

NPDES Systems – Nutrient Limitations and Impact on Water Quality

CSEAO Summer Conference
June 3, 2019

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Today's Discussion

- A. Clean Water Act Water Quality Standard Overview
- B. Ohio's Nutrient Water Quality Standards
- C. Ohio's NPDES Limitation Process
- D. 2018 Statewide Nutrient Mass Loading Report

A - Water Quality Standards (WQS) Overview



- Who Establishes WQS
- What are WQS

Who sets WQS?

- U.S. EPA publishes national recommendations
- States establish standards under the Clean Water Act
- U.S. EPA must approve State standards
- U.S. EPA must propose and promulgate federal standards for States that fail to adopt standards that meet CWA requirements

What are WQS?

- Statement of how clean we want our waters-
three elements
 - Use Designations
 - Water supply, recreation, fish and wildlife
 - Criteria
 - **narrative** and **numeric criteria and values** derived from methods described in rule
 - Antidegradation
- Found in Ohio Administrative Code 3745-1

Use Designations

Defined in 3745-1-07;

Assigned in 3745-1-08 to -32

- **Aquatic Life**
 - Warmwater
 - Exceptional warmwater
 - Modified warmwater
 - Seasonal salmonid
 - Coldwater
 - Limited resource water
- **Water Supply**
 - Public
 - Agricultural
 - Industrial
- **Recreation**
 - Bathing waters
 - Primary contact
 - Secondary contact

Table 9-1. Use designations for water bodies in the Scioto river drainage basin.

Water Body Segment	Use Designations											Comments		
	S R W	Aquatic Life Habitat						Water Supply			Recreation			
		W H	E W H	M W H	S S H	C W H	L R W	P W S	A W S	I W S	B W		P C R	S C R
 Scioto river - at RM 33.6 - Greenlawn dam (RM 129.8) to the mouth - Olentangy river (RM 132.3) to Greenlawn dam - Dublin rd. WTP dam (RM 133.4) to the Olentangy river (RM 132.3) - O'Shaughnessy dam (RM 148.8) to the Dublin rd. WTP dam - at RM 180.04 - all other segments Pond creek Dry run Wolf run Carroll run Sheep Pen run		+						o	+	+		+	PWS intake - U.S. Enrichment (emergency intake)	
		+							+	+		+		
				+					+	+		+		ECBP ecoregion - impounded
		+							+	+		+		
		+						+	+	+		+		PWS intake - Columbus
		+						o	+	+		+		PWS intake - Marion
		+							+	+		+		
		+							+	+		+		
		*							*	*		*		
		*							*	*		*		
		*							*	*		*		

Water Quality Criteria

1. **Narrative** 3745-04

- Free From

2. **Numerical** 3745-33 to -37

- Aquatic life (chemical and biological)
- Wildlife
- Aesthetics
- Human health
- Water supply
- Recreational & aesthetics

Antidegradation – National Program

3745-01-05

- Decision making process for new discharger or additional pollutants, or dredge/fill activities
- Levels of Protection
 - Tier I - existing uses must be protected (whether designated in rule or not)
 - Tier II – higher quality waters can be lowered only if a need is shown, but must maintain use
 - Tier III – Outstanding national resource waters, water quality cannot be lowered

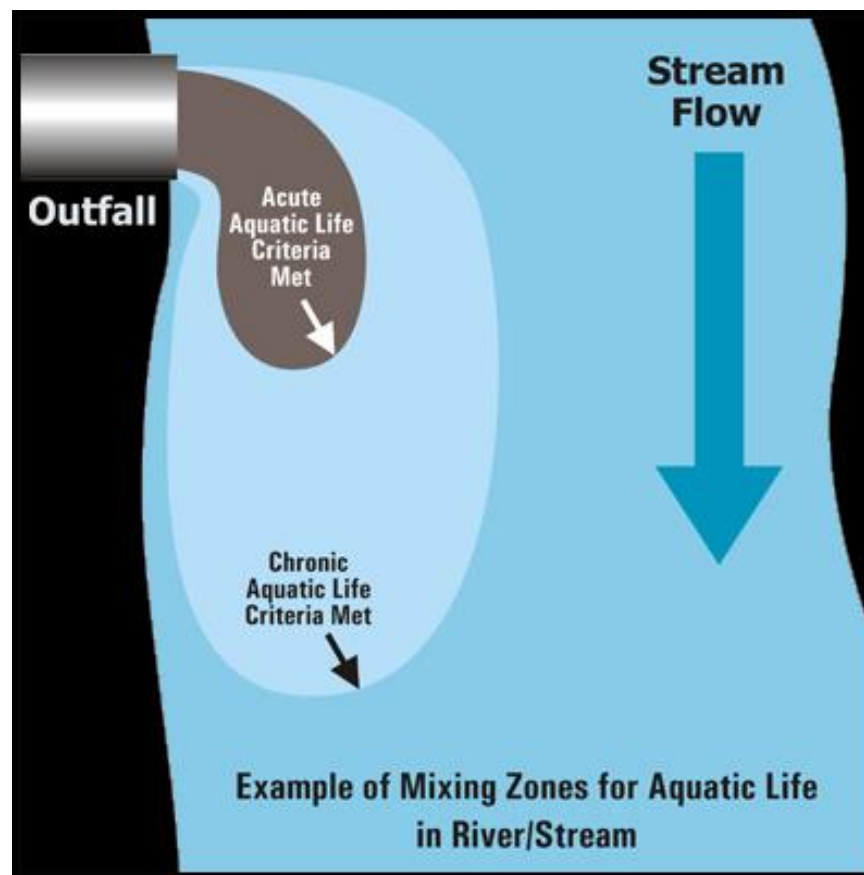
B – Ohio's Nutrient Water Quality Standards

- Mixing Zones
- Numerical Criteria
 - Nitrogen
 - Ammonia
 - Nitrate + Nitrite
 - Total Phosphorus
- Antidegradation (BADCT)

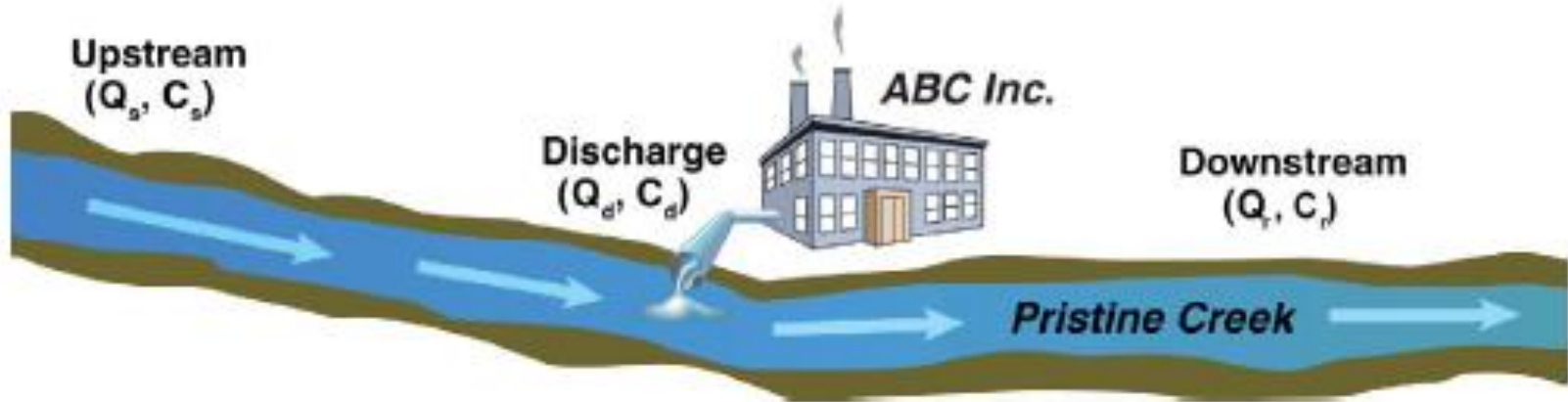


Stream Mixing Zones

- Risk based associated with location and exposure impact
- Acute (max) and Chronic (ave) Impacts
 - Inside Mixing Zone Maximum (IMZM)
 - Outside Mixing Zone Maximum (OMZM)
 - Outside Mixing Zone Average (OMZA)



Receiving Stream Example



- Pristine Creek, Ohio River Basin
 - Aquatic Life = Warmwater
 - Critical Conditions - Winter water temp 10°C , pH 8
 - Water Supply = Public, Agriculture, Industrial
 - Recreation = Primary

Ammonia, Nitrogen

3745-1-35

3

Table 35-1. Statewide water quality criteria for the protection of aquatic life.

Page 1 of 2

Chemical	Form ¹	Units ²	IMZM ³	OMZM ³	OMZA ³
Ammonia-N (WWH)	T	mg/l	--	Table 35-2	Table 35-5
Ammonia-N (EWH)	T	mg/l	--	Table 35-3	Table 35-6
Ammonia-N (MWH)	T	mg/l	--	Table 35-2	Table 35-7
Ammonia-N (SSH ⁴)	T	mg/l	--	Table 35-4	a
Ammonia-N (CWH)	T	mg/l	--	Table 35-4	Table 35-8
Ammonia-N (LRW)	T	mg/l	--	Table 35-2	--
Arsenic	D ⁶	µg/l	680	340	150
Arsenic	TR ⁷	µg/l	680	340	150
Cadmium ⁸					
Chlorine (WWH, EWH, MWH, CWH)	R	µg/l	--	19	11
Chlorine (LRW)	R	µg/l	--	19	--
Chlorine (SSH ⁴)	R	µg/l	--	b	b

Ammonia- WWH, OMZM

3745-1-35

Table 35-2.
Warmwater habitat, modified warmwater habitat and limited resource water
outside mixing zone maximum total ammonia-nitrogen criteria (mg/l).

pH	6.5	6.7	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4
Temp. (°C)																		
0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.7	10.6	8.4	6.7	5.4	4.3
1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.5	10.5	8.3	6.6	5.3	4.2
2	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.3	10.3	8.2	6.5	5.2	4.2
3	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.1	10.2	8.1	6.5	5.2	4.1
4	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.0	10.1	8.0	6.4	5.1	4.1
5	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.9	9.9	7.9	6.3	5.0	4.0
6	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.7	9.8	7.8	6.3	5.0	4.0
7	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.6	9.7	7.8	6.2	5.0	4.0
8	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.5	9.6	7.7	6.1	4.9	3.9
9	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.4	9.6	7.6	6.1	4.9	3.9
10	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.3	9.5	7.6	6.0	4.8	3.9

Nitrate + Nitrite, Nitrogen

3745-1-33

Chemical	Form ¹	Units ²	OMZA ³	
			Drinking	
			Ohio river	Lake Erie
Methyl bromide	T	µg/l	48	
Methylene chloride ⁵	T	µg/l	5.0 ^a	47
Nickel	TR	µg/l	610	
Nitrate-N + Nitrite-N	T	µg/l	10,000 ^a	10,000
Nitrite-N	T	µg/l	1,000 ^a	
Nitrobenzene	T	µg/l	17	
Nitrosoamines ⁵	T	µg/l	0.0080	

Total Phosphorus

Table 37-1. Statewide water quality criteria for the protection against adverse aesthetic conditions.

Chemical	Form ¹	Units ²	IMZM ³	OMZM ³	Drinking
2-Chlorophenol	T	µg/l	--	--	0.1 ^a
2,4-Dichlorophenol	T	µg/l	--	--	0.3 ^a
MBAS (foaming agents)	T	mg/l	--	0.50	--
Oil & grease	T	mg/l	--	10 ^b	--
Phenol	T	µg/l	--	--	1.0 ^a
Phosphorus	T	mg/l	c	--	c

Total Phosphorus Footnote C

- Total phosphorus shall be limited to the extent necessary to prevent:
 - nuisance growths and algae, weed and slimes that result in a violation of the water quality criteria set forth in paragraph E of rule 3745-1-04 of the Administrative Code or,
 - for public water supplies, that result in taste or odor problems.
- In areas where such nuisance growths exist, phosphorus discharges from point sources determined significant:
 - shall not exceed a daily average of one milligram per liter as total P,
 - or such stricter requirements as may be imposed in accordance with the International Joint Commission.
- Major Lake Erie Basin Dischargers have a 1 mg/l average per rule OAC 3745-33-06

Antidegradation BADCT

Table 5-1. Best available demonstrated control technology for new sources discharging sanitary wastewater.

Parameter	Thirty-day Limit	Daily or Seven-day Limit	Maximum/Minimum Limit
CBOD ₅	10 mg/l	15 mg/l	n/a
Total suspended solids	12 mg/l	18 mg/l	n/a
Ammonia			
(Summer)	1.0 mg/l	1.5 mg/l	n/a
(Winter)	3.0 mg/l	4.5 mg/l	
Dissolved oxygen	n/a	n/a	6.0 mg/l (minimum)
Total residual chlorine	n/a	n/a	0.038 mg/l (maximum)
E. coli*	126 / 100 ml	235 / 100 ml	n/a

* E. coli is to be considered a design standard only. Effluent limitations will not be incorporated into a control document based solely on this table.

C - Ohio's NPDES Permit Process



- NPDES Regulatory Framework
- NPDES Program Areas
- NPDES Permit Limitations
 - Technology Based Effluent Limits (TBELs)
 - Water Quality Based Effluent Limits (WQBELs)
- Monitoring

NPDES Regulatory Framework

- National Pollutant Discharge Elimination System (NPDES)
- Authorized by Clean Water Act Section 402, Ohio Revised Code 6111.03
- Regulated under 40 CFR , OAC 3745
- Do I need an NPDES permit?
 - point source
 - pollutants
 - waters of the state

NPDES Program Areas

- Program Authority
 - U.S. EPA Lead
 - States, Territories, Tribes Lead
 - 5 Areas of Delegation (Individual, General, Pretreatment, Federal Facilities, Sewage Sludge)
- Program Areas
 - Municipal Sources
 - (POTW, Pretreatment, Sludge, Wet Weather, MS4)
 - Non-Municipal Sources
 - (Process, Non-process, Storm Water, CAFOs, Vessels)
- Facility Designation
 - Major (Muni > 1MGD, Non-Muni – rating sheet)
 - Minor
- Permit Types – Individual and General
- Permit Limits – compare TBELs to WQBELs use most stringent

Develop TBELs

- Technology Based Effluent Limits (TBELs)
 - Levels Playing Field
 - Categorical Effluent Standards
 - 56 federal industrial categories
 - 1 federal and 1 state municipal category
 - Different Control Levels
 - BPT, BCT, BAT, NSPS, BADCT
- Applying Effluent Guidelines
 - 40 CFR 400-471
 - Many are Production Based (lb/day)
- Example BADCT Winter Ammonia Max= 4.5 mg/l

Develop WQBELs

- Water Quality Based Effluent Limits (WQBELs)
 - Determine Water Quality Standards
 - Characterize Effluent & Receiving Water
 - Model & Calculate Parameters
 - Apply Reasonable Potential

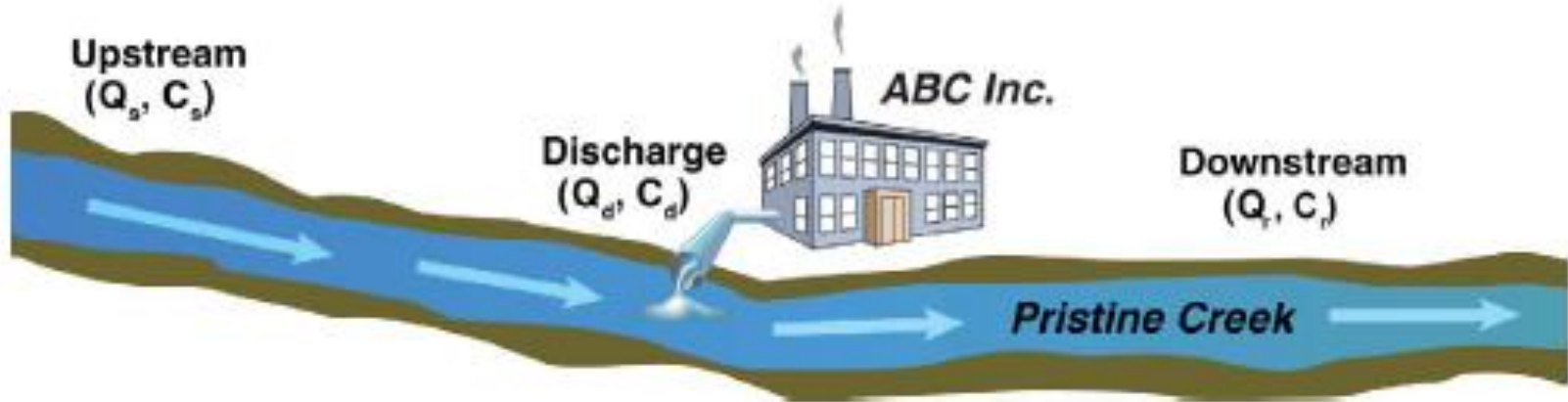
Develop WQBELs – Water Quality Standard

- WQS Components
 - Designated Uses =
 - Warmwater Habitat
 - Water Supply – Drinking, Agriculture, Industrial
 - Primary Recreation
 - Numeric and Narrative Criteria -
 - Antidegradation
 - General High Quality Water

Develop WQBELs - Characterize

- Identify Pollutants of Concern
 - Identified in 303(d) list as impaired or threatened
 - Review pretreatment, influent and sludge data
- Identify Critical Conditions
 - Low Flow, Temp, pH, Hardness, Dissolved Organic Carbon
- Model Receiving Water
 - Simple (mass balance)
 - Complex when interactive dischargers
- Calculate Parameters

WQBEL Example – Mass Balance



Mass (kg/day) = Flow (Q in cfs) * Pollutant (C in mg/l)

$$Q_s C_s + Q_d C_d = Q_r C_r$$

Q_s = critical upstream flow

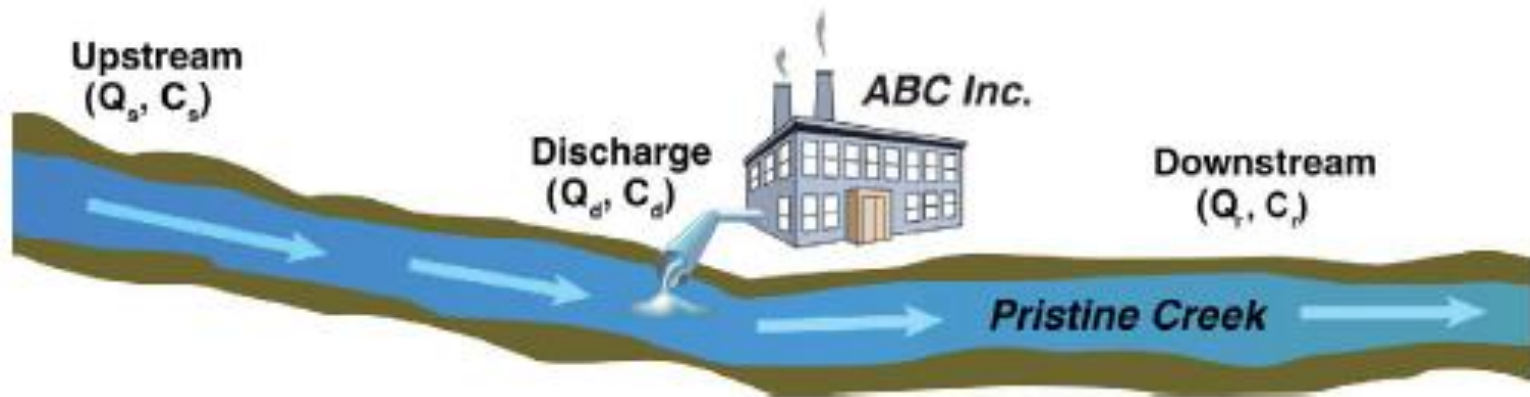
C_s = upstream concentration of pollutant

Q_d = discharge flow

C_d = discharge concentration of pollutant

Q_r = downstream flow

C_r = water quality criterion of pollutant



The following values are known for ABC Inc., and Pristine Creek:

Q_s = critical upstream flow	= 1.20 cfs
C_s = upstream concentration of pollutant	= 0.75 mg/l
Q_d = discharge flow	= 0.55 cfs
Q_r = downstream flow	= 0.55 + 1.2 = 1.75 cfs
C_r = water quality criterion of Ammonia	= 9.5 mg/l

$$C_d = \frac{(1.75 \text{ cfs}) \left(9.5 \frac{\text{mg}}{\text{l}}\right) - (1.20 \text{ cfs}) \left(0.75 \frac{\text{mg}}{\text{l}}\right)}{0.55 \text{ cfs}}$$

WQBEL for Ammonia = 28.6 mg/l

Apply NPDES Requirements

- Compare TBELs vs WQBELs
 - Example Ammonia (max)
 - WQBEL = 28.6 mg/l , TBEL = 4.5 mg/l
- Determine Limitations
 - Apply the most stringent NH₃ = 4.5 mg/l
- Apply Reasonable Potential
 - Which parameters to include in permit
 - Limit > 50% but < 100% of Existing Discharge, Monitoring
 - Limit > 100% of Existing Discharge, Limit
- Include Monitoring Frequency – 1/mo, 3/wk

NPDES Monitoring and Reporting

- **Monitoring Conditions**
 - Monitoring Location (influent, internal, effluent)
 - Monitoring Frequency
 - Sample Collection (grab, composite)
- **Analytical Methods**
 - 40 CFR 136
- **Reporting Results - eDMR**
- **Recordkeeping**
 - Sewage Sludge 5 yrs
 - Everything Else 3 yrs

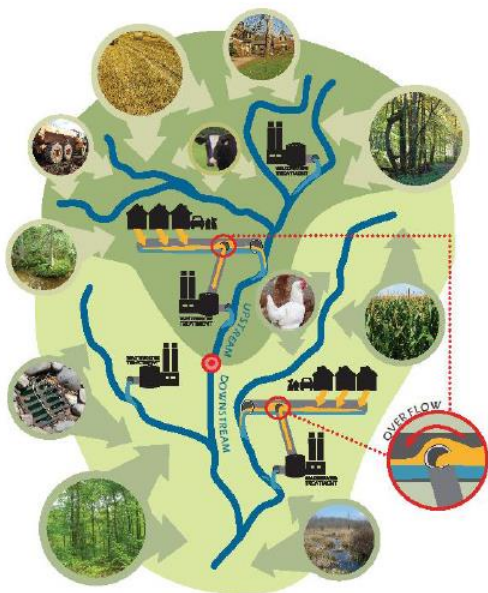
Table - Final Outfall - 002 - Final

Effluent Characteristic Parameter	Discharge Limitations							Monitoring Requirements		
	Concentration Specified Units				Loading* kg/day			Measuring Frequency	Sampling Type	Monitoring Months
	Maximum	Minimum	Weekly	Monthly	Daily	Weekly	Monthly			
00056 - Flow Rate - GPD	-	-	-	-	-	-	-	1/Day	24hr Total Estimate	All
00300 - Dissolved Oxygen - mg/l	-	6.0	-	-	-	-	-	1/Day	Grab	All
00400 - pH - S.U.	9.0	6.5	-	-	-	-	-	1/Quarter	Grab	Quarterly
00530 - Total Suspended Solids - mg/l	-	-	18	12	-	-	-	1/Quarter	Grab	Quarterly
00610 - Nitrogen, Ammonia (NH3) - mg/l	-	-	4.5	3.0	-	-	-	1/Quarter	Grab	Winter-Qtrly
00610 - Nitrogen, Ammonia (NH3) - mg/l	-	-	1.5	1.0	-	-	-	1/Quarter	Grab	Summer - Qtrly
00665 - Phosphorus, Total (P) - mg/l	-	-	-	-	-	-	-	1/Quarter	Grab	Quarterly
01350 - Turbidity, Severity - Units	-	-	-	-	-	-	-	1/Day	Estimate	All
31616 - Fecal Coliform - #/100 ml	-	-	2000	1000	-	-	-	1/Quarter	Grab	Winter-Qtrly
31616 - Fecal Coliform - #/100 ml	-	-	400	200	-	-	-	1/Quarter	Grab	Summer - Qtrly
50060 - Chlorine, Total Residual - mg/l	0.038	-	-	-	-	-	-	1/Quarter	Grab	Summer - Qtrly
80082 - CBOD 5 day - mg/l	-	-	15	10	-	-	-	1/Quarter	Grab	Quarterly

D – 2018 Statewide Nutrient Mass Loading Report



Nutrient Mass Balance Study for Ohio's Major Rivers



Ohio EPA must report nutrient total load and load sources every two years.

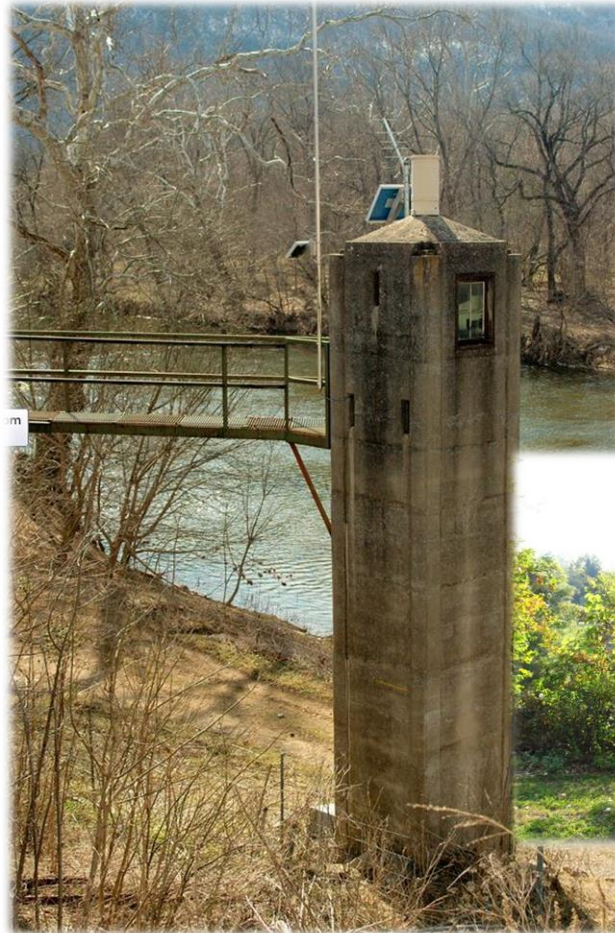
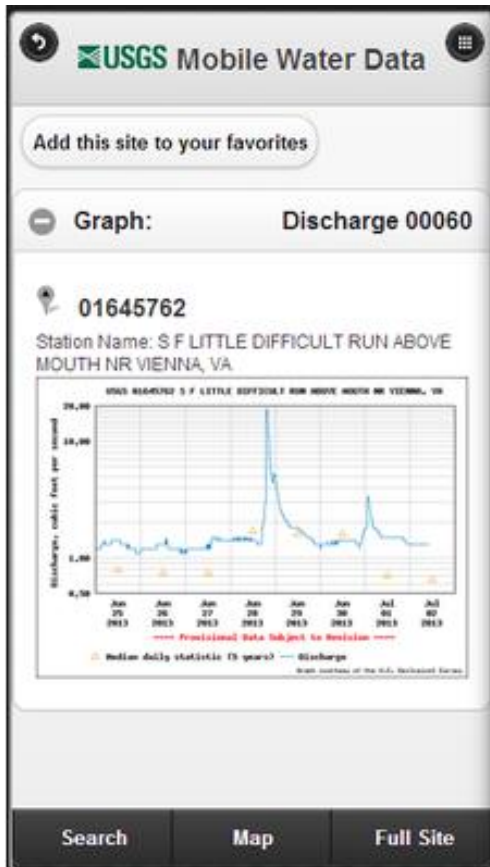
Division of Surface Water
Modeling, Assessment
and TMDL Section
April 16, 2018



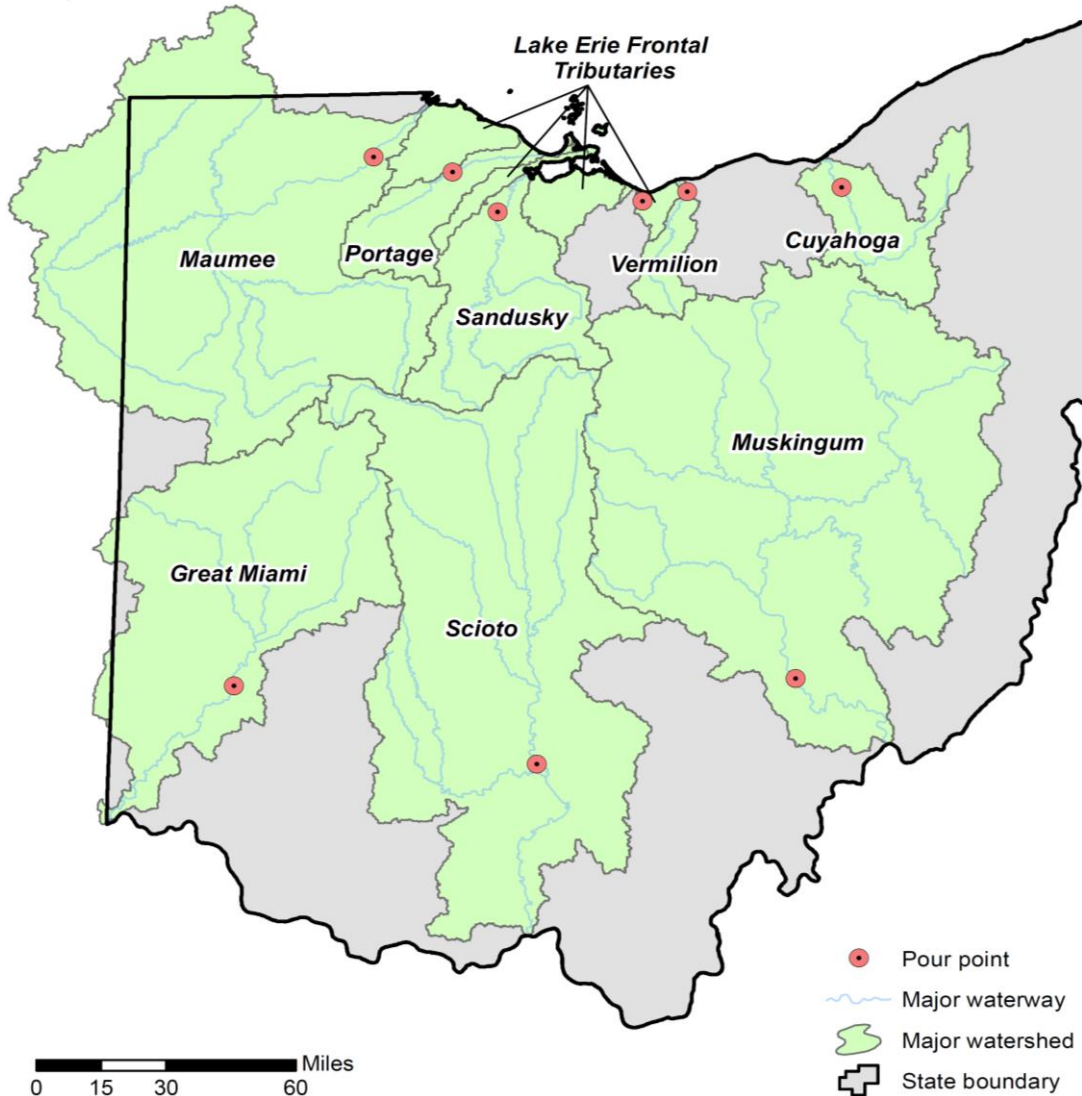
Ohio Statewide Nutrient Mass Loading Report

- Report every two years, due at same time as Integrated Water Quality Report (IR)
- Based on Water Year (Oct - Sept)
- ***Total Load*** = **PS** + **HSTS** + **NPS**
 - Know **Stream Loadings** and Point Source (**PS**) Loadings (includes combined sewer est.)
 - Estimate Home Sewage Treatment Systems (**HSTS**)
 - Remainder is Nonpoint Source (**NPS** - urban and rural)

Flow Monitoring and Sampling



Ohio EPA's Nutrient Mass Balance Study



Study Area Covered

- 7 major watersheds, plus Lake Tribs.
- 26,000 sq. mi. (in Ohio)
- 66% of Ohio's land area

HSTS Load Inputs

- Estimate Population Not on Sanitary Sewers
- Nutrient Yields
 - Total Phosphorus = 1.13 lb/year/person
 - Total Nitrogen = 8.13 lb/year/person
- HSTS Nutrient Delivery Ratios

Phos	Removal Efficiency	Nitrogen	Removal Efficiency
	80% On-site working		40% On-site working
	40% On-site failing		40% On-site failing
	6% Discharging		0% Discharging

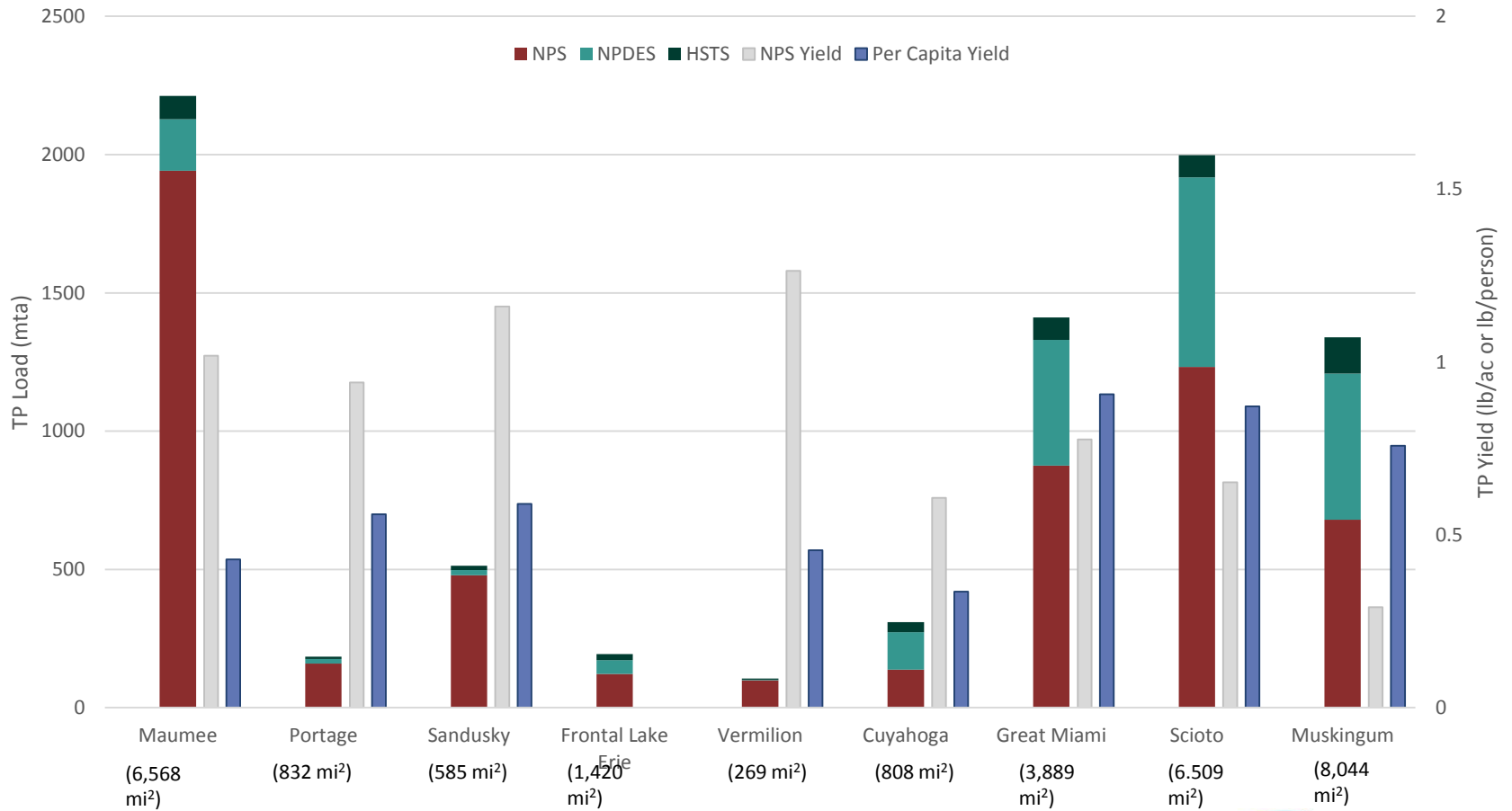
HSTS Load Inputs (cont.)

- Categories of HSTS by Location
Ohio Department of Health 2012 Survey

Location	Onsite working (%)	Onsite failing (%)	Discharging (%)
Northwest	41.5	26.5	32
Northeast	44	27	29
Central	42.8	25.2	32
Southwest	64	14	22
Southeast	61.2	10.8	28

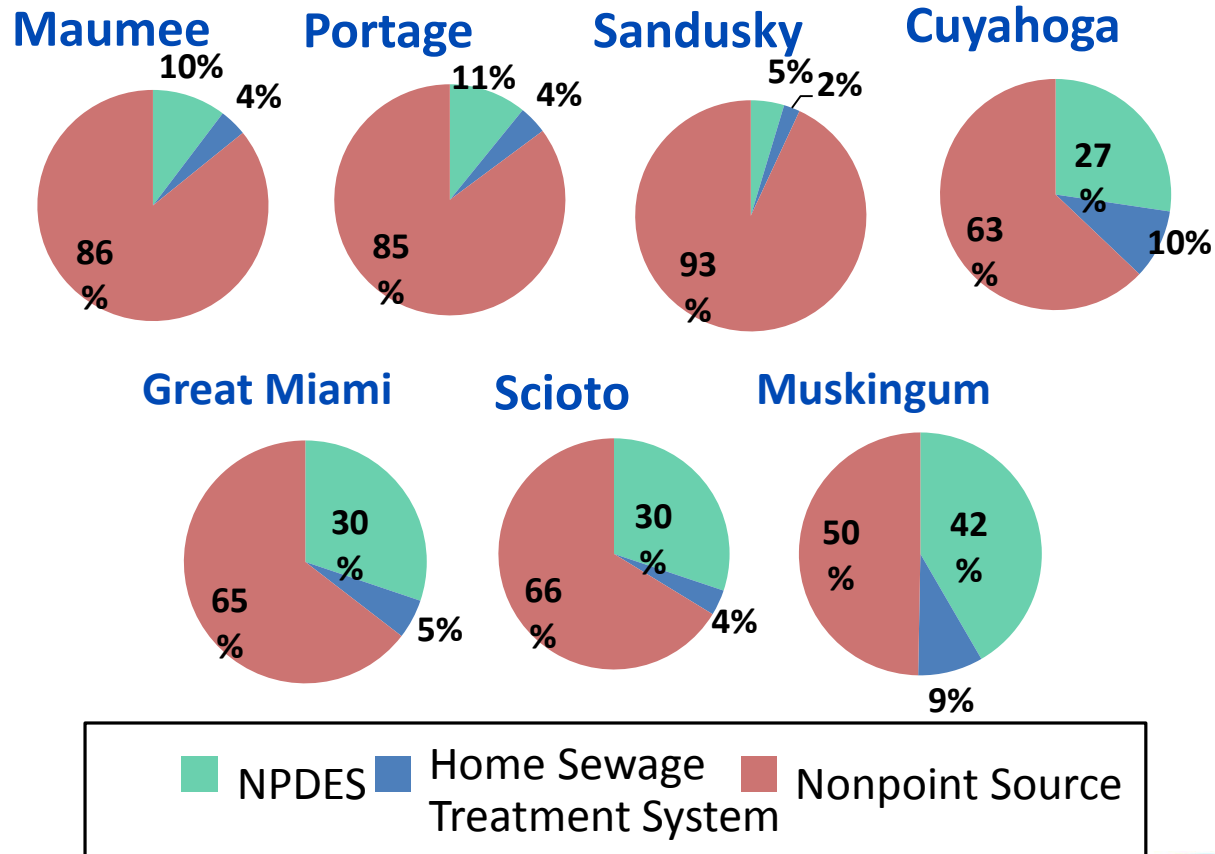
- So what is the overall HSTS Contribution?

Average Total Phosphorus Loads

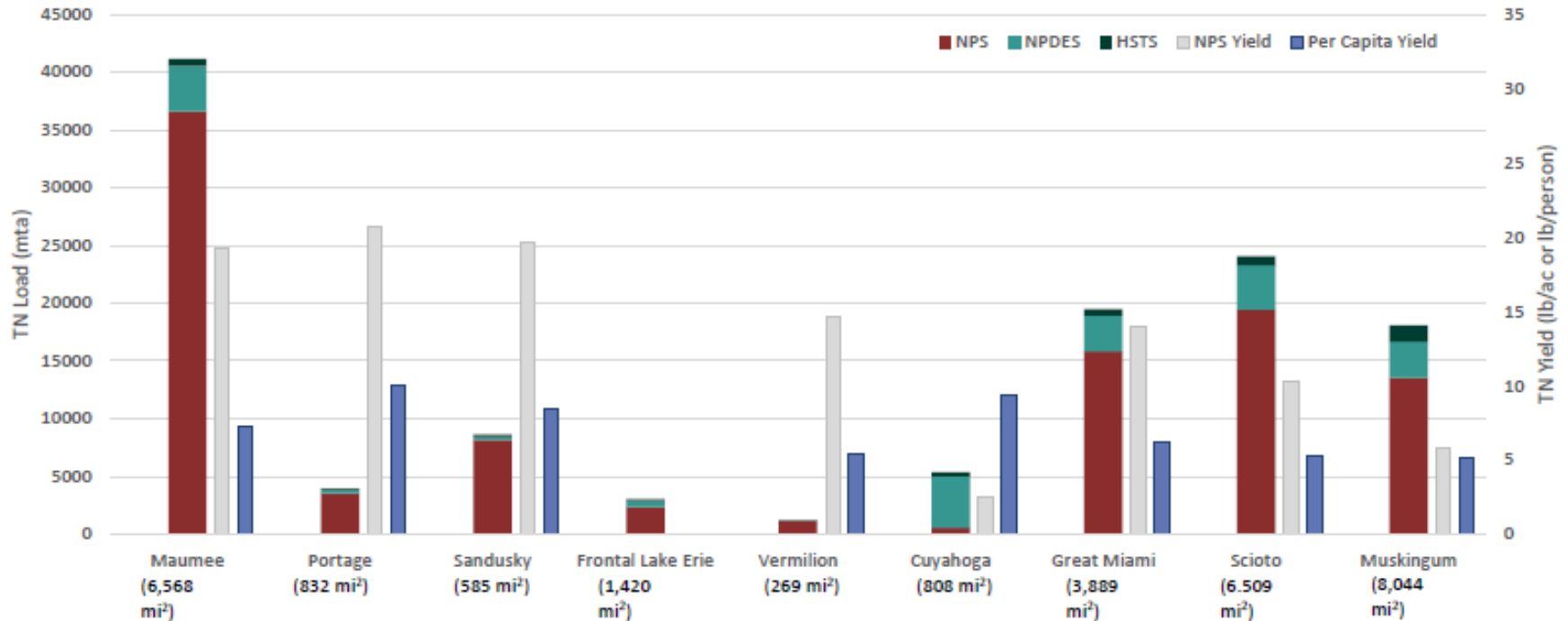


Total Phosphorus Loads by Source:

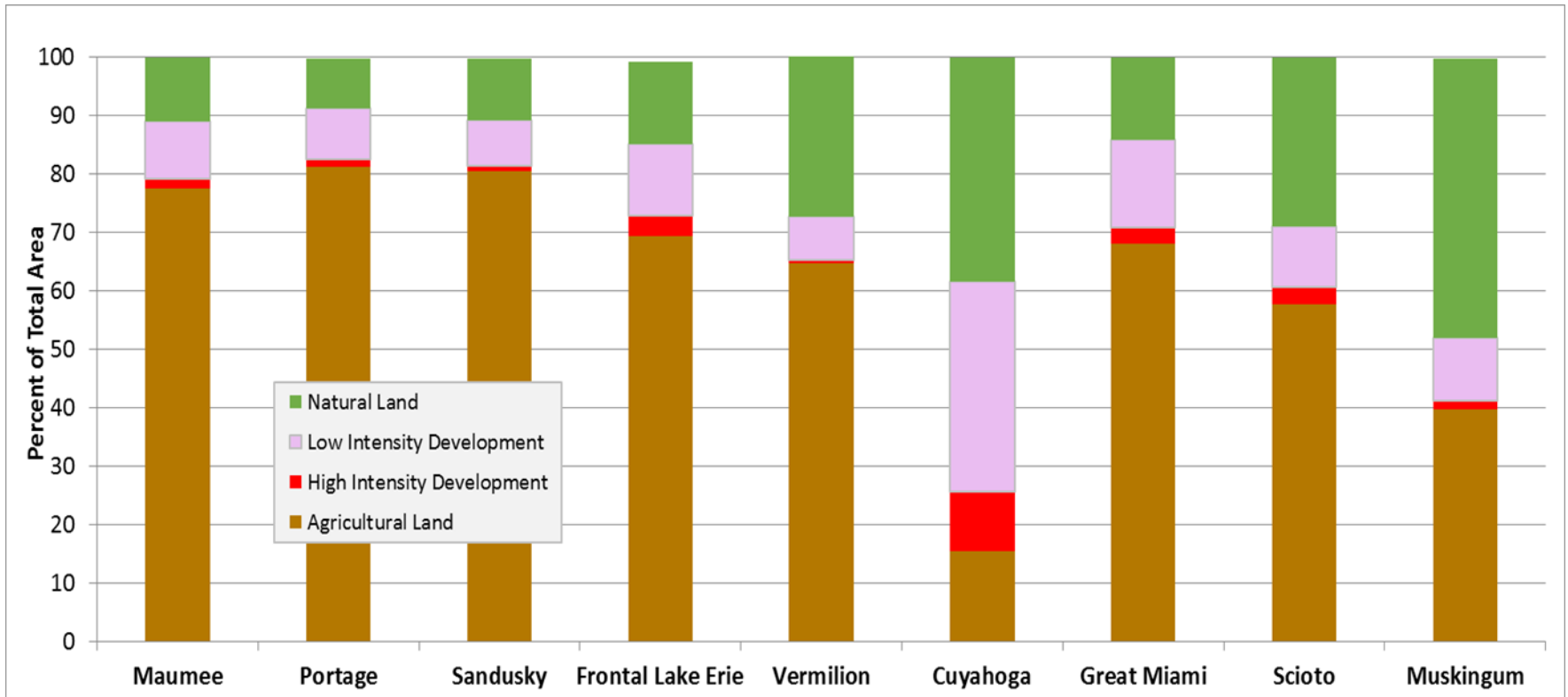
Major Ohio Watersheds (average water year)



Average Total Nitrogen Loads



Watershed Land Use



Questions?

Thank You