Holistic Approach to Improved Nutrient Management

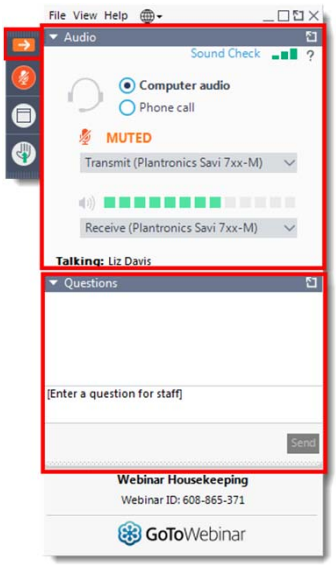
A Pre-Workshop Webcast

Thursday, June 4, 2020

2:00 – 4:30 pm ET

1

GoToWebinar Housekeeping: Attendee Participation



Your Participation

Open and close your control panel.

Join audio:

- Choose **Mic & Speakers** to use VoIP
- Choose **Telephone** and dial using the information provided

Submit questions and comments via the Questions panel.

Note: Today's presentation is being recorded and will be available shortly after today's webcast.

2

Today's Moderators

Harry Zhang, PhD, PE
Research Program Manager –
Integrated Water & Stormwater, WRF

Dave Clark, PE
Principal Investigator,
Senior Vice President, HDR

Water Environment Federation
the water quality people

The Water Research Foundation

3

Today's Agenda

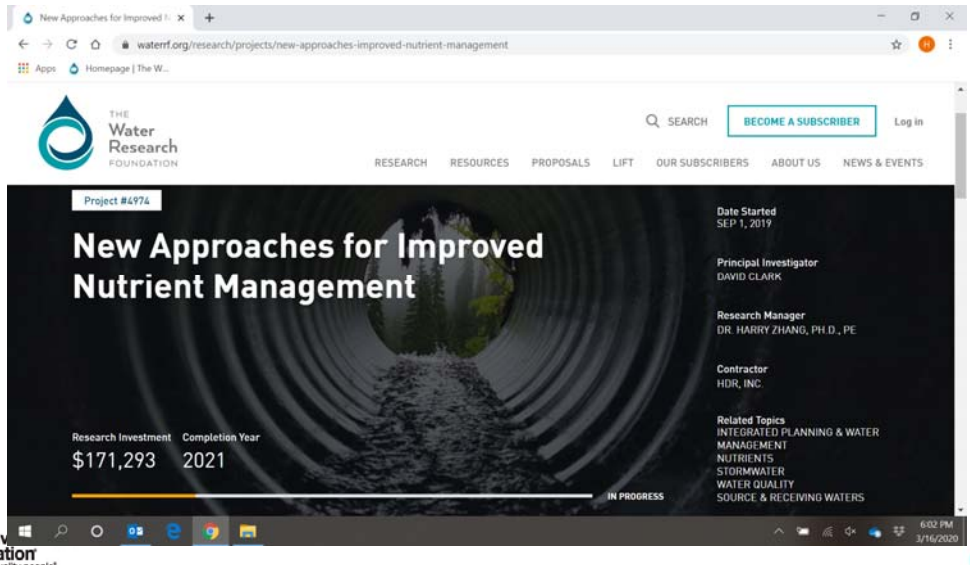
- WRF Welcome and Brief Overview: Harry Zhang (WRF)
- Project Overview and Research Plan: Dave Clark (HDR)
- Delaware River Basin Water Quality and Management Implications: Namsoo Suk (Delaware River Basin Commission)
- Philadelphia Water Department and River Wastewater Dischargers: Adam Hendricks (Philadelphia Water Department)
- Integrated Planning and Competing Interests in the Holistic Nutrient Management: Trent Stober (HDR)
- Watershed Perspectives of Nutrient Management and Ongoing Nutrient Reduction Efforts in San Francisco Bay Area: Mike Falk (HDR)
- Setting Criteria to Support Holistic Nutrient Management: Dave Dilks (LimnoTech)
- Utility Panel Discussion
- Questions and Answers

Water Environment Federation
the water quality people

The Water Research Foundation

4

Project Web Page (WRF #4974)



Water Environment Federation the water quality people

THE Water Research FOUNDATION

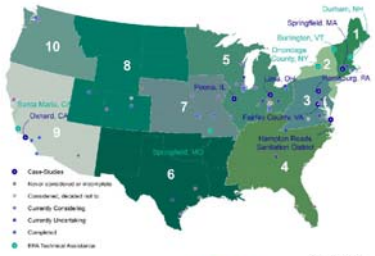
5

Holistic Approach and Integrated Planning Framework

(WRF Project 4854)

PROJECT NO. SIWM9R14/4854

Toolbox for Completing an Alternatives Analysis as Part of an Integrated Planning Approach to Water Quality Compliance



PROJECT NO. SIWM9R14/4854

User's Guide for Integrated Wastewater and Stormwater Planning

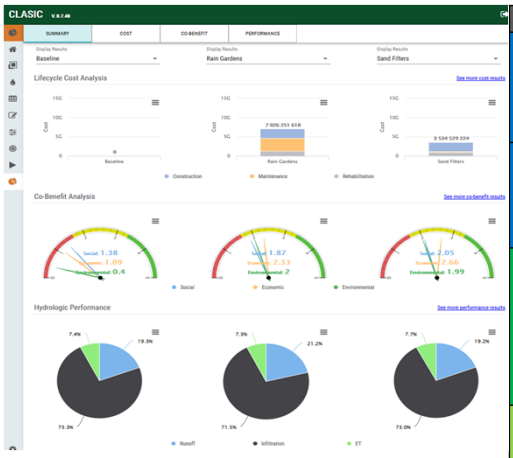
Water Environment Federation the water quality people

THE Water Research FOUNDATION

6

Community-enabled Lifecycle Analysis of Stormwater Infrastructure Costs (CLASIC)

- EPA National Priorities Grant #836173



Output	Included in CLASIC Life Cycle Cost Tool
Pollutant Load Reduction	· TSS (Total Suspended Solids) · **TN (Total Nitrogen)** · **TP (Total Phosphorus)** · FIB (Fecal Indicator Bacteria)
Hydrologic	· Runoff Volume · Volume Infiltrated · Volume Evapo-transpired · Number of runoff events
Life Cycle Cost (LCC)	· Net Present Value o Construction o Maintenance o Replacement · Average Annual Cost Over Design Life · Per unit cost for scenario comparison
Co-Benefits	· Score of economic, environmental, social performance based on user selected importance factors and performance output

Water Environment Federation
the water quality people

THE Water Research FOUNDATION

7

THE Water Research FOUNDATION

Project Overview and Research Plan

Dave Clark, PE

HDR

Water Environment Federation
the water quality people

THE Water Research FOUNDATION

8


Project Overview and Research Plan

9


Project Overview and Research Plan

10

Holistic Approach to Improved Nutrient Management

- Phase 1 Goals
  - Engagement
    - Point and Nonpoint Sources
    - Regulatory Agencies
    - Stakeholders
  - Research Plan Development
    - Phase 2 Roadmap
      - Foster Innovation and New Opportunities
      - Improve Nutrient Management

Water Environment Federation the water quality people

THE Water Research FOUNDATION

11

Holistic Approach to Improved Nutrient Management": Phase 1 (WRF RFP#4974)

THE Water Research FOUNDATION

BACWA BAY AREA CLEAN WATER AGENCIES

PHILADELPHIA WATER DEPARTMENT

CEDAR RAPIDS City of Five Seasons

HDR

LimnoTech

IOWA SOYBEAN Association

UNIVERSITÉ LAVAL

Water Environment Federation the water quality people

THE Water Research FOUNDATION

12

Project Overview and Research Plan

- Task 1: Literature Review
- Task 2: Stakeholder Workshops
  - Workshop No. 1 BACWA and San Francisco Bay
  - Workshop No. 2 Philadelphia Water Department and Delaware River
  - Workshop No. 3 Iowa Soybean Association with Point and Nonpoint Sources
- Task 3: Development of a Research Roadmap Based on Findings from Tasks 1 and 2

Water Environment Federation the water quality people

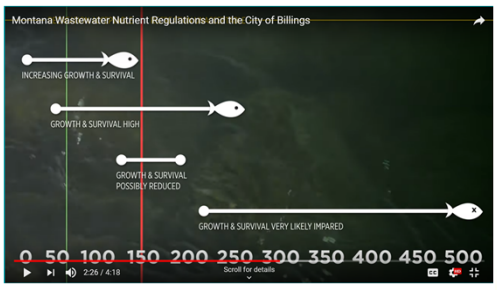
The Water Research Foundation

13

Nutrient Issues

- Montana Wastewater Nutrient Regulations and the City of Billings

https://www.youtube.com/watch?v=4mRsCGG_h2g



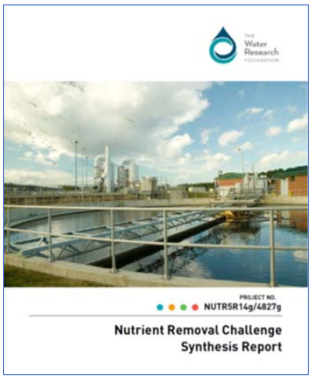
Water Environment Federation the water quality people

The Water Research Foundation

14

Task 1: Literature Review

- WRF Research
  - Nutrient Removal Challenge (NUTR5R14g/4827g)
  - Modeling Guidance for Nutrient Target Setting (LINK1T110)
  - Innovation-Stimulating Regulations (NTRY-17-06 #04826)
  - Etc.
- Other Nutrient Management Approaches and Incentives
  - Colorado Nutrient Incentive Program
  - Iowa Nutrient Reduction Exchange
  - European Nutrient Regulations
  - Gray Literature



Water Environment Federation the water quality people

The Water Research Foundation

15

Task 2: Stakeholder Workshops

- Workshop No. 1 BACWA and San Francisco Bay
- Workshop No. 2 Philadelphia Water Department and Delaware River
- Workshop No. 3 Iowa Soybean Association and City of Cedar Rapids with Point and Nonpoint Sources

Water Environment Federation the water quality people

The Water Research Foundation

16

Workshop No. 1 BACWA and San Francisco Bay – March 19, 2020 Webcast

- 2014 Watershed Permit
  - Unique Collaboration of 37 WRRFs, Regulators, Scientists
  - Innovative and Cooperatively Developed
    - Evaluate the Potential Nutrient Discharge Reduction by Treatment Optimization and Side-Stream Treatment
    - Evaluate the Potential Nutrient Discharge Reduction by Treatment Upgrades or Other Means
    - Support Monitoring, Modeling, and Embayment Studies
- 2019 Watershed Permit Renewal
  - Targets
  - Incentives

BACWA BAY AREA CLEAN WATER AGENCIES

Water Environment Federation the water quality people

THE Water Research FOUNDATION

17

Workshop No. 1 BACWA and San Francisco Bay – March 19, 2020 Webcast

- Puget Sound Collaboration Workshop – December 18, 2019
  - Developing an Approach for Protection of Puget Sound

Water Environment Federation the water quality people

THE Water Research FOUNDATION

18

Workshop No. 2 Philadelphia Water Department and Delaware River – June 4, 2020 Webcast

- Delaware River and Estuary
  - 12 WRRF Dischargers
  - Dissolved Oxygen Sags
  - Toxics
  - Endangered Species
    - Atlantic Sturgeon
- Potential Collaboration

19

Workshop No. 2 Philadelphia Water Department and Delaware River - June 4, 2020 Webcast

- Philadelphia Water Department:
  - Bay Area Clean Water Agencies (BACWA) Nutrient Reduction Study, November 9, 2018

20

Workshop No. 3 Iowa Soybean Association and City of Cedar Rapids with Point and Nonpoint Sources

- Iowa Soybean Association (ISA)
  - Largest State-based Row-crop Commodity Association
    - ISA Supports >40,000 Soybean Farmers
- City of Cedar Rapids
  - Middle Cedar Partnership Project Collaboration with Growers
  - USDA-NRCS Regional Conservation Partnership Program (RCPP)

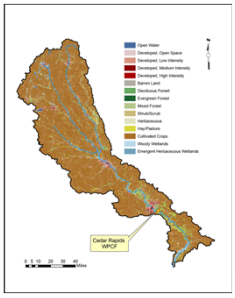
Water Environment Federation the water quality people

The Water Research Foundation

21

Workshop No. 3 Iowa Soybean Association and City of Cedar Rapids

- Both Nitrogen and Phosphorus
- Agricultural BMPs
- Nutrient Management from WRRF Agencies:
  - Treatment
  - Urban Stormwater
  - CSO/SSOs
- Drinking Water Impairment
  - Harmful Algal Blooms
- Regulatory and Implementation Strategies to Facilitate Nonpoint Source Partnerships



Water Environment Federation the water quality people

The Water Research Foundation

22

Task 3: Development of a Research Roadmap Based on Findings from Tasks 1 and 2

1. Policy
   - Holistic Watershed Perspective
     - Watershed-based Permitting
     - Trading and Offset Programs
2. Guidance
   - Permit Writer Guidance
   - Compendium of BMP Approaches and Tools
3. Regulations & Regulatory Tools
   - Integrated Planning
   - Adaptive Management Strategies

Water Environment Federation the water quality people

The Water Research Foundation

23

Topics and Discussion

- Delaware River Basin Water Quality and Management Implications - *Namsoo Suk*
- Philadelphia Water Department and River Wastewater Dischargers - *Adam Hendricks*
- Integrated Planning and Competing Interests in the Holistic Nutrient Management - *Trent Stober*
- Watershed Perspectives of Nutrient Management and Ongoing Nutrient Reduction Efforts in San Francisco Bay Area - *Mike Falk*
- Setting Criteria to Support Holistic Nutrient Management - *Dave Dilks*

Water Environment Federation the water quality people

The Water Research Foundation

24

Utility Panel Discussion

- Jason Cruz, Environmental Scientist, Philadelphia Water Department (PWD)
- Steve Hershner, Utilities Director, City of Cedar Rapids, Iowa
- Michael S. Connor, PhD, Retired Director of East Bay Dischargers Authority / Bay Area Clean Water Agencies (BACWA)
- Jeff Clarke, Commissioner, Mukilteo Water and Wastewater District, Washington

Water Environment Federation the water quality people

THE Water Research FOUNDATION

25

Topics for Discussion

Key Questions for Discussion

1. *What lessons learned from site-specific experiences are valuable?*
2. *What can be applied constructively in other locations?*
3. *What are the barriers to successful implementation of key lessons learned?*

Water Environment Federation the water quality people

THE Water Research FOUNDATION

26

Today's Speakers

Namsoo Suk
Delaware River Basin Commission

Adam Hendricks,
Philadelphia Water Department

Trent Stober, PE
HDR

Mike Falk, PhD, PE
HDR

Dave Dilks, PhD
LimnoTech

27

Namsoo Suk, PhD
Director, Science & Water Quality Management
Delaware River Basin Commission

28

Delaware River Basin Commission

Delaware River Basin Water Quality and Management Implications

Namsoo Suk, Ph. D.
Director, Science and Water Quality Management

Pre-Workshop Webcast on Holistic Approach
to Improved Nutrient Management
June 4, 2020

29

Delaware River Basin Commission

Federal interstate compact agency established in 1961:

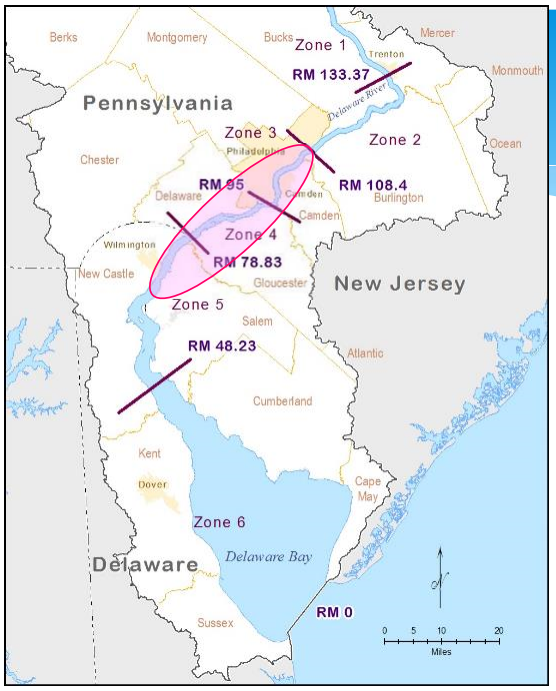
DRBC:

- Delaware
- New Jersey
- Pennsylvania
- New York
- Federal Government

Broad Responsibilities for:

- Water Supply
- Drought Management
- Flood Loss Reduction
- Water Quality (Pollution Control)
  - Establish Water Quality Standards
  - Monitoring & Assessment
  - Load Reductions
- Watershed Management
- Regulatory Review (Permitting)
- Outreach/Education
- Recreation

30



Delaware River Estuary

Water Quality Management Zones:

Zone 1: Non-tidal (Upstream from Trenton)

Estuary:

Zone 2 - 5: Tidal Delaware River

Zone 6: Delaware Bay

River Miles:

RM 0.0 = Atlantic Ocean

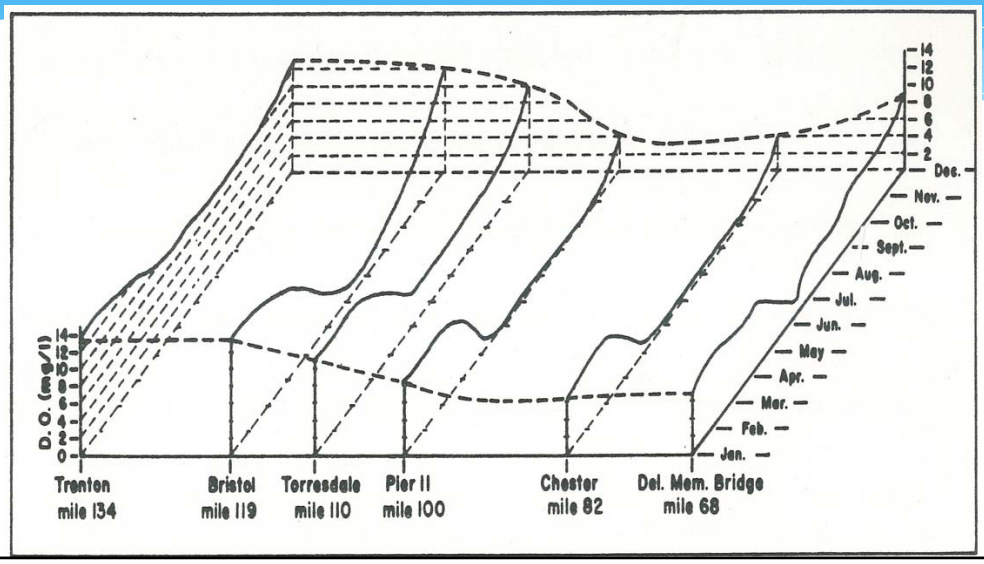
RM 70 = City of Wilmington

RM 100 = Ben Franklin Bridge, Philadelphia / Camden

RM 133 = "Head of Tide", Trenton, NJ

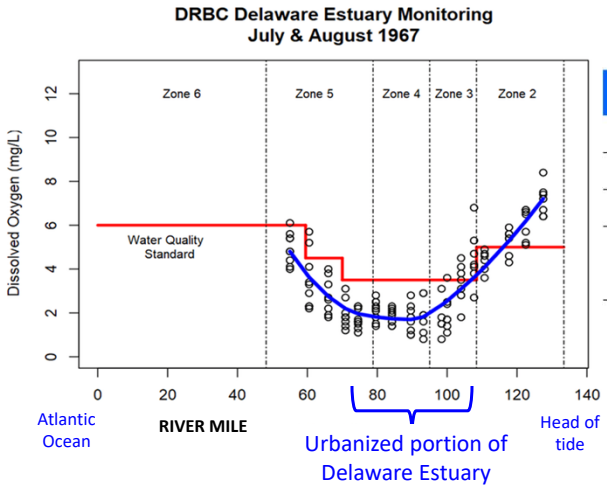
31

Delaware Estuary Dissolved Oxygen 1963



32

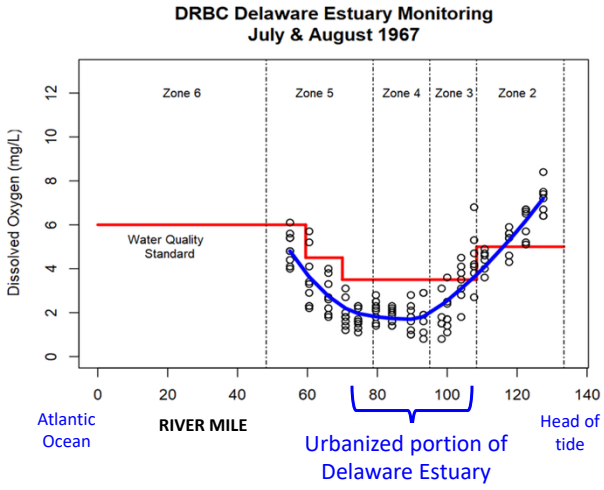
DRBC Aquatic Life Use and D.O. Criteria (1967)



Zone	River Mile	Aquatic Life Use	Migratory Fishes	24-hour average D.O. Criteria
2	108.4 – 133.4	maintenance and propagation of resident fish and other aquatic life	passage of anadromous fish	5.0 mg/l
3	95 – 108.4	maintenance of resident fish and other aquatic life	passage of anadromous fish	3.5 mg/l
4	78.8 – 95	maintenance of resident fish and other aquatic life	passage of anadromous fish	3.5 mg/l
5	70 – 78.8	maintenance of resident fish and other aquatic life	passage of anadromous fish	3.5 mg/l
	48.2 – 70	maintenance and propagation of resident fish and other aquatic life	passage of anadromous fish	4.5 – 6.0 mg/l
6	0 – 48.2	maintenance and propagation of resident fish and other aquatic life maintenance and propagation of shellfish	passage of anadromous fish	6.0 mg/l

33

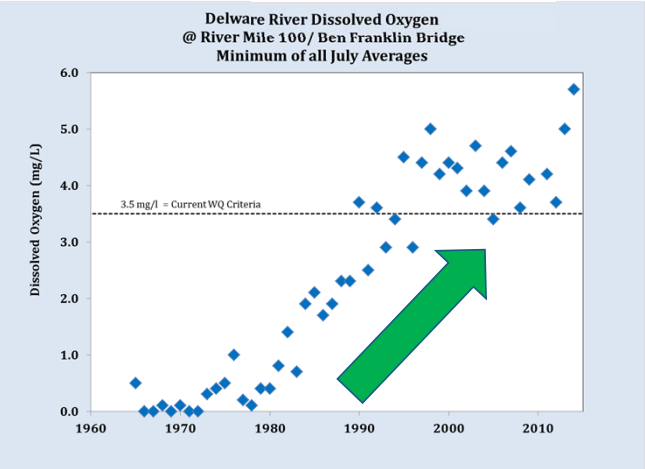
Dissolved Oxygen in Delaware Estuary



- DRBC issued CBOD wasteload allocations (WLAs) for Zones 2 – 5 in 1968
- Implementation of CBOD WLAs
  - Via DRBC's dockets (equivalent to NPDES permit)
  - Over 70 point source dischargers get CBOD effluent load limits with minimum required CBOD percent reduction
  - Secondary treatment added at wastewater treatment plants 70's & 80's – funding CWA
- By 2000's D.O criteria is nearly always met

34

DRBC Collaborative Results
Aquatic Life Benefits



- A dead zone in the Estuary restored.
- Significant improvement in dissolved oxygen.

News / Local News / Easton Area

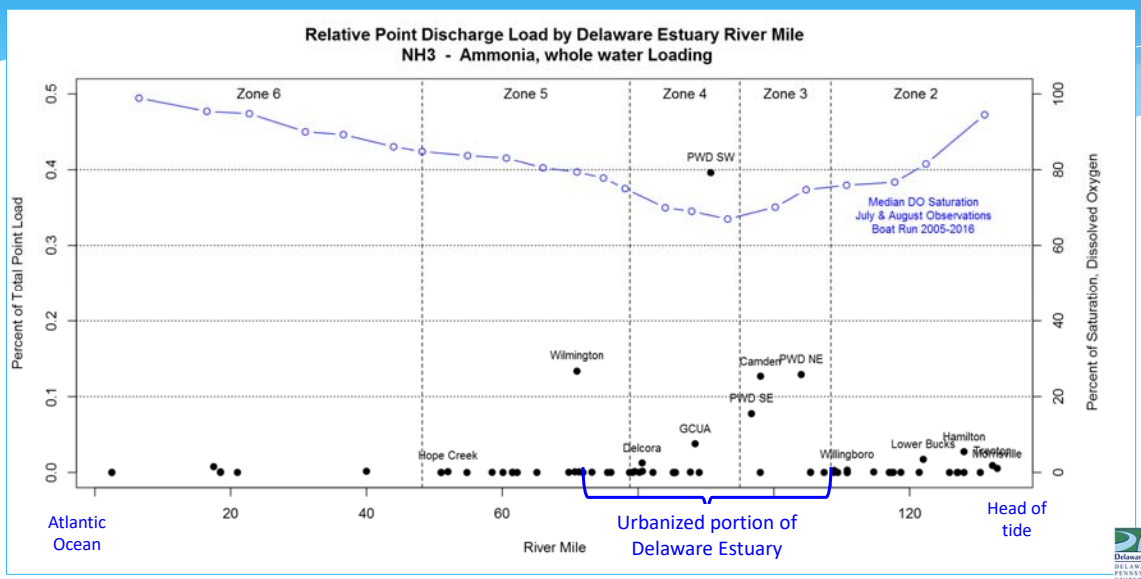
Shad making a big comeback in Delaware River

There's good news for one of N.J.'s most endangered fish

Updated Oct 28, 2017; Posted Oct 28, 2017

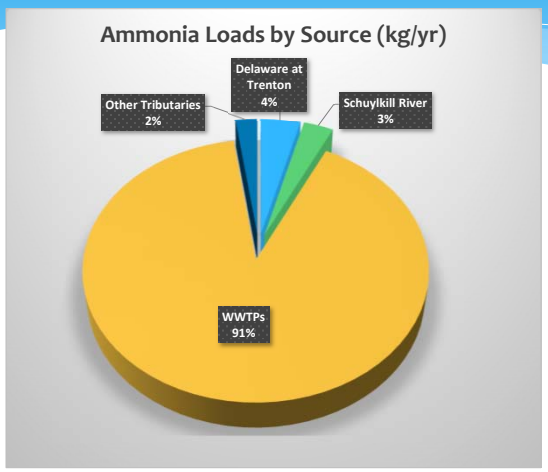
35

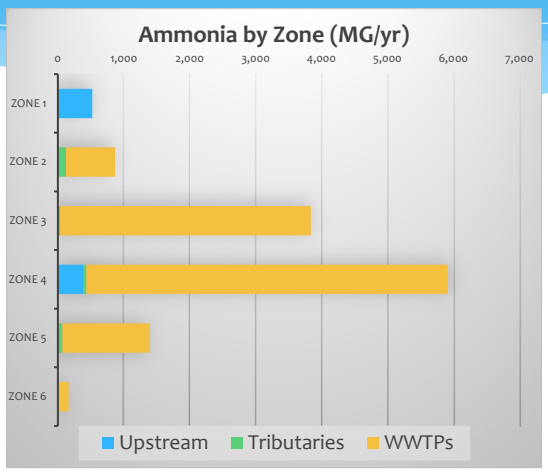
Dissolved Oxygen Sag and Ammonia-Nitrogen Loads



36

Ammonia-Nitrogen Loads in 2018 (draft)





37

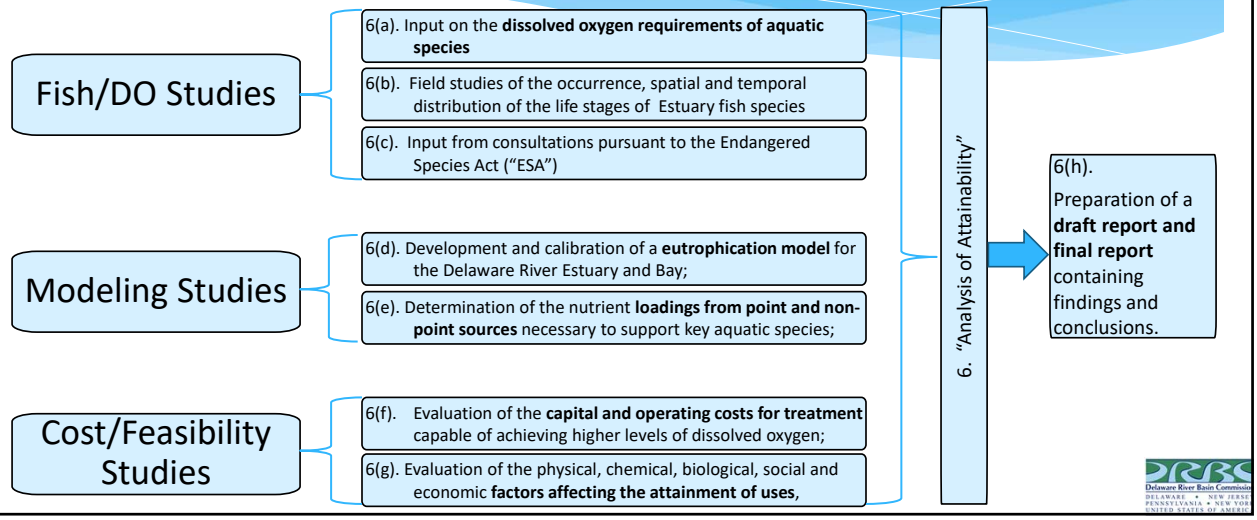
Resolution 2017-4

Adopted on September 13, 2017

- Shared achievement & goals
  - Significant improvement of water quality and aquatic life uses of Zones 3, 4 and upper Zone 5 since 1967
  - Continuous water quality improvement
    - ✓ DO early action Co-regulators' Workgroup
    - ✓ DO partnership lead by Philadelphia Water Department (PWD)
- Studies required before Rulemaking: 6(a) – 6(h).
- Recognition of DRBC's Water Quality Advisory Committee.
- Directs initiation of rulemaking to revise the designated aquatic life uses consistent with the results of the studies and the Clean Water Act.
  - Preparation of a draft attainability assessment within 3.5 years (March 2021).
  - Commission to issue a final rule and an implementation strategy within 6 years.

38

DRBC Resolution 2017-04
Studies Required Before Rulemaking



39

DRBC Actions

- Enhanced monitoring (2018-2019):
  - Point discharge monitoring
  - BoatRun to year-round
  - Added salinity at tidal boundaries
  - Added nitrate sensors at Trenton & Chester gages
  - Extensive tributary monitoring
  - Light extinction monitoring
  - Primary productivity study
- Dissolved Oxygen requirements for key sensitive species in the Delaware Estuary by ANSDU (https://www.nj.gov/drbc/library/documents/Review_DOreq_KeySensSpecies_DelEstuary_ANStoDRBCnov2018.pdf)
- Development a linked hydrodynamic and water quality model
- Treatability and cost evaluation

40

Engineering evaluation & cost estimate

- Contracted with Kleinfelder
- Planning level cost estimate for top 12 loading facilities to achieve new ammonia effluent levels
- Coordination with facilities
- Initiated summer 2018
- Final report by summer 2020

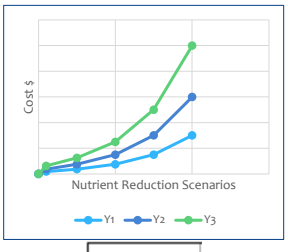
Effluent Level	Generic Conventional Activated Sludge Plant	Generic Pure Oxygen Activated Sludge Plant	Generic Fixed Film (RBC and TF) Plant
NH_3-N – 10 mg/L	Replace process air system, construct additional final clarifiers and modify RAS system	Add downstream BAF sized for approximately 50% of plant flow	Add downstream BAF sized for approximately 45% of plant flow
NH_3-N – 5 mg/L	Conversion to IFAS with medium level of media addition to aeration tanks	Add downstream BAF sized for approximately 75% of plant flow	Add downstream BAF sized for approximately 70% of plant flow
NH_3-N – 1.5 mg/L	Conversion to IFAS with high level of media addition to aeration tanks	Add downstream BAF sized for 100% of plant flow	Add downstream BAF sized for 100% of plant flow
TN – 4 mg/L	Conversion to IFAS with high level of media addition plus downstream DF	Add downstream BAF sized for 100% of plant flow plus DF	Add downstream BAF sized for 100% of plant flow plus DF

BAF = biological aerated filter
IFAS = integrated fixed film activated sludge
DF = denitrification filter
RAS = return activated sludge

41

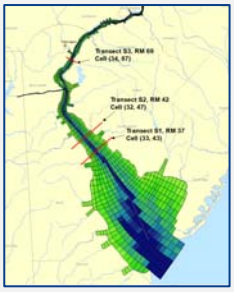
Elements of "Attainability Analysis"

Point Source Nutrient Reduction Cost Evaluation



Effluent Level
NH_3-N – 10 mg/L
NH_3-N – 5 mg/L
NH_3-N – 1.5 mg/L
TN – 4 mg/L

Hydro/WQ Model



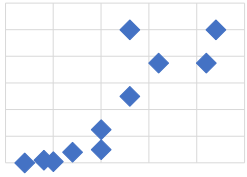
Refined Candidate Scenarios

? ? ? ?

How much would DO condition improve if:
- Each of the point source nutrient scenarios were implemented
- Tributary boundaries were reduced
- Nonpoint sources were reduced
- Various sources reduced

Increasing Cost $

Points Represent Hypothetical Scenarios



Increasing Dissolved Oxygen

Increasing Estuary Value

"Attainability"
- Natural condition
- Technological limitations
- Socioeconomic constraints and benefits

42

Stakeholder and Expert Input

Water Quality Advisory Committee	
Academia / Science	Stroud Water Research Center
Delaware	DNREC
Environmental Group	Delaware Riverkeeper Network
Watershed Organization	Wildlands Conservancy
National Parks Programs	National Park Service
New Jersey	NJDEP
New York	NYDEC
Pennsylvania	PADEP
Industry	Chemours and Exelon
Municipal	Philadelphia Water and City of Wilmington
US EPA	US EPA

Expert Panel for Estuary Model Development	
U.S. Army Corps of Engineers	Dr. Carl Cerco (Retired)
Rutgers University	Dr. Bob Chant
Tufts University	Dr. Steve Chapra
U.S. EPA Region 4	Tim Wool
LimnoTech (Technical consultant)	Dr. Vic Bierman

43

Contact Information

Namsoo Suk, Ph.D.

E-Mail: Namsoo.Suk@drbc.gov

Phone: (609) 477-7235

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

44

Adam Hendricks
Research Program Supervisor
Philadelphia Water Department

45

46

PHILADELPHIA WATER DEPARTMENT

OVERVIEW

1. PWD Background
2. Wastewater Facilities
3. Internal Nutrient Planning
4. DO Partnership
5. Key Takeaways

47

•Philadelphia Water Department Background

48

What Does PWD Do?

PWD provides integrated water, wastewater, and stormwater services

Drinking Water

Wastewater

Stormwater

Rehab & Replacement

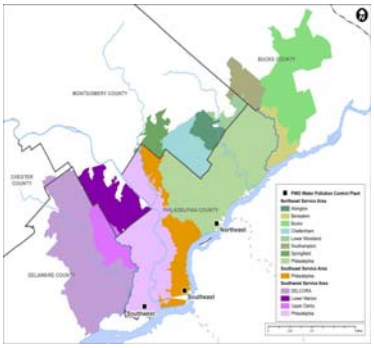
Delivery and Collection

Water Environment Federation the water quality people

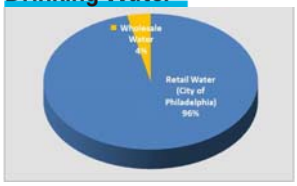
The Water Research Foundation

Capacity and Service

We are a regional service provider.
We predominantly serve Philadelphia,
but our capacity allows us to serve wholesale customers outside of city limits,
helping to keep rates low as possible.

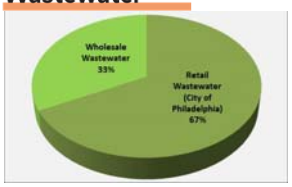


Drinking Water



Retail: 1.6 Million People
+ **Wholesale:** 1 Customer

Wastewater



Retail: 2.3 Million People
+ **Wholesale:** 10 customers

Water Environment Federation the water quality people

The Water Research Foundation

•PWD's Wastewater Treatment Facilities

51

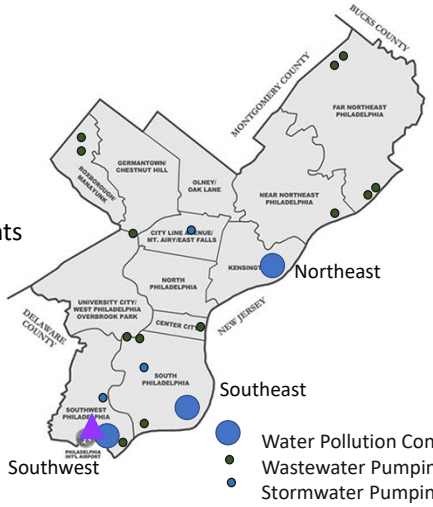
PWD's Wastewater Facilities

Collection System

- **3,716** miles of sewers
- **19** pumping stations

Treatment

- **3** water pollution control plants
- **~400 MGD** average flow
- Centralized biosolids handling facility



Water Environment Federation
the water quality people

The Water Research Foundation

52

Wastewater Master Plan

- First Edition Complete in 2016

5 Components

- Basic Data
- Wet Weather Capacity Improvements
- Asset Replacement Evaluation
- Planning for Future Regulations
- Moving Towards a Utility of the Future

Post-WWMP

- 6-month and 1-year progress updates on recommendations made

53

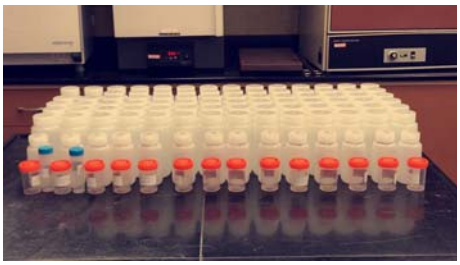
Major Drivers for Change to Wastewater Facilities

54

- Nitrogen Management Planning
  - BioWin Modeling
  - Sidestream Planning
  - Mainstream Planning

55

Wastewater Process Modeling



- There are various whole plant wastewater process models (Sumo, GPS-X, BioWin)
- Models can be developed using historical data
- Special sampling can help get a better model

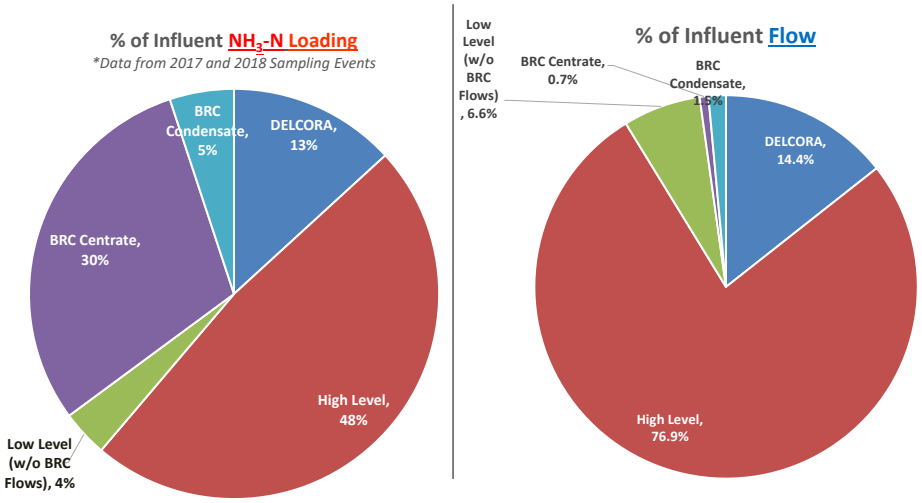
- PWD completed special sampling, calibration, and validation of the models of all three of our water pollution control facilities

Water Environment Federation
the water quality people

The Water Research Foundation

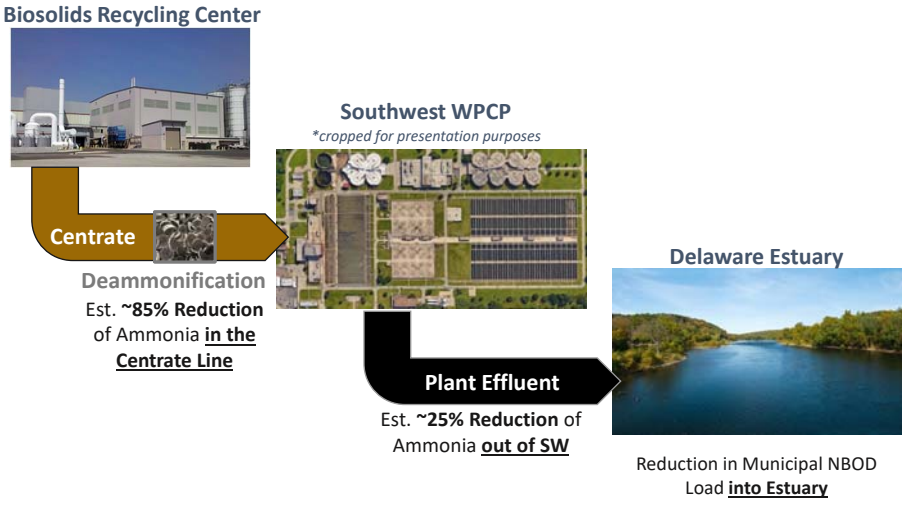
56

Sidestream Planning at SW WPCP



57

Sidestream Planning at SW WPCP



58

Sidestream Planning at SW WPCP

Sidestream Treatment by the Numbers:

- **Normalized cost: <$0.50/lb-NBOD-removed**
- **Reduction in PWD's (all 3 plants) NBOD Load: ~10%**

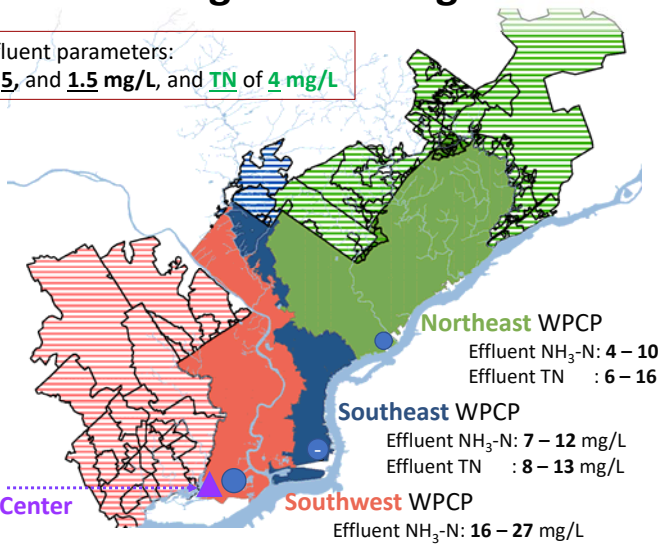
Water Environment Federation the water quality people

The Water Research Foundation

59

Mainstream Nitrogen Planning

*Targeted effluent parameters:
NH_3-N of **10**, **5**, and **1.5 mg/L**, and **TN** of **4 mg/L**



Northeast WPCP
Effluent NH_3-N: **4 – 10** mg/L
Effluent TN : **6 – 16** mg/L

Southeast WPCP
Effluent NH_3-N: **7 – 12** mg/L
Effluent TN : **8 – 13** mg/L

Biosolids Recycling Center

Southwest WPCP
Effluent NH_3-N: **16 – 27** mg/L
Effluent TN : **18 – 30** mg/L

Note: effluent level ranges are from 2014-March '19 data.

Water Environment Federation the water quality people

The Water Research Foundation

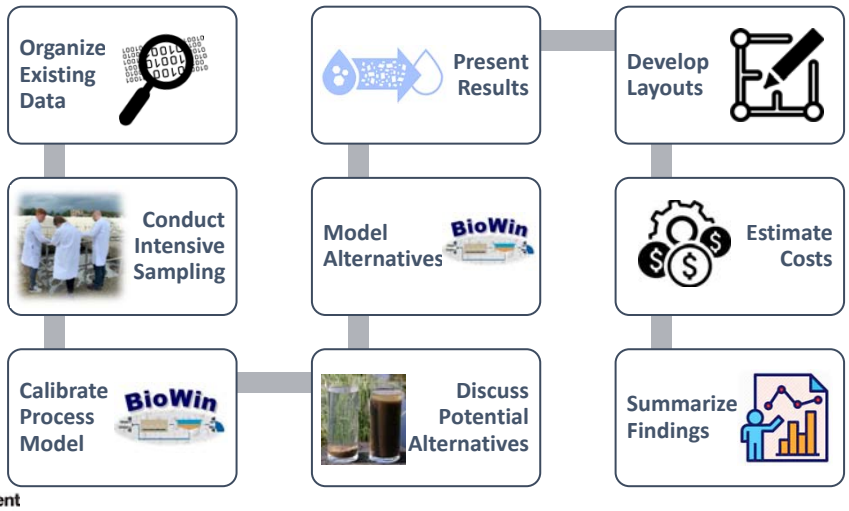
60

Mainstream Nitrogen Planning

- The WPCP evaluations used PWD's **process models** to assess the potential of **NH_3-N and TN reduction** through **both minor and major** infrastructure/process upgrades
- **External** (consulting) **teams** completed the technology screening, modeling evaluations, and cost estimate development
- **Internal teams** are developing a final matrix of options and executive level summary

61

Mainstream Nitrogen Planning

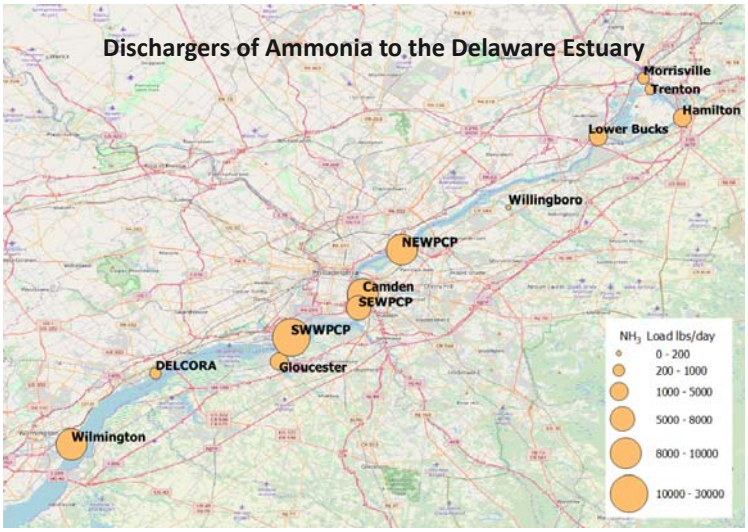


62

- Dissolved Oxygen Partnership

63

DO Partnership



Water Environment Federation
the water quality people

THE Water Research FOUNDATION

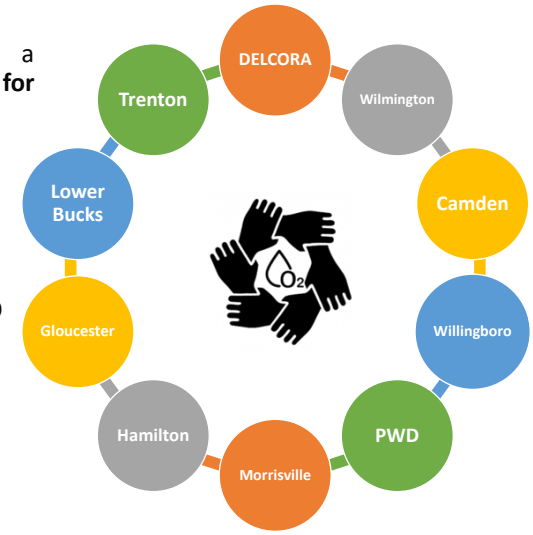
64

DO Partnership

The DO Partnership is a **collaborative framework for municipal dischargers**.

Mission: "To collaborate to improve DO in the Delaware Estuary."

- P&R has a contract with the DO Partnership Facilitator to:
  - Remain objective
  - **Convene** quarterly **meetings**
  - **Discuss** common interests and goals
  - **Present** on low-cost, science-based WWTP-related alternatives



Water Environment Federation
the water quality people

The Water Research Foundation

65

•Key Takeaways

66

Key Takeaways

- Planning for major nutrient management strategies can be an important first step.
- Process modeling can be a helpful tool to evaluate plant alternatives.
- Development of regional partnerships can help to share information and coordination efforts.
- Look for optimizations alternatives first, sidestream opportunities, and then major process upgrades.

Water Environment Federation the water quality people

The Water Research Foundation

67

Next Steps for PWD

- Complete mainstream nitrogen analyses for all three plants (~90% complete)
- Analyze all options for best alternatives to reduce combined NBOD load to the estuary
- Start pilot program to evaluate new/emerging nutrient management technologies
- Build sidestream facility (Bid Year 2023)

Water Environment Federation the water quality people

The Water Research Foundation

68

- Thank You!

69

Trent Stober, PE
HDR

70

Competing Demands in Holistic Nutrient Management and Role for Integrated Planning

A Pre-Workshop Webcast

March 19, 2020

Water Environment Federation
the water quality people

The Water Research Foundation

71

National Water Quality Events and Trends Indicate Nearing Tipping Point

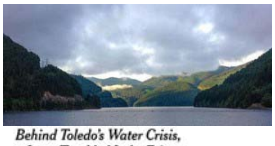
Water Environment Federation
the water quality people

The Water Research Foundation

72

Algae in the News

- West Coast – Detroit Reservoir & City of Salem
  - Oregon Governor Deploys National Guard, Declares Salem Water Situation Emergency (OPB, 5/31/2018) – bottled water/portable water tanks
  - Detection of low levels of cyanotoxins in drinking water supply
- Midwest – Lake Erie & City of Toledo (August 2014)
  - 500,000 residents under water advisory after toxins detected in water supply
  - State of Ohio declares western Lake Erie as impaired (2018)
- East Coast – James River (VA) & NY State
  - James River – freshwater blue-green & marine dinoflagellate blooms
  - Upstate NY lake blue-green blooms & Long Island marine blooms



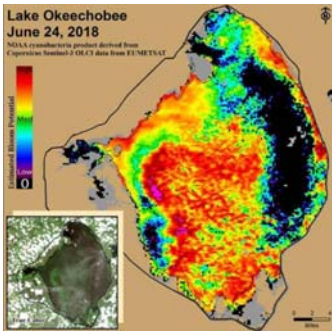
Behind Toledo's Water Crisis, a Long-Troubled Lake Erie

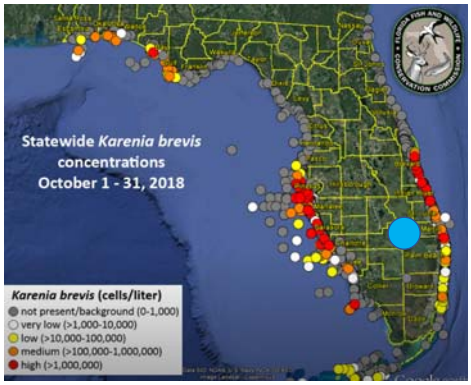
Water Environment Federation the water quality people

The Water Research Foundation

73

Florida Experiencing Chronic Red Tide and Harmful Algal Blooms





Water Environment Federation the water quality people

The Water Research Foundation

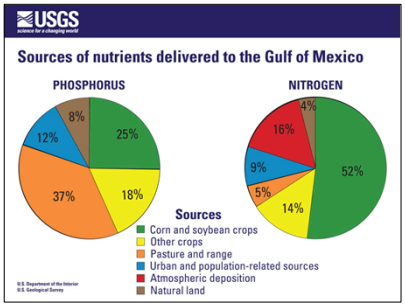
74

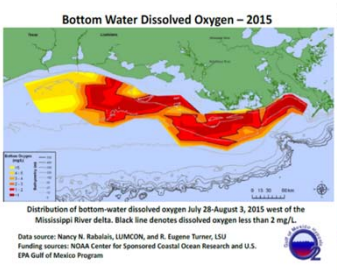
Washington Governor's Orca Task Force

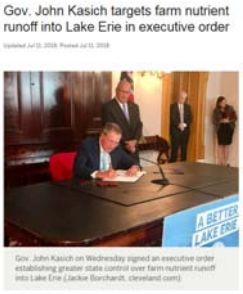
Endangered Species: Orcas and Chinook Salmon
Puget Sound Food Web

75

Central United States Water Resource Impacts

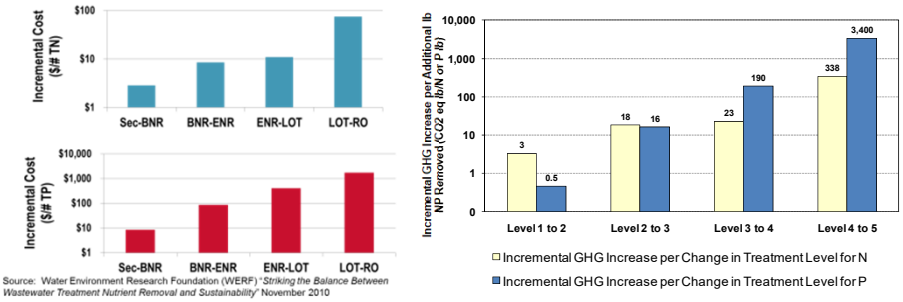






76

Nutrient Removal is Complicated by Increasing Incremental Costs and Environmental Tradeoffs



Source: WRF, Striking the Balance Between Wastewater Treatment Nutrient Removal and Sustainability, November 2010

77

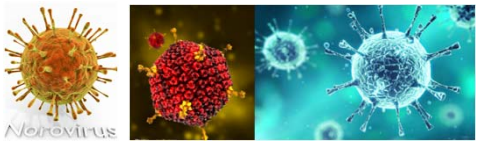
Holistic Nutrient Management Balanced with All Community Drivers

- Regulatory Drivers
- Operational Drivers
- Financial Drivers

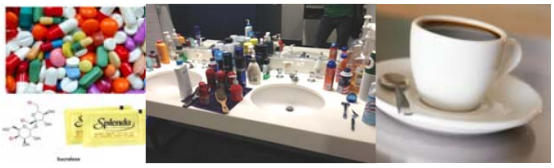
78

Holistic Nutrient Management Needs Consideration of Emerging Regulatory Drivers

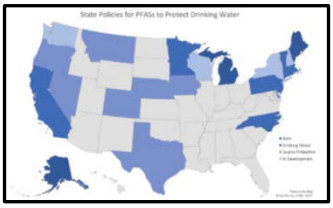
Coliphage Recreational Criteria



Contaminants of Emerging Concern



PFAS



Source: AWWA Per- and Polyfluoroalkyl Substances (PFAS)

Water Environment Federation the water quality people

The Water Research Foundation

79

Operational Drivers

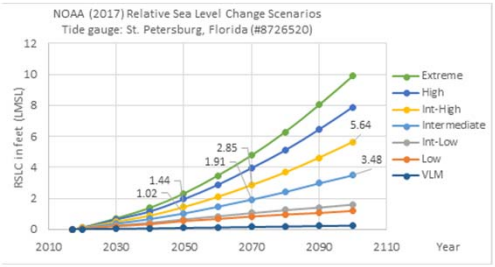
- Asset Management & Aging Infrastructure
- Community Growth
- System Capacity
- System Maintenance
- Sustainable Management - Resiliency

Water Environment Federation the water quality people

The Water Research Foundation

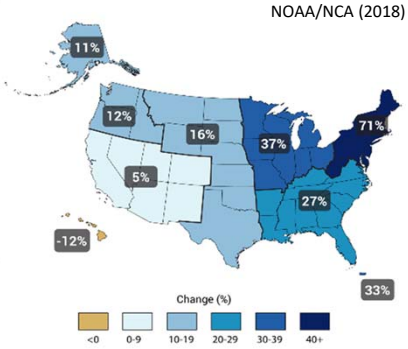
80

Climate Uncertainty Increases Utility Risk to Infrastructure Impacts



Observed Changes in Very Heavy Precipitation
(1% of all daily events).for POR 1958 - 2012

NOAA/NCA (2018)

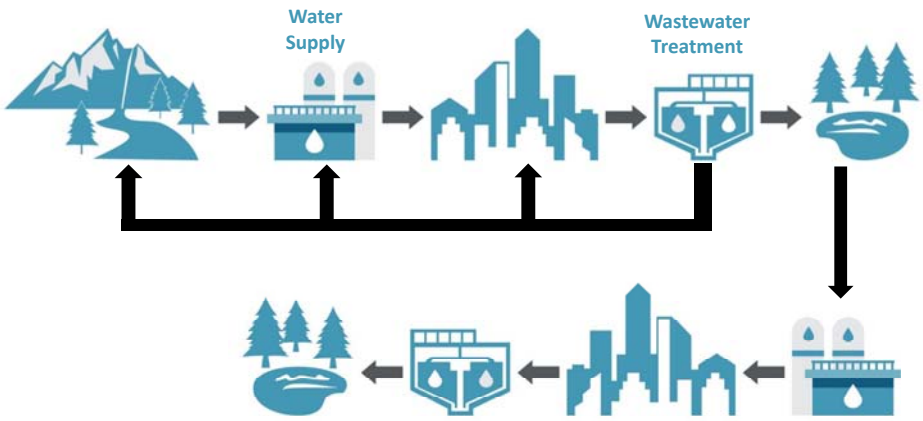


Water Environment Federation
the water quality people

The Water Research Foundation

81

Evolving Approach to Water Infrastructure Planning



Water Environment Federation
the water quality people

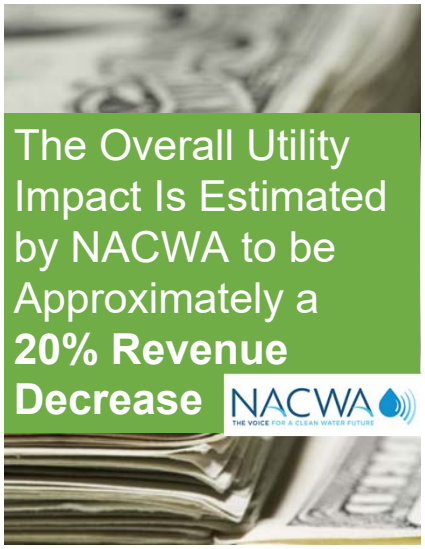
The Water Research Foundation

82

Financial Drivers

- Continued Growth and Economic Development
- Need for Public Support of Infrastructure Investment
- Economic Revitalization/Partnerships
- Bonding Capacity & Financing
- Funding – Connection fees, rates, etc.

COVID-19 Impacts



Water Environment Federation the water quality people

The Water Research Foundation

83

Federal Clean Water Act Amendment Codifies Integrated Planning

- Integrated Planning
  - Permit Compliance Schedules for Multiple Terms
  - Enforcement Action Implementation
  - Report to Congress on Integrated Plans
- Municipal Ombudsman
- Green Infrastructure
- Savings/Transition Provisions


One Hundred Fifteenth Congress
of the
United States of America

Water Environment Federation the water quality people

The Water Research Foundation

84

Meet Jamie Piziali
EPA's First Municipal Ombudsman

- Appointment Announced March 16, 2020
- 14-Year EPA Career
- NPDES Permit Program
- Led Green Infrastructure Program

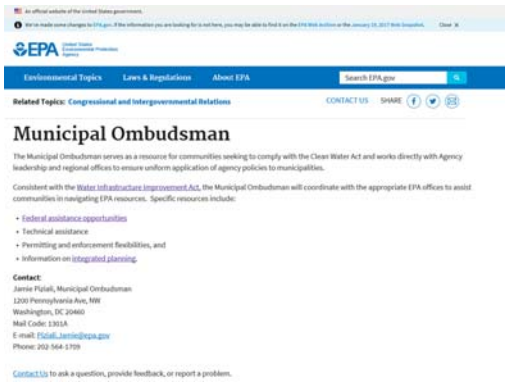
www.epa.gov/ocir/municipal-ombudsman

#EPAat50

85

Office of Municipal Ombudsman Priorities

- Impartial resource to assist with CWA Programs
- Coordination with Regional Offices for national consistency
  - Financing Assistance
  - CWA Flexibilities
  - Integrated Planning Opportunities
- Outreach to Clean Water Partners
- Web presence



www.epa.gov/ocir/municipal-ombudsman

#EPAat50

86

Integrated Planning Framework Provides Opportunity to Frame Holistic Nutrient Management Strategies

- Voluntary
- Optimized
- Prioritized
- Affordable

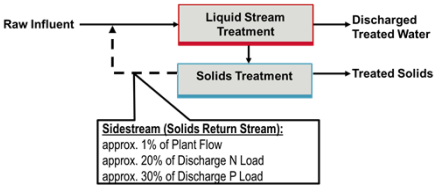
Water Environment Federation the water quality people

The Water Research Foundation

87

Holistic Nutrient Management Approach through Integrated Planning

- Develop Understanding of Holistic Utility Needs
  - Knowns
  - Known Unknowns
  - Unknown Unknowns
- Prioritize Low Hanging Fruit at Facilities
  - Address Existing Process Issues
  - Provide Multiple Process Benefits
  - Implement Cost-Effective First Steps
- Look Outside the Fence
  - Multi-Benefit Stormwater Investments
  - Watershed Management Opportunities



DEMON® Reactor at Strass WWTP

Water Environment Federation the water quality people

The Water Research Foundation

88

Holistic Nutrient Management Approach through Integrated Planning

- Develop Understanding of Holistic Utility Needs
  - Knowns
  - Known Unknowns
  - Unknown Unknowns
- Prioritize Low Hanging Fruit at Facilities
  - Address Existing Process Issues
  - Provide Multiple Process Benefits
  - Implement Cost-Effective First Steps
- Look Outside the Fence
  - Multi-Benefit Stormwater Investments
  - Watershed Management Opportunities

Water Environment Federation the water quality people

The Water Research Foundation

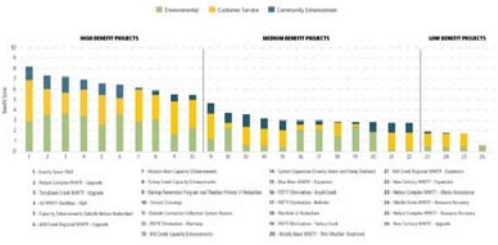
89

Holistic Nutrient Management Approach through Integrated Planning

- Schedule Long-Range Nutrient Reduction Investments Considering all Utility Needs
  - Asset Management
  - Resource Recovery
  - Stormwater & Resiliency
  - One Water Opportunities

Process

- Scout Evolving Technology
- Establish & Measure Key Performance Indicators
- Learn from Successes and Implementation



Triple Bottom Line Approach to Prioritization

Nereda® Reactor at Gamerwolde WWTP

Water Environment Federation the water quality people

The Water Research Foundation

90

Mike Falk, PhD, PE
HDR

91

THE Water Research FOUNDATION

HDR

LimnoTech

UNIVERSITÉ LAVAL

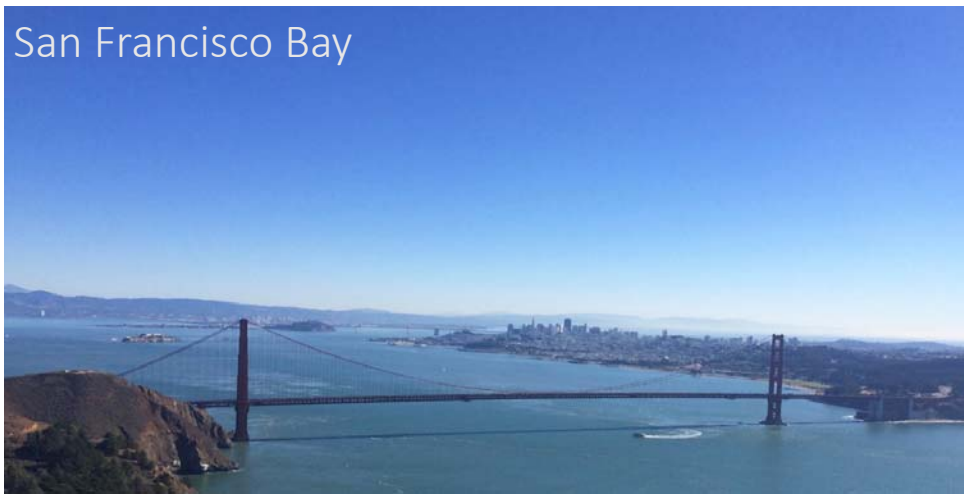
BACWA BAY AREA CLEAN WATER AGENCIES

The Bay Area Nutrient Mgmt Experience: A Coordinated Effort across 37 WRRFs

Mike Falk, HDR

92

San Francisco Bay



Nutrient Enriched, but Not Exhibiting Typical Problems

93

WRRFs: Largest Source of Nutrient Loads

BACWA BAY AREA CLEAN WATER AGENCIES

BACWA is a joint powers authority formed by the five largest Bay Area Water Resource Recovery Facilities (WRRFs)

94

Working Together for Practical Regulation

BACWA
(wastewater utilities)

Water Boards
Regional Water Board
(regulatory)

SFEI AQUATIC SCIENCE CENTER
San Francisco Estuarine Institute
(science)

SAN FRANCISCO BAYKEEPER
Non-Govt Organizations
(NGOs)

The approach in the Bay Area for managing nutrients has received national attention and lauded for its collaboration, as evidenced by receipt of a National Environmental Achievement Award in 2019 from the National Association of Clean Water Agencies (NACWA). NACWA is the nationally recognized leader in legislative, regulatory, and legal clean water advocacy.

National Environmental Achievement AWARDS

Water Environment Federation the water quality people

The Water Research Foundation

95

1st Nutrients Watershed Permit 2014

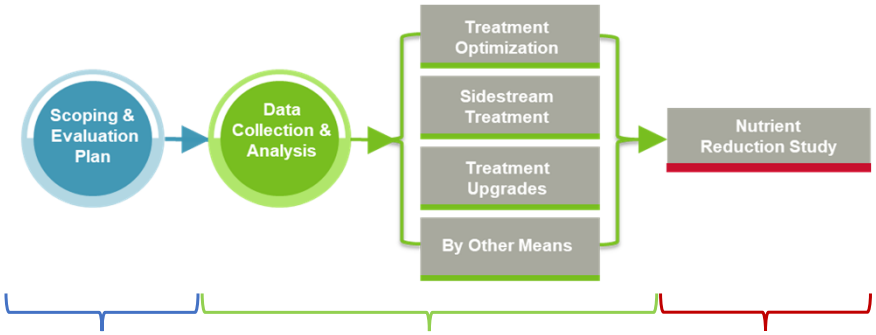
- NO LOAD CAPS
- SUPPORT FOR SCIENCE (Baywide Model)
- GROUP REPORTING
- REGIONAL STUDY

Water Environment Federation the water quality people

The Water Research Foundation

96

Approach to Regional Study



Approved in Feb 2015

Data Collection: Spring 2015
Site Visits: Spring – Fall 2015
Final Plant Reports: 2017/2018

Summer 2018

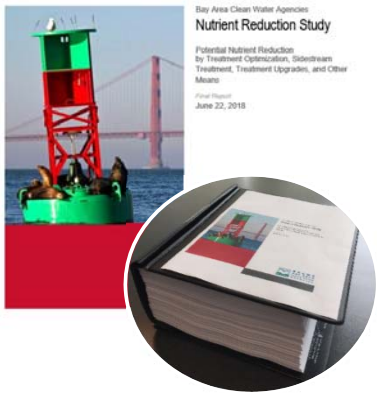
97

Regional Study Treatment Levels

Level	Study	Ammonia	TN	TP
Level 1	Optimization / Sidestream	--	--	--
Level 2	Upgrades	2 mg N/L	15 mg N/L	1.0 mg P/L
Level 3	Upgrades	2 mg N/L	6 mg N/L	0.3 mg P/L

98

Regional Study Key Outcomes



Strategy	TN Load Reduction to the Bay	TP Load Reduction to the Bay	Total Present Value ($ Mil)
Optimization	7%	34%	$266 M
Sidestream	19%	12%	$766 M
Upgrade Level 2	57%	59%	$9.4 B
Upgrade Level 3	82%	88%	$12.4 B

Water Environment Federation the water quality people

The Water Research Foundation

99

Regional Study Key Observations

1. Treatment upgrades come with significant cost
2. Nutrient reduction results in:
   - Increase in energy and chemical demands
   - Increase in greenhouse gas emissions
   - Reduction in chemicals of emerging concern discharged to the Bay
   - Reduction in solids produced at treatment plants
3. Each plant is unique and the costs vs. nutrient reduction potential are wide ranging. The information in this study provides a menu to optimize the tradeoffs between costs and nutrient reduction.

Water Environment Federation the water quality people

The Water Research Foundation

100

2nd Nutrients Watershed Permit 2019

NO LOAD CAPS	INCREASED SUPPORT FOR SCIENCE
REGIONAL STUDIES: *1) Recycled Water and 2) Nature Based Solutions*	RECOGNIZES EARLY ACTORS

Water Environment Federation the water quality people

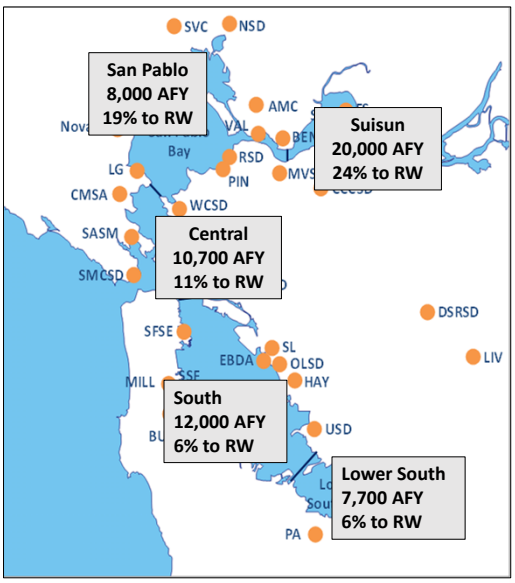
The Water Research Foundation

101

Current Recycled Water Quantities

- ~6% of Baywide plant effluent goes to recycled water
- Recycled water is expected to double by 2035
- The primary application is industrial (~40%)

6% Baywide Flow Reduction ≠ 6% Baywide Load Reduction



Water Environment Federation the water quality people

The Water Research Foundation

102

Nature Based Solutions Concept: Horizontal Levee Has Received Considerable Attention

Technology Benefits:

- Nutrient Reduction
- Addresses Sea Level Rise
- Habit Restoration

Background: https://youtu.be/OHt7qtI1kso

Horizontal Levees are Currently being Considered for Upwards of 5 Site Locations Across the Bay

Water Environment Federation the water quality people

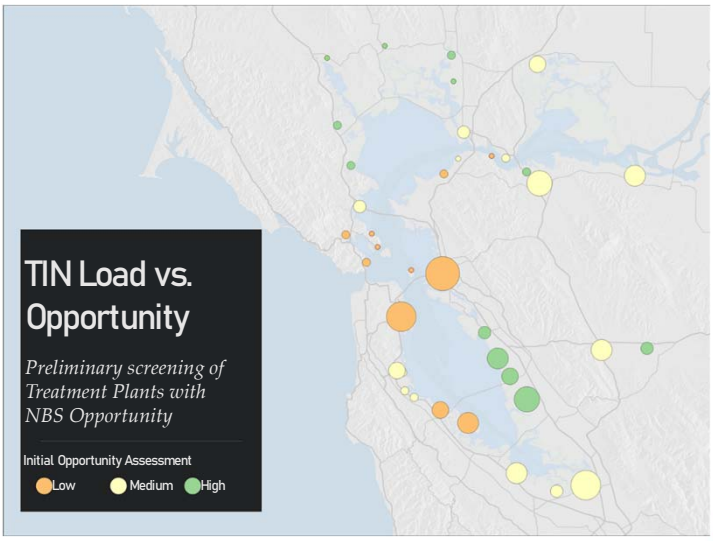
The Water Research Foundation

103

Nature Based Solutions Potential Sites and Benefits

Environmental Benefits:

- Nutrient Reduction
- Addresses Sea Level Rise
- Habit Restoration



Water Environment Federation the water quality people

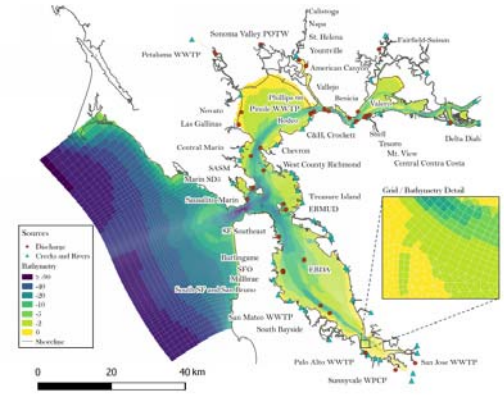
The Water Research Foundation

104

Key Take Aways for Others to Consider

1. Get the Loads Right
2. Collaboration is Key
3. Produce Unit Metrics

   (e.g., $/lb nutrient removed)
4. Incentivize Early Adopters
5. Water Quality Response



Baywide Model Developed by SFEI for Advancing the Science

SFEI | AQUATIC SCIENCE CENTER

SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

Water Environment Federation the water quality people

The Water Research Foundation

105

Dave Dilks, PhD
LimnoTech

Water Environment Federation the water quality people

The Water Research Foundation

106

Setting Criteria to Support Holistic Nutrient Management

WRF Pre-Workshop Webcast

David Dilks, Ph.D.
LimnoTech, Ann Arbor MI

107

Outline

- Survey of nutrient criteria development
- Options for developing nutrient ~~criteria~~ targets
- Site-specific approaches and holistic nutrient management

108

Nutrient Criteria (and Targets)

- At what level do we need to limit nutrients to maintain acceptable water quality?
  - Process should be straightforward, criteria exist for countless other pollutants
- Progress in setting criteria has been slow
  - 1995: National Nutrient Assessment Workshop
  - 1998: EPA Numeric Nutrient Strategy
  - 2001: Guidance for developing nutrient criteria plans
  - 2009: An Urgent Call to Action
  - 2011: Reaffirmed commitment
  - 2016: Renewed Call to Action

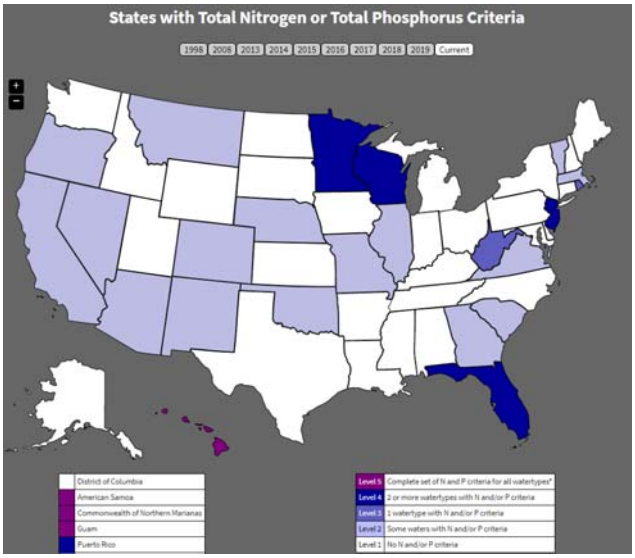
Water Environment Federation the water quality people

The Water Research Foundation

109

Current Nutrient Criteria Status

- Only one State has a complete set of nutrient criteria for all water body types
- The majority of States have no numeric nutrient criteria whatsoever



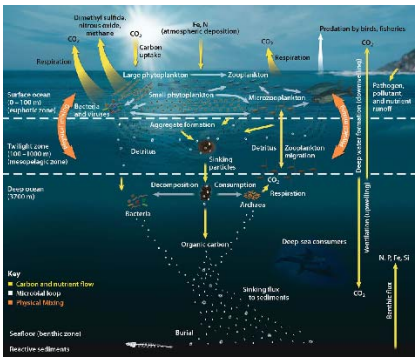
Water Environment Federation the water quality people

The Water Research Foundation

110

Why Has Nutrient Criteria Development Taken So Long?

- The relationship between nutrients and water quality is complicated
  - Multiple potential endpoints
    - Hypoxia, harmful algal blooms, biotic indices, aesthetics
  - Many endpoints contain multiple levels of relationships
    - Nutrients -> algae -> cyanotoxins



- Response to nutrients strongly depends on site-specific factors
  - Hydrology, temperature, water clarity, shading, habitat

Water Environment Federation the water quality people

The Water Research Foundation

111

Approaches for Developing Numeric Nutrient Criteria

- EPA has defined three categories of approaches for developing numeric nutrient criteria

1. Reference condition approach
2. Empirical stressor-response analysis
3. Process-based (mechanistic) modeling

Water Environment Federation the water quality people

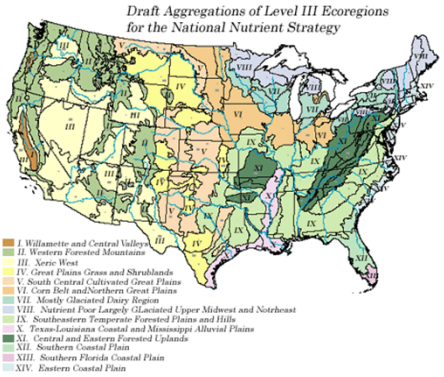
The Water Research Foundation

112

Approaches for Developing Numeric Nutrient Criteria

- EPA has defined three categories of approaches for developing numeric nutrient criteria

1. Reference condition approach
   - Set criteria at levels consistent with those observed in relatively pristine (i.e. "reference") water bodies
   - Potentially overly stringent, as it doesn't consider the threshold where impairment begins



Water Environment Federation the water quality people

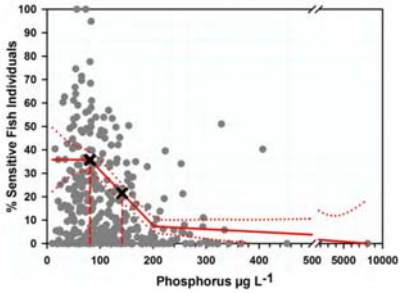
The Water Research Foundation

113

Approaches for Developing Numeric Nutrient Criteria

- EPA has defined three categories of approaches for developing numeric nutrient criteria

1. Reference condition approach
2. Empirical stressor-response analysis
   - statistical relationships between ambient nutrient concentrations and the response variable across many sites



Water Environment Federation the water quality people

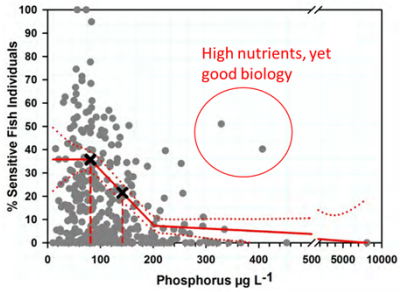
The Water Research Foundation

114

Approaches for Developing Numeric Nutrient Criteria

- EPA has defined three categories of approaches for developing numeric nutrient criteria

1. Reference condition approach
2. Empirical stressor-response analysis
   - statistical relationships between ambient nutrient concentrations and the response variable across many sites

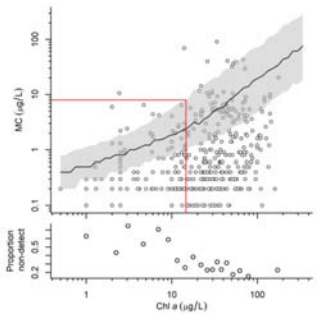


115

Approaches for Developing Numeric Nutrient Criteria

- EPA has defined three categories of approaches for developing numeric nutrient criteria

1. Reference condition approach
2. Empirical stressor-response analysis
   - draft nutrient criteria guidance recently released for lakes

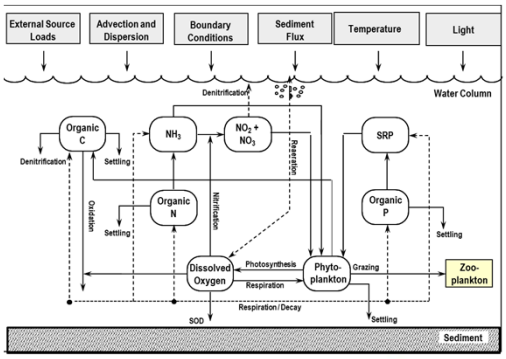


116

Approaches for Developing Numeric Nutrient Criteria

- EPA has defined three categories of approaches for developing numeric nutrient criteria

1. Reference condition approach
2. Empirical stressor-response analysis
3. Process-based (mechanistic) modeling
   - Describe systems using process-based load-response models
   - Links nutrient load to endpoints of concern
   - Calibrated to site-specific conditions



117

Nutrient Criteria/Targets and Holistic Approaches

- Of the three methods, mechanistic models are best suited to support holistic approaches
  - Specification of maximum ambient nutrient concentrations limits flexibility
    - Locally elevated nutrient concentrations may cause no problems
  - Allows targets to set for allowable loads, rather than ambient nutrient concentrations

- Reference condition and stressor-response approaches are better suited for widespread application across large numbers of water bodies

118

WRF Has Been Providing Guidance on More Rigorous Methods for Nutrient Targets

- EPA has developed guidance for developing nutrient criteria using the reference condition and stressor-response approaches
- Similar guidance has not been available for the process-based modeling approach
  - Lack of guidance can serve as an impediment for more rigorous approaches being taken
- Recent WRF projects were designed to provide such guidance

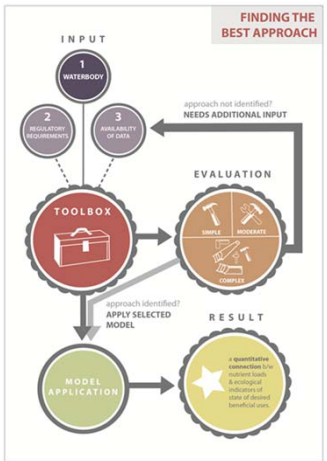
Water Environment Federation the water quality people

The Water Research Foundation

119

WRF Research on Site-Specific Nutrient Targets

- LINK1T11
  - Developed Toolbox of 30 potentially applicable models for setting nutrient targets
  - Developed a Model Selection Decision Tool



Process-based Models

- AQUATOX
- AT2K
- BATHTUB
- BLTM/QUAL2E
- CE-QUAL-ICM
- CE-QUAL-RIV1
- CE-QUAL-W2
- ECOMSED/RCA
- EFDC/HEM-3D
- EFDC-A2EM
- EPD-RIV1
- HEC-RAS
- HSPF
- LAKE2K
- LSPC
- PHOSMOD
- QUAL2E
- QUAL2K
- QUAL2KW
- SWAT
- SWMM
- TPWQM
- WARMF 6.1
- WASP5
- WASP7

Water Environment Federation the water quality people

The Water Research Foundation

120

WRF Research on Site-Specific Nutrient Targets

- LINK3R16
  - Guidance on defining how much data are needed to support a site-specific model for setting nutrient targets
  - Methods to estimate uncertainty in model predictions

Category	Data Requirements for Larger, Deeper Rivers
Model Forcing Functions	
Spatial Coverage	Monitoring station(s) at upstream boundary (or boundaries, for a branched system). Monitoring station at each tributary or point source that the scoping model indicates will change instream concentration of any state variable of concern by more than a predetermined amount (e.g., 1%). If economically feasible, samples above and below the mixing zone of major inputs should be collected.
Temporal Frequency	Sufficient frequency to capture any important temporal variability in forcing functions. If no watershed model is available defining tributary loading over time, sampling should include sufficient number of wet weather events to allow development of a regression between loa and tributary flow.
Temporal Extent	Seasonal, beginning early enough to capture the nutrient loads that contribute to the impairment and of sufficient duration to capture all environmental impairments of concern
Sampling Parameters	All nutrient forms and organic carbon represented as state variables in the selected model framework. Dissolved oxygen, temperature, flow, suspended solids, conductivity. Flow, either directly measured or from a nearby gaging station.
Ambient Calibration Data	
Spatial Coverage	Stations located with sufficient resolution to capture any significant (e.g., >10% change) gradient in important state variables as predicted by the scoping model. Stations located no more than 0.5 days travel time apart in absence of spatial gradients. Additional stations located corresponding to any significant resource areas of concern.
Temporal Frequency	Sufficient to capture any important temporal variability in ambient conditions: • Continuous dissolved oxygen and pH, if these are endpoints of concern. Sufficient resolution to capture any significant (e.g., >20% change) temporal gradient in important state variables as predicted by the scoping model.
Sampling Parameters	All state variables considered by the model. Secchi depth.
Number of Events	Minimum of two years, with at least one year representative of critical (or near critical) environmental conditions.
Key Processes	
	Sediment oxygen demand, if dissolved oxygen is an endpoint of concern. Sediment nutrient flux, if sediment feedback is believed to contribute to the impairment.

Water Environment Federation the water quality people

THE Water Research FOUNDATION

121

Potential Benefits of Site-Specific Nutrient Targets

- Spokane River/Lake Spokane example
  - Water quality standard expressed as “no decrease in dissolved oxygen > 0.2 mg/l”
  - Site-specific water quality model developed for TMDL that linked P loads -> algae -> dissolved oxygen
- Presence of model has allowed many innovative “trades”
  - Within a facility over time
  - Within a facility between pollutants
- Bubble permit between facilities now in development

Water Environment Federation the water quality people

THE Water Research FOUNDATION

122

Challenges Facing Holistic Approaches with Respect to Nutrient Targets

- Cost and time for data collection to support models
- Varying acceptance of site-specific approaches across States
- Requirements for a water quality criterion specific to nutrients

123

Challenges Facing Holistic Approaches with Respect to Nutrient Targets

- Cost and time for data collection
  - If it was easy and inexpensive to develop site-specific models, there would be a lot more of them
- Varying acceptance of site-specific approaches across States
- Requirements for a water quality criterion specific to nutrients

124

Challenges Facing Holistic Approaches with Respect to Nutrient Targets

- Cost and time for data collection
- Varying acceptance of site-specific approaches across States
  - Some States readily accept the use of site-specific nutrient targets
  - Others do not

Development of Type III Site Specific Alternative Criteria for Nutrients

FDEP Bureau of Assessment and Restoration Support

- Requirements for a water quality criterion specific to nutrients

Water Environment Federation the water quality people

The Water Research Foundation

125

Challenges Facing Holistic Approaches with Respect to Nutrient Targets

- Cost and time for data collection
- Varying acceptance of site-specific approaches at a State-specific level
- Requirements for a water quality criterion specific to nutrients
  - Site-specific approaches can be used to set numeric nutrient criteria, but it gets messy
  - Better to express the criterion in terms of the environmental endpoint of concern, control nutrient loads

Water Environment Federation the water quality people

The Water Research Foundation

126

Summary

- The most commonly used approaches for setting numeric water quality targets have some serious limitations
- Site-specific approaches exist that provide flexibility for innovative holistic management, but…
  - They require a significant amount of data
  - They may require regulators to step out of their comfort zone

127

Today's Panelists

Jason Cruz
Philadelphia Water Department

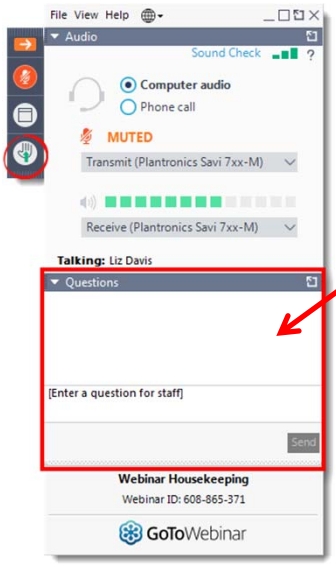
Steve Hershner
City of Cedar Rapids, Iowa

Jeff Clarke
Mukilteo Water and Wastewater District, Washington

Michael S. Connor, PhD
Retired Director of East Bay Dischargers Authority/BACWA

128

Time for Questions



Your Participation

- Please continue to submit your text questions and comments using the Questions panel.

Note: Today's presentation is being recorded and will be available shortly after today's webcast.

Water Environment Federation the water quality people

The Water Research Foundation

129

Thank You

Water Environment Federation the water quality people

The Water Research Foundation

130