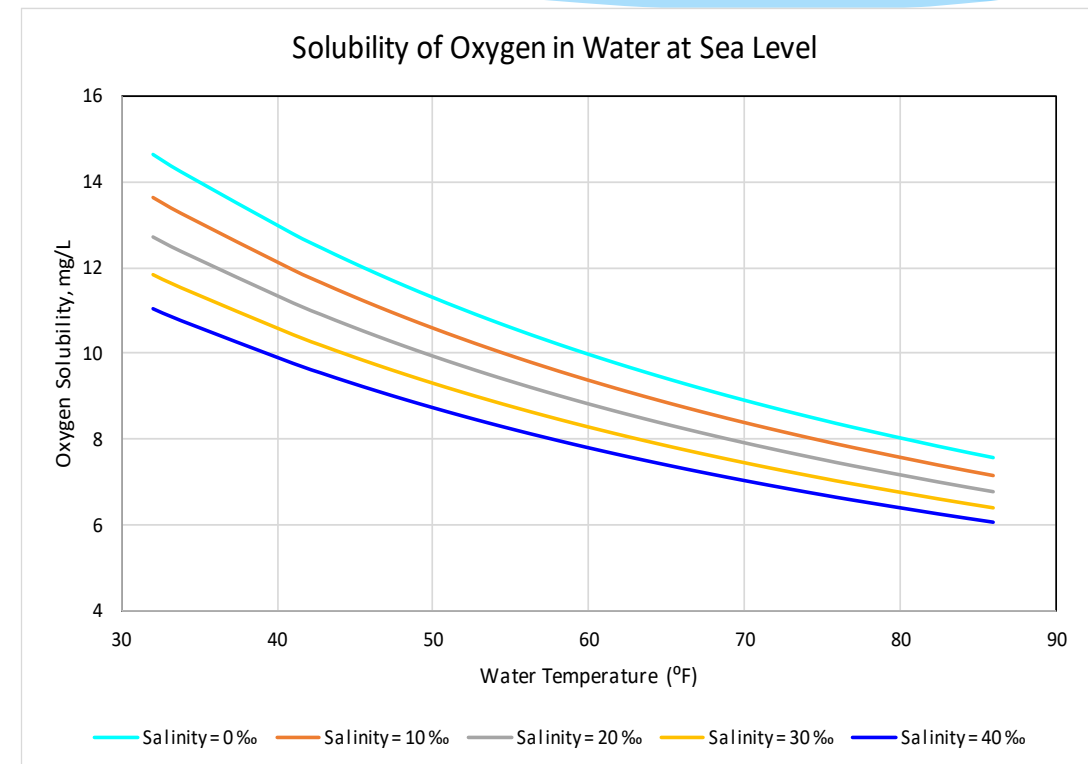 - Water Quality Model

Goal

- Develop a linked hydrodynamic and water quality model that will be used to allocate the loads of oxygen demanding nutrients that can be discharged from point and non-point sources into the Delaware Estuary while maintaining the desired levels of dissolved oxygen.

- The achievable level of dissolved oxygen will be turned into water quality criteria through DRBC's rule making processes

What is Dissolved Oxygen (DO)?

- **Dissolved Oxygen** is the amount of gaseous oxygen (O_2) dissolved in the water.

- **Oxygen enters** the water by direct absorption from the atmosphere, by rapid movement, and via photosynthesis of phytoplankton/ submerged aquatic vegetation.

- **Oxygen is consumed** by decay of organic carbon, oxidation of ammonia, decay of organic matter in sediment layer, and respiration of phytoplankton/ aquatic vegetation.

- Fully saturated DO ranges 7.8 to 14 mg/L for freshwater depending on water temperatures.

Solubility of Oxygen in Water at Sea Level

Chart: Oxygen Solubility, mg/L (y-axis, 4 to 16) vs. Water Temperature (°F) (x-axis, 30 to 90). Lines: Salinity = 0‰, Salinity = 10‰, Salinity = 20‰, Salinity = 30‰, Salinity = 40‰.

Dissolved Oxygen in Delaware Estuary

July & August Dissolved Oxygen by Year
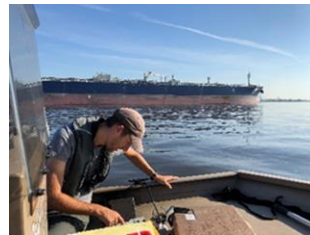**USGS Monitor 01467200 Delaware River at Ben Franklin Bridge**
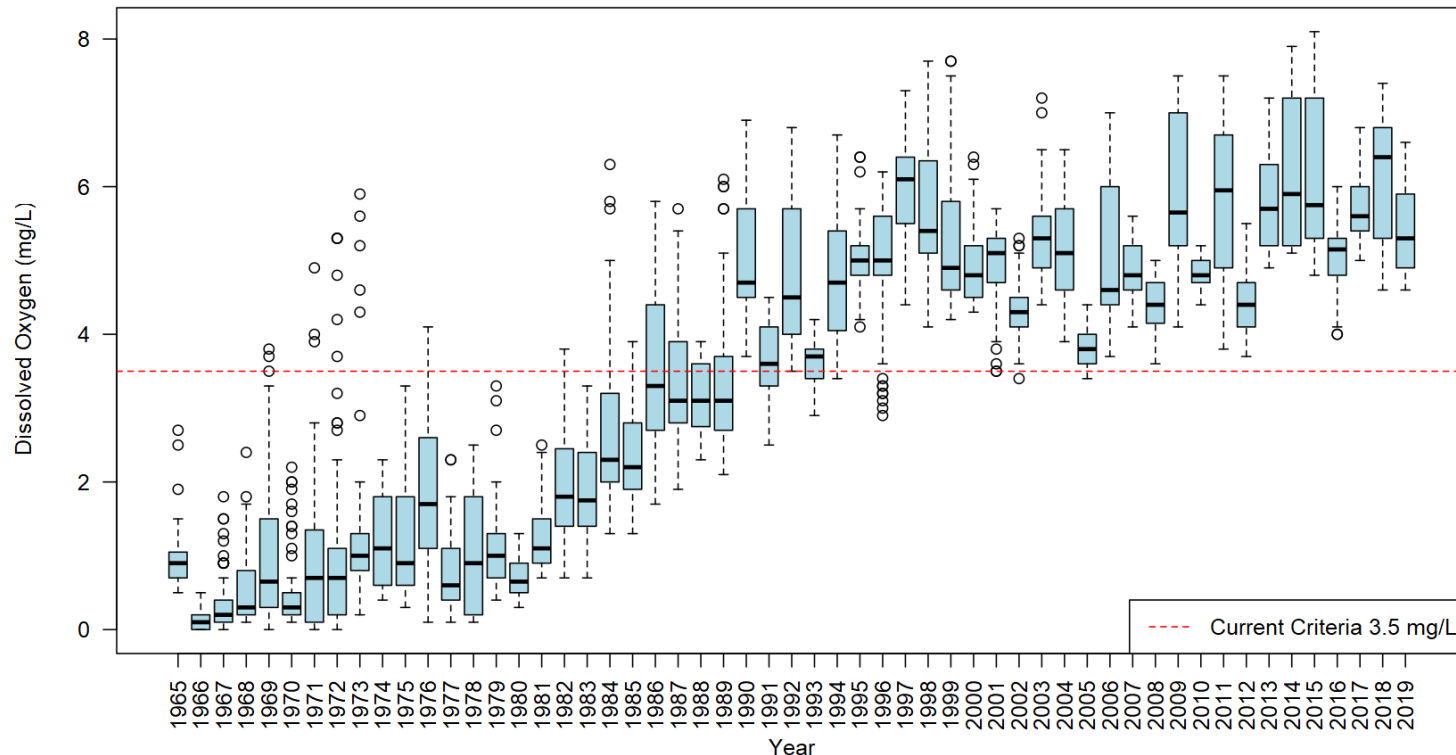
- Historically, summer DO in estuary near Philadelphia & Camden was too low due to human wastes.

- DRBC adopted water quality standards (1967) & wasteload allocation (1968) to support the maintenance of resident fish and passage of anadromous fish with DO criteria of 3.5 mg/L

- What should be the next generation dissolved oxygen water quality criteria for the urban portions of the Delaware Estuary to properly protect aquatic life use?

Actions Underway – Highlights

DRBC Resolution 2017-4:

- Development a linked hydrodynamic and water quality model

- Engineering evaluation & cost estimate for improved WWTP ammonia & TN
  - Benefit analysis

- DO needs study for Delaware Estuary fish species

- Enhanced monitoring:

  - Point discharge monitoring

  - BoatRun (ambient) to year-round

  - Added salinity at tidal boundaries

  - Added nitrate sensors at Trenton & Chester gages

  - Extensive tributary monitoring

  - Light extinction monitoring

  - Primary productivity study

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Modeling Approach

- Assess available data and conduct additional monitoring to fill gaps
  - Sources
  - Ambient water

- Develop a linked hydrodynamic and water quality model
  - Environmental Fluid Dynamics Code (EFDC)
  - Water Quality Analysis Simulation Program (WASP8)

- Calibrate linked model
  - Intensive monitoring period 2018-2019

- Conduct forecast simulations with calibrated model
  - Determine levels of external sources required to achieve varying levels of ambient dissolved oxygen
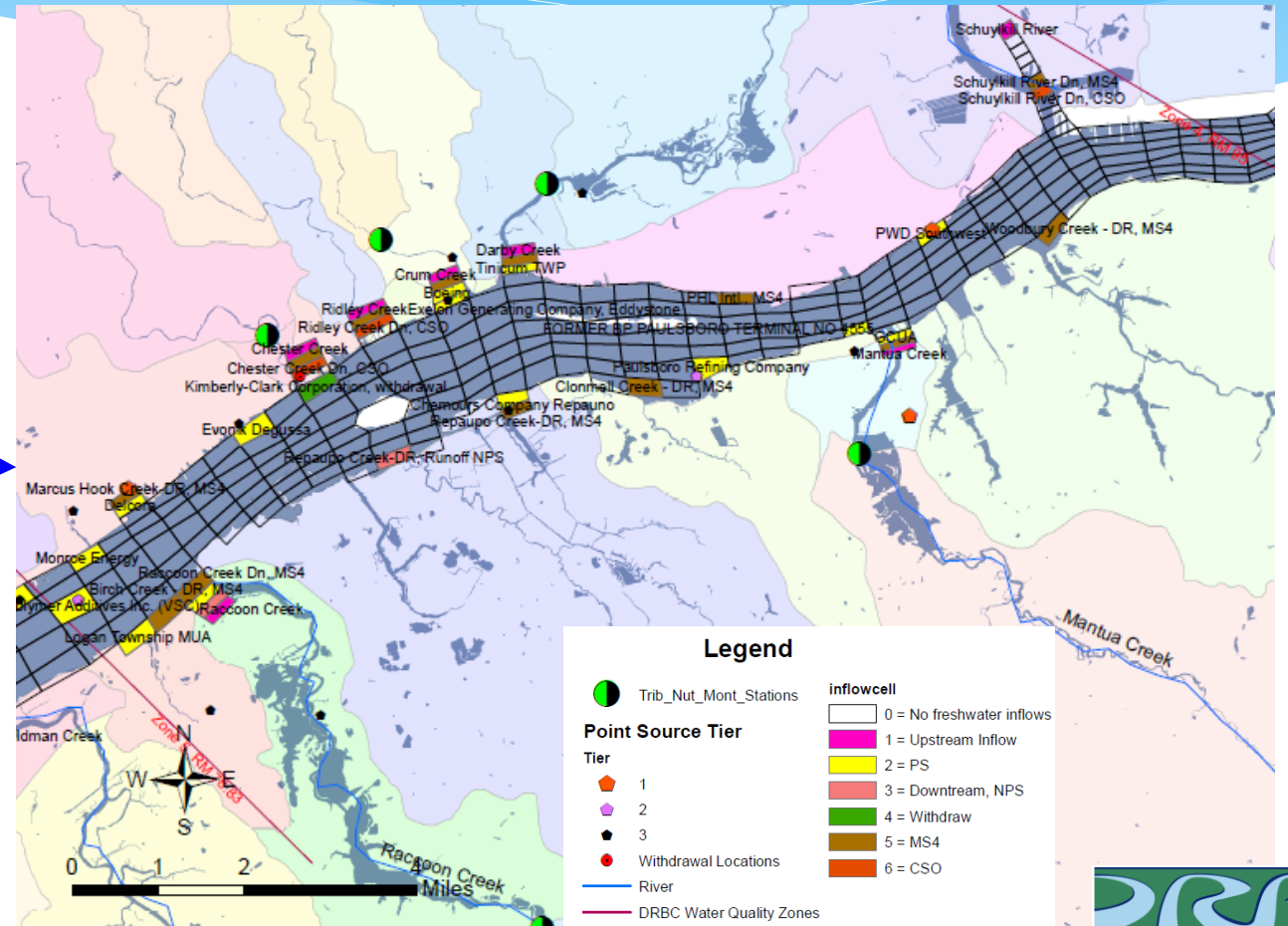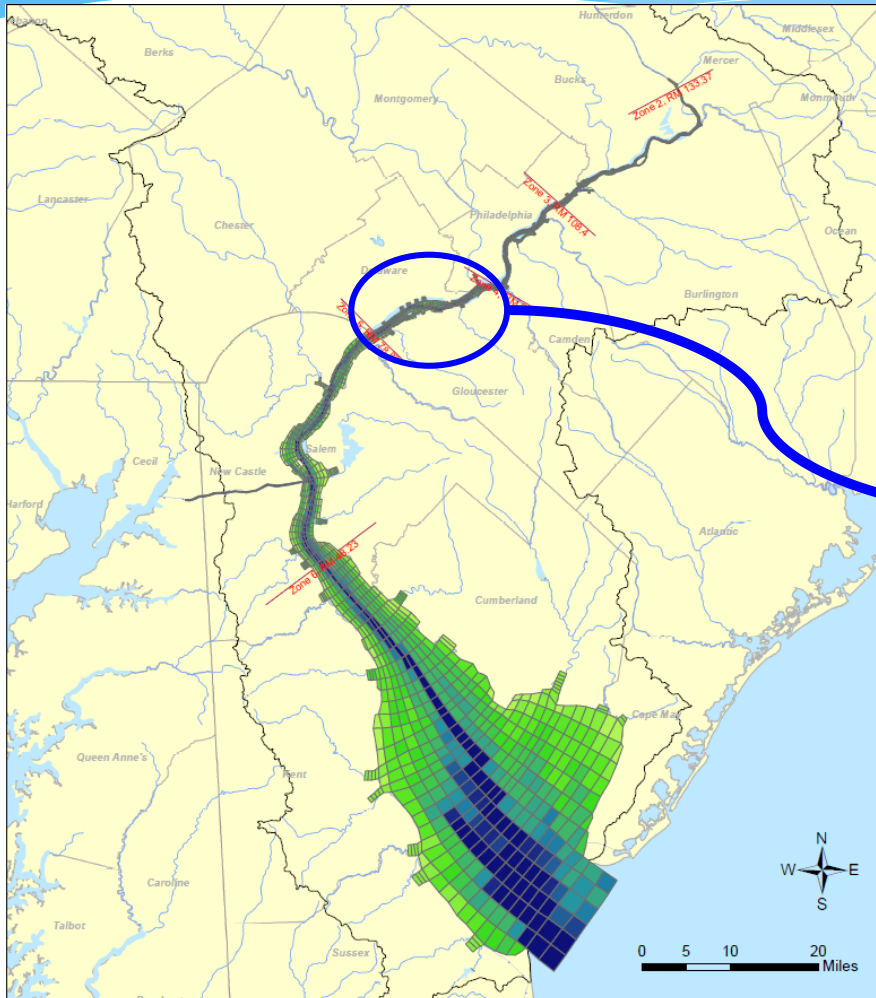
Hydrodynamic Model
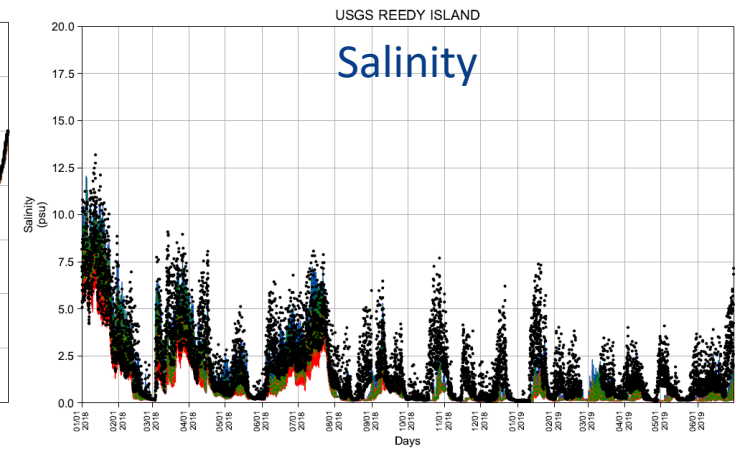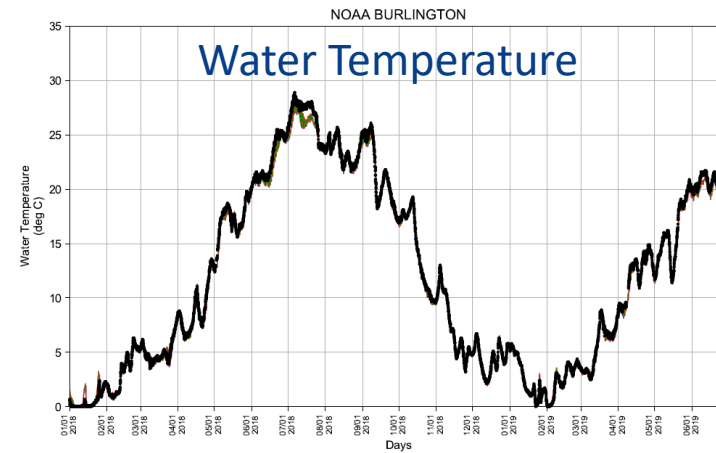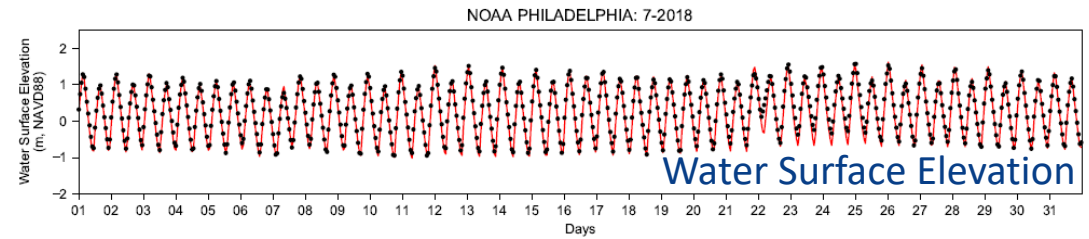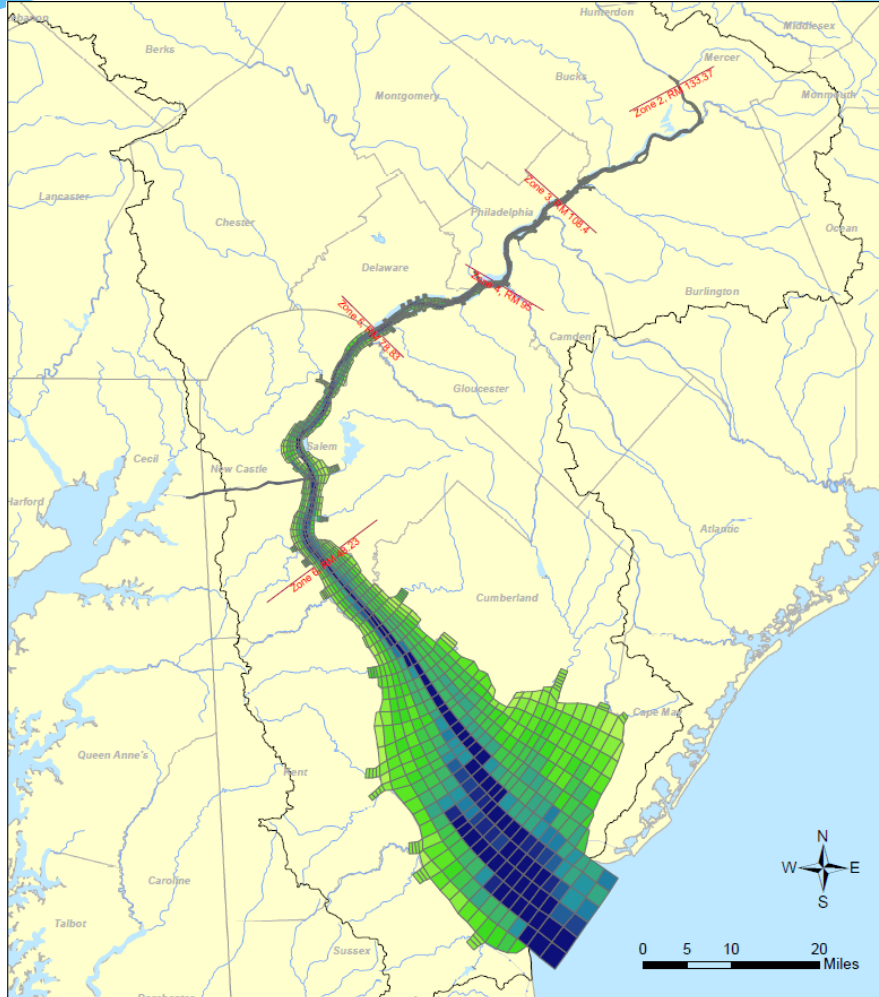
Conceptual WQ Model Nutrient Loads

- Tributary Loads
  - Delaware River at Trenton (head of tide)
  - Schuylkill River
  - 25+ other tributaries

- Tidal Boundaries
  - Ocean at mouth of Delaware Bay
  - C&D Canal

- Direct Basin Loads
  - Wasteloads: WWTPs, CSOs, MS4
  - Nonpoint Source (runoff outside MS4)
  - Wet/Dry deposition onto water surface
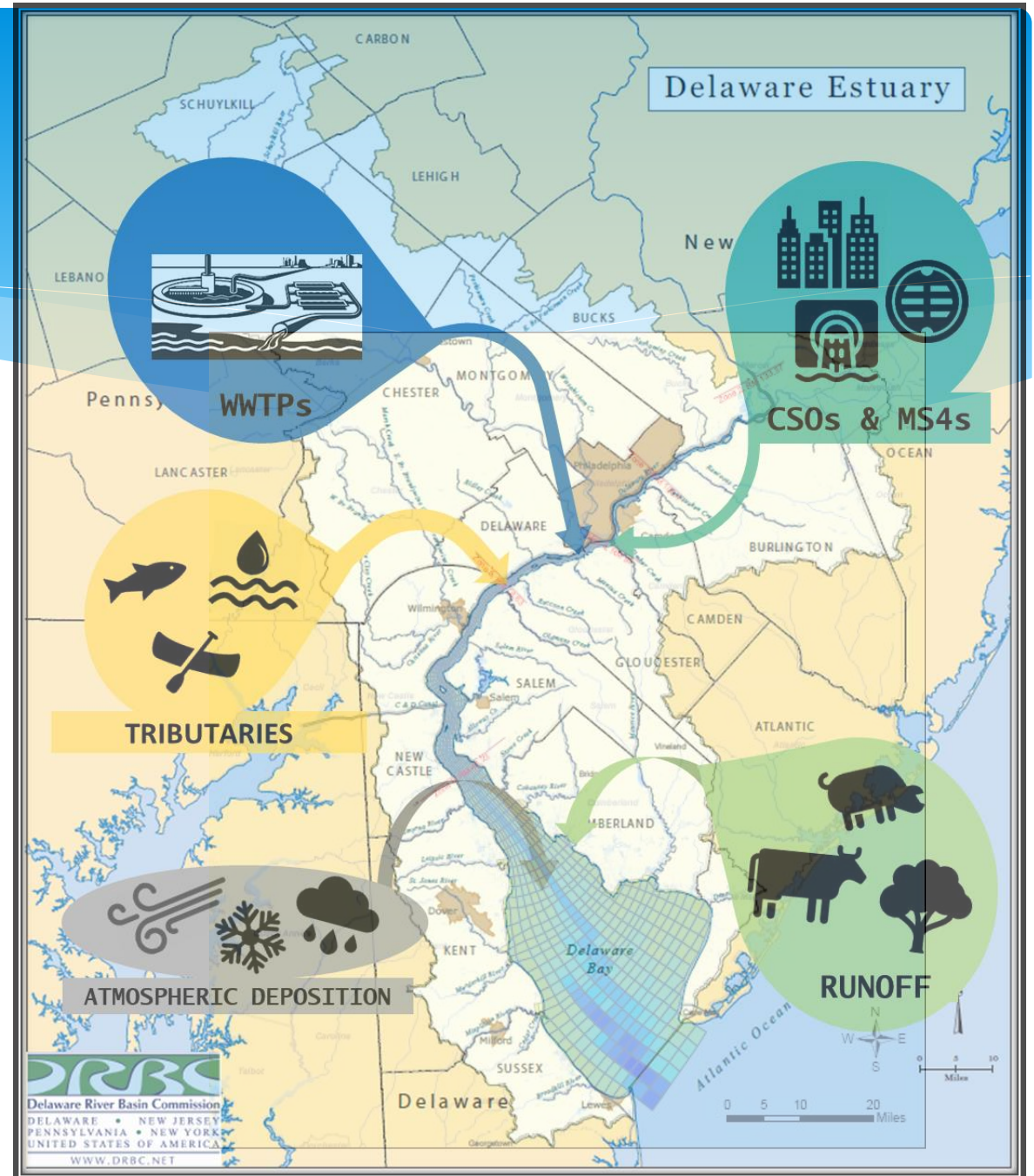
Water Quality Model

Modeling Progress to Date

- Preliminary calibration of EFDC hydrodynamic model
  - Water surface elevation
  - Salinity
  - Water temperature

- Continued cross-checking of EFDC-WASP8 linkage
  - Flow rates / Mass balance
  - Optimize computational time step and reduce overall simulation time

- Water Quality Model
  - Develop daily nutrients loads and boundary conditions for 2018
  - Initiate model calibration

Funding Support

Questions?

More Information: https://www.nj.gov/drbc/quality/conventional/DO.html

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