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Nutrient Overview

NACWA Summer Meeting

July 16, 2008

Mike Tate, PE

Kansas Department of Health and Environment

Our Vision: Healthy Kansans living in safe and sustainable environments

Overview

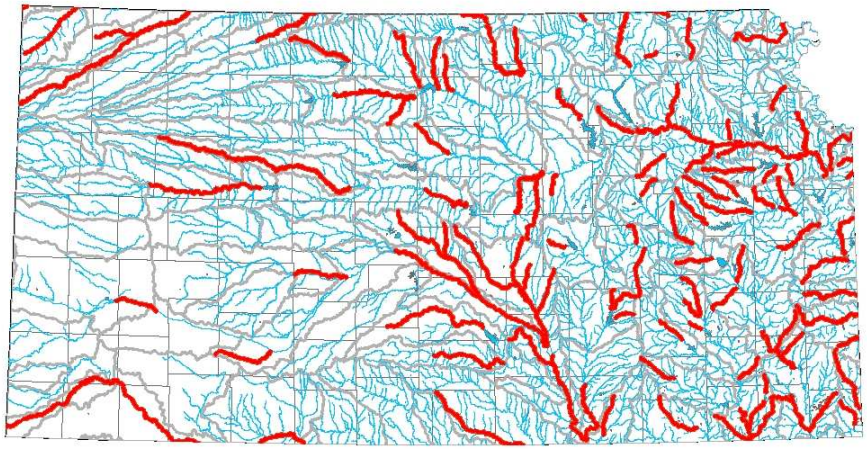
- KS Nutrient Reduction Plan Implementation
- NRDC Secondary Treatment Petition
  - Technology-based Nutrient Reduction

Kansas Nutrient Reduction Plan

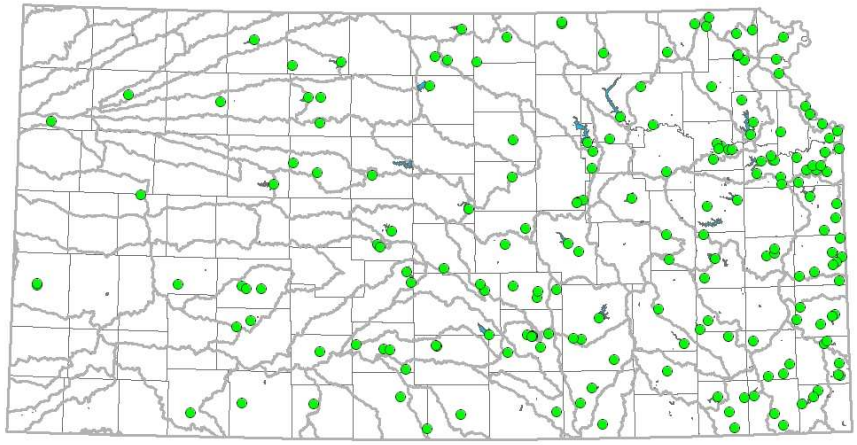
Update

Our Vision: Healthy Kansans living in safe and sustainable environments

Kansas Nutrient Related Impairments

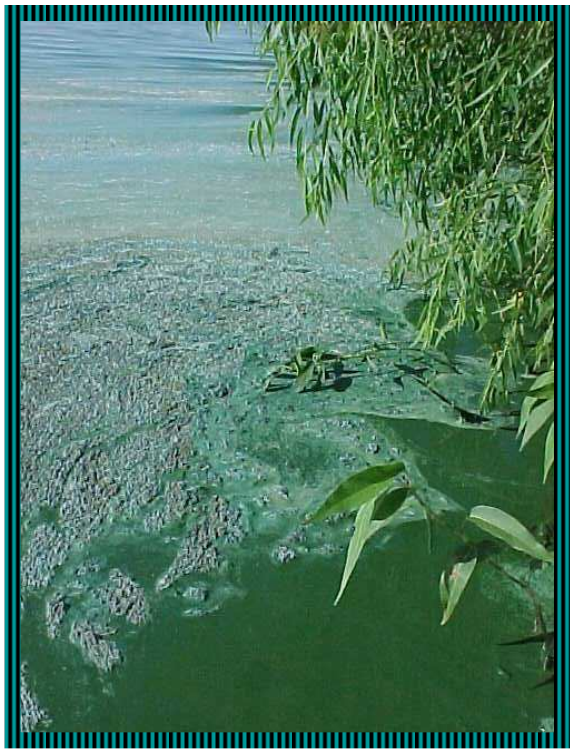


244 Impaired Stream Segments



187 Impaired Reservoirs

Impaired Reservoirs – Examples



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Impaired Streams – Examples

Summary of Plan

- Nutrient reduction in surface water is needed
  - Either we set the agenda, or others eventually will
- Criteria problematic at this time
  - More time and study needed to develop
  - Likely to delay water quality improvements
- Shared nutrient reduction can produce results
  - Fiscally doable
  - The right thing to do
- Targeted NPS actions = greatest results

Guiding Principles

- Nutrients are a serious surface water problem
- PS/NPS both contribute to nutrient problems
- TN and TP both need attention
  - Gulf Hypoxia target - 30% reduction for each
- PWS reservoirs top priority in-state issue
- Provide leadership
  - Identify reduction goals
  - Identify reasonable first steps
  - Involve stakeholders
- Avoid having others drive the agenda

Nutrient Reduction Plan - Goals

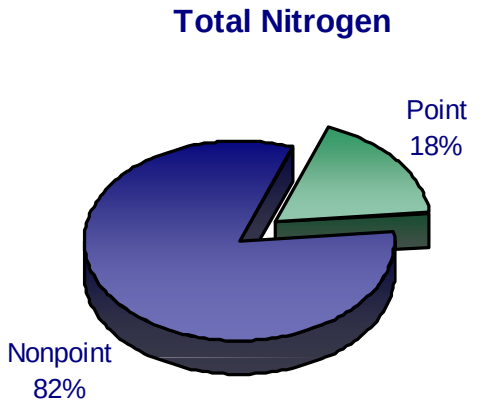
- 30% reduction of nutrient export
  - Total Nitrogen and Total Phosphorus
- Phosphorus emphasis above reservoirs
- Technology-based limits for point sources
- Focused reduction of NPS nutrients
- Eventually set basin-specific criteria
  - Implementation of eutrophication/nutrient TMDLs
  - Watershed Restoration And Protection Strategies

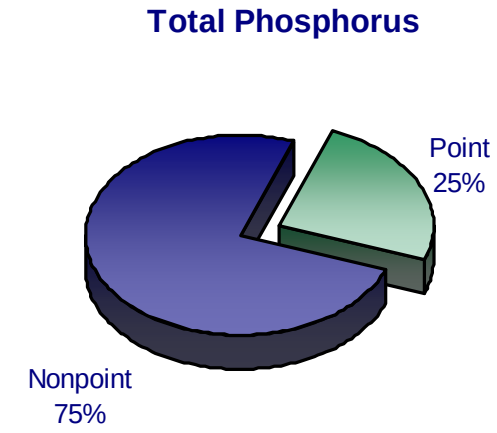
Nutrient Reduction Plan - How

- State Water Plan is driving force
  - Manage, conserve & develop Kansas' water resources
    - Improved WQ and nutrients already addressed
    - Evaluating inclusion in individual basin plans
- WRAPS is primary implementation mechanism
  - **W**atershed **R**estoration **A**nd **P**rotection **S**trategies
    - Rely on local leadership for success
    - Can bring PS and NPS together
    - Target NPS funds

The Nutrient "Budget"

- Looked at water exiting KS
  - Total Nitrogen
  - Total Phosphorus
- Looked at WWTF effluent
  - PS Nitrogen
  - PS Phosphorus
- Estimated NPS from above
  - NPS Nitrogen = Total – PS
  - NPS Phosphorus = Total - PS

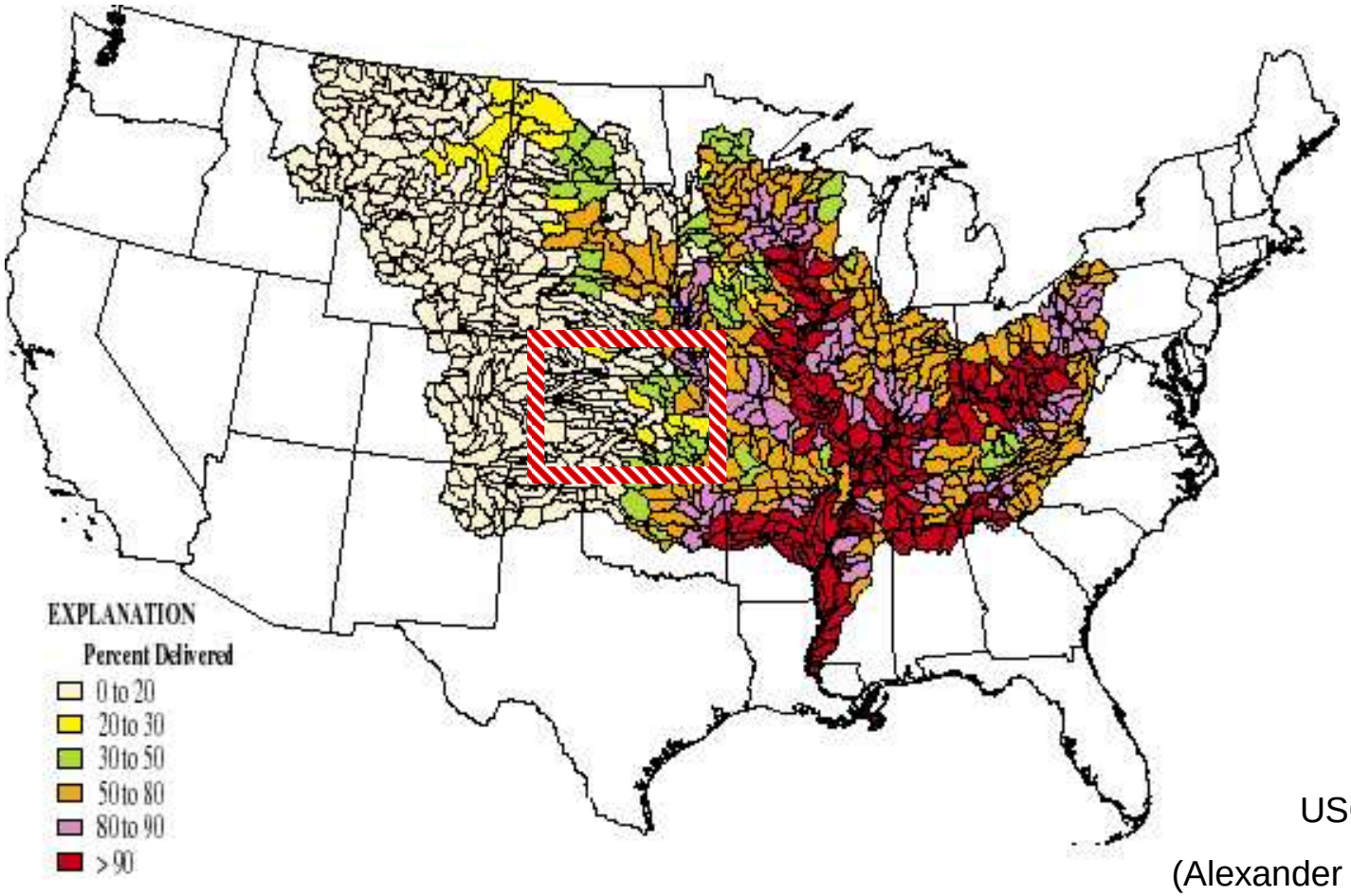




The PS/NPS Debate

- Other studies have indicated
  - PS = 3% to 11% of total
  - NPS = 89% to 97% of total
- Why is Kansas Different?
  - USGS study on impact for Gulf hypoxia
    - Closer to larger river, more transport to Gulf
    - Therefore, more export if located on large river
    - Largest cities located on large rivers

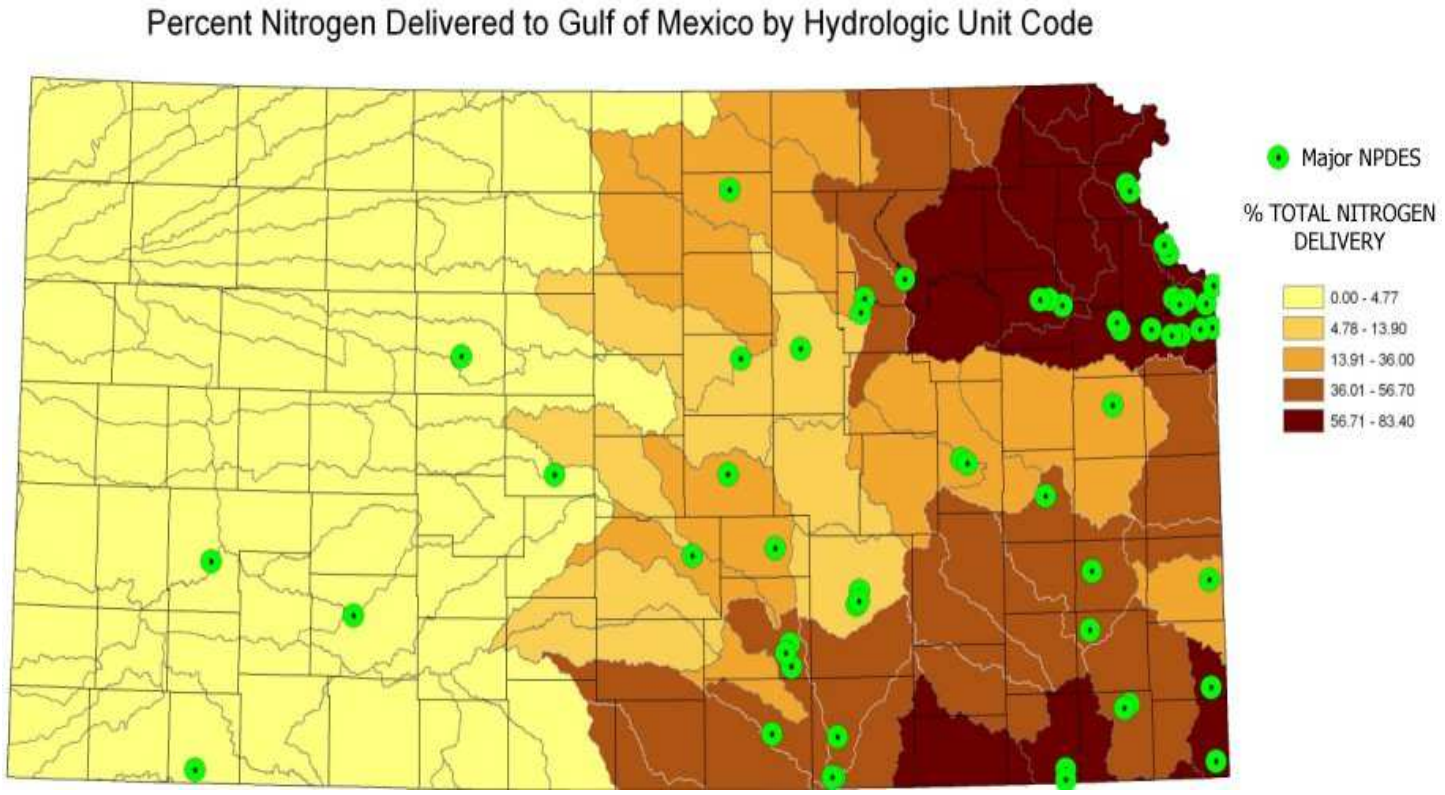
Gulf TN Transport - National



USGS

(Alexander et al. 2000)

Gulf TN Transport/Large WWTFs



- Large = >1 MGD Design Flow (Approx. 10,000 Population)
- Large = 85% of Permitted Wastewater Flow in Kansas

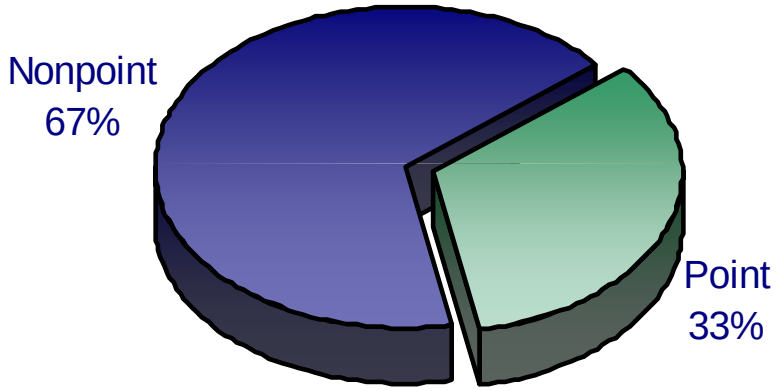
Nutrient Reduction Plan - PS

- Technology-based criteria for point sources
  - Biological nutrient removal (BNR)
    - No chemical addition or filtration
      - Adds pollutants
      - O&M costs increase approximately 2X
  - Mechanical plants > 1 MGD
    - TN – 8 mg/L TP – 1.5 mg/L
    - Permit limits based on annual average
    - Industrial
      - Study to assess applicability of nutrient removal

Nutrient Reduction Plan

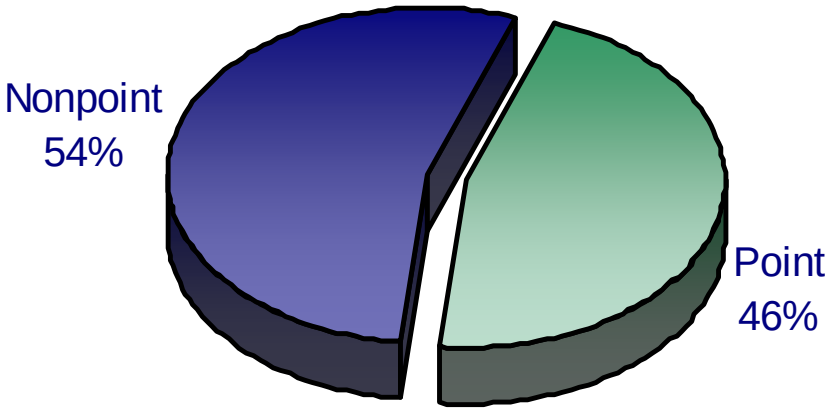
Total Nitrogen

Target Reduction Responsibility



Total Phosphorus

Target Reduction Responsibility

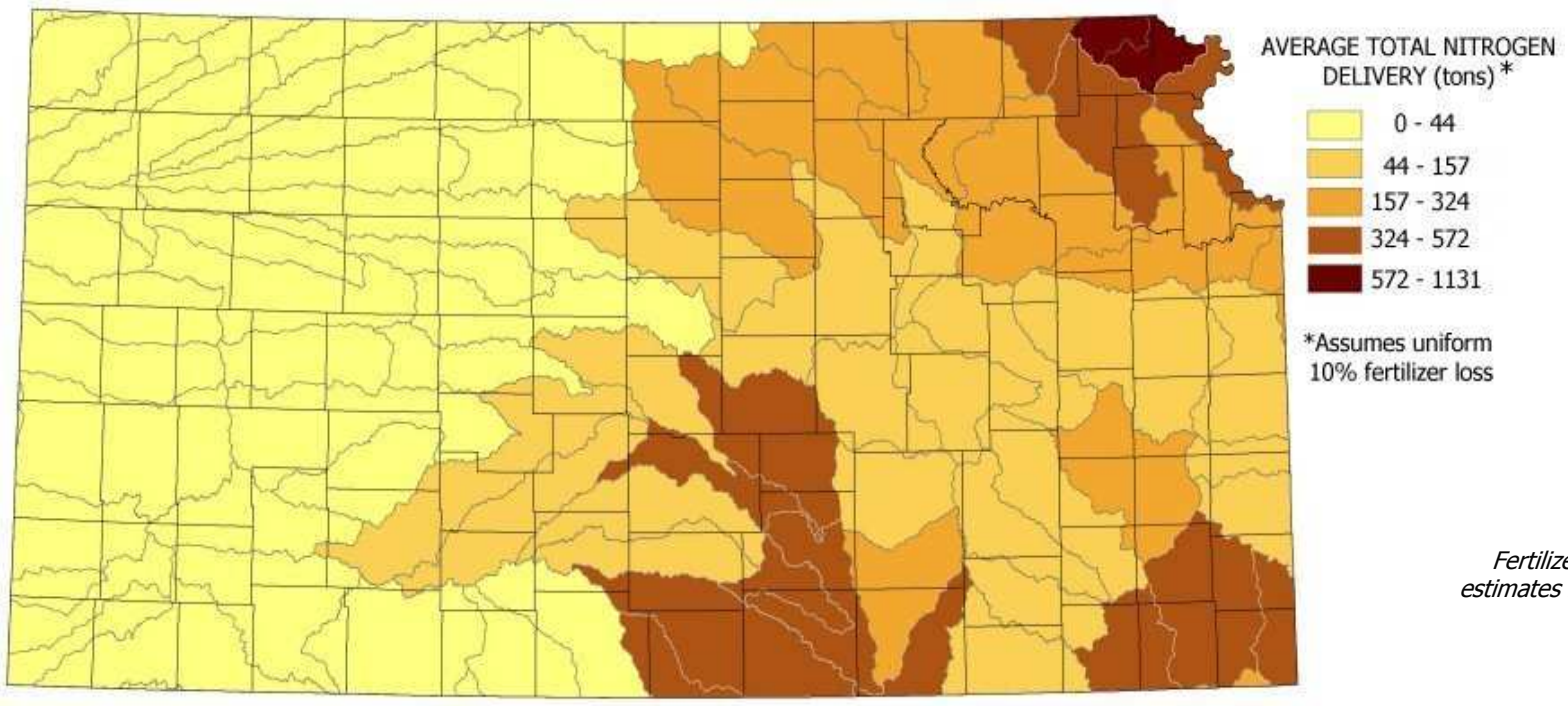


Nutrient Reduction Plan - NPS

- Focus NPS $$ on most critical areas
  - Identify areas with potential surface water impacts
  - Identify priority areas
- Identify technical fixes
  - Manure management
  - Soil testing/Data interpretation
  - Soil management
  - Fertilizer application

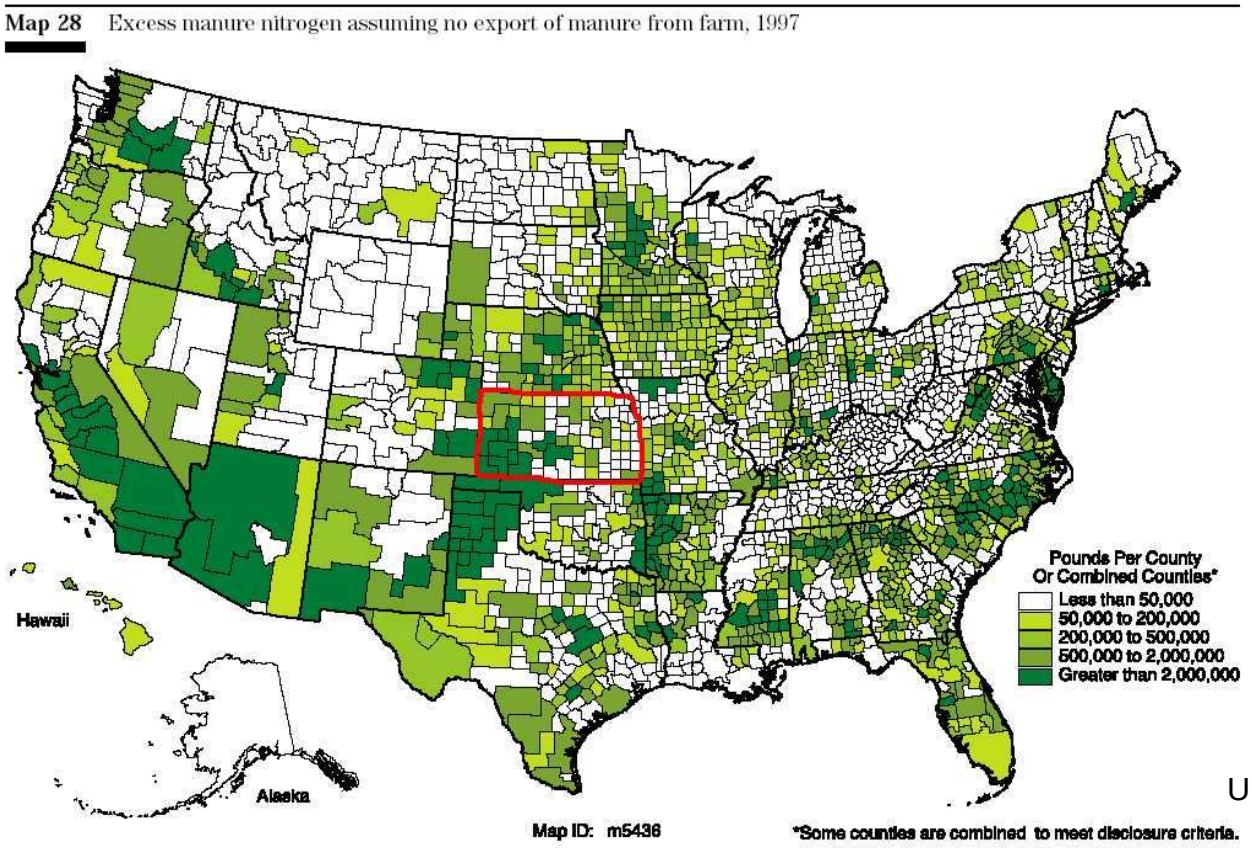
Nitrogen Fertilizer Use

Mass Nitrogen Fertilizer Transport



Fertilizer Institute estimates 2-20% runoff

Manure Nitrogen



U.S. Department of Agriculture
2000

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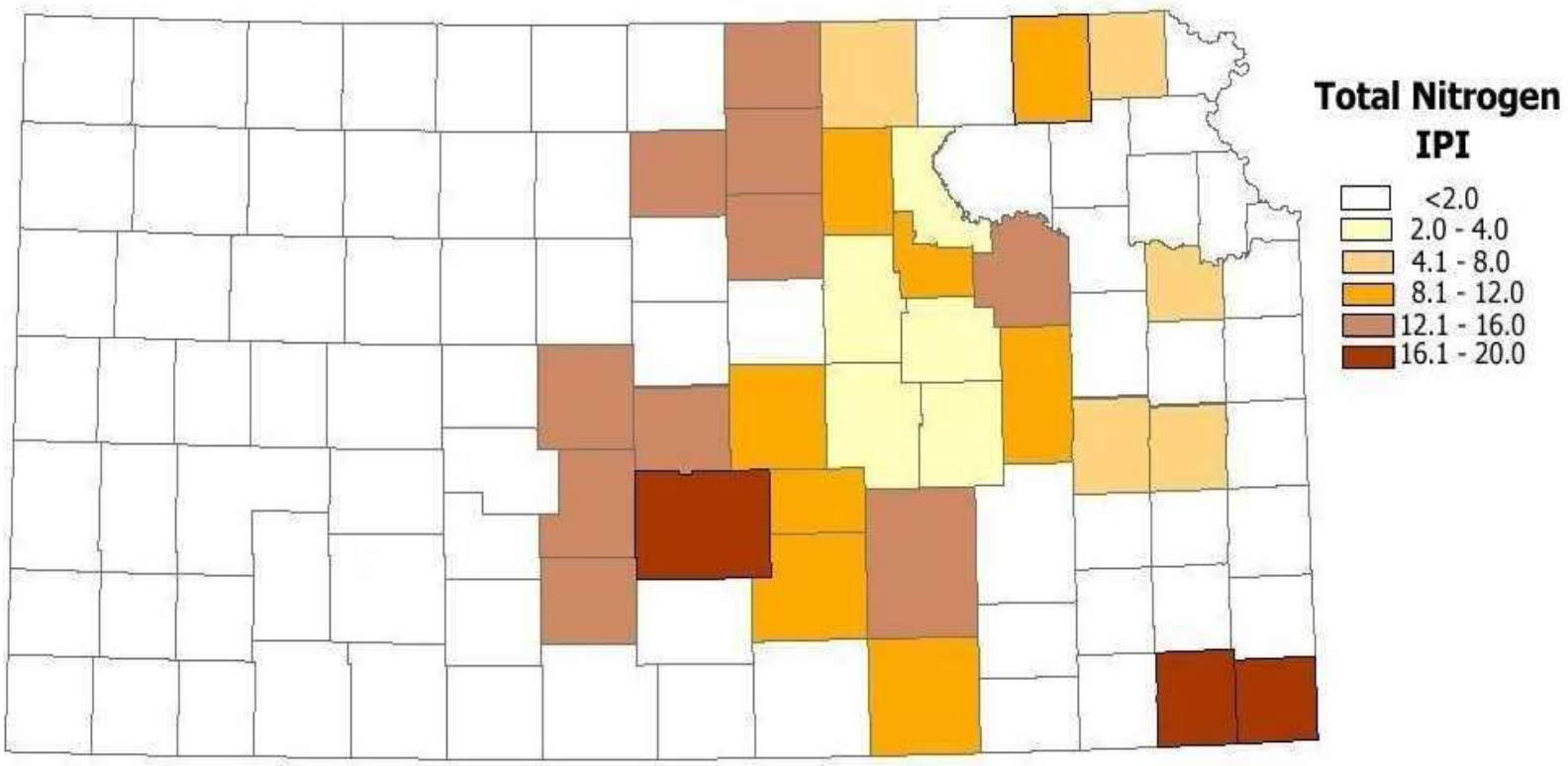
Improvement Potential Index (IPI)

KDHE NPS Targeting Concept

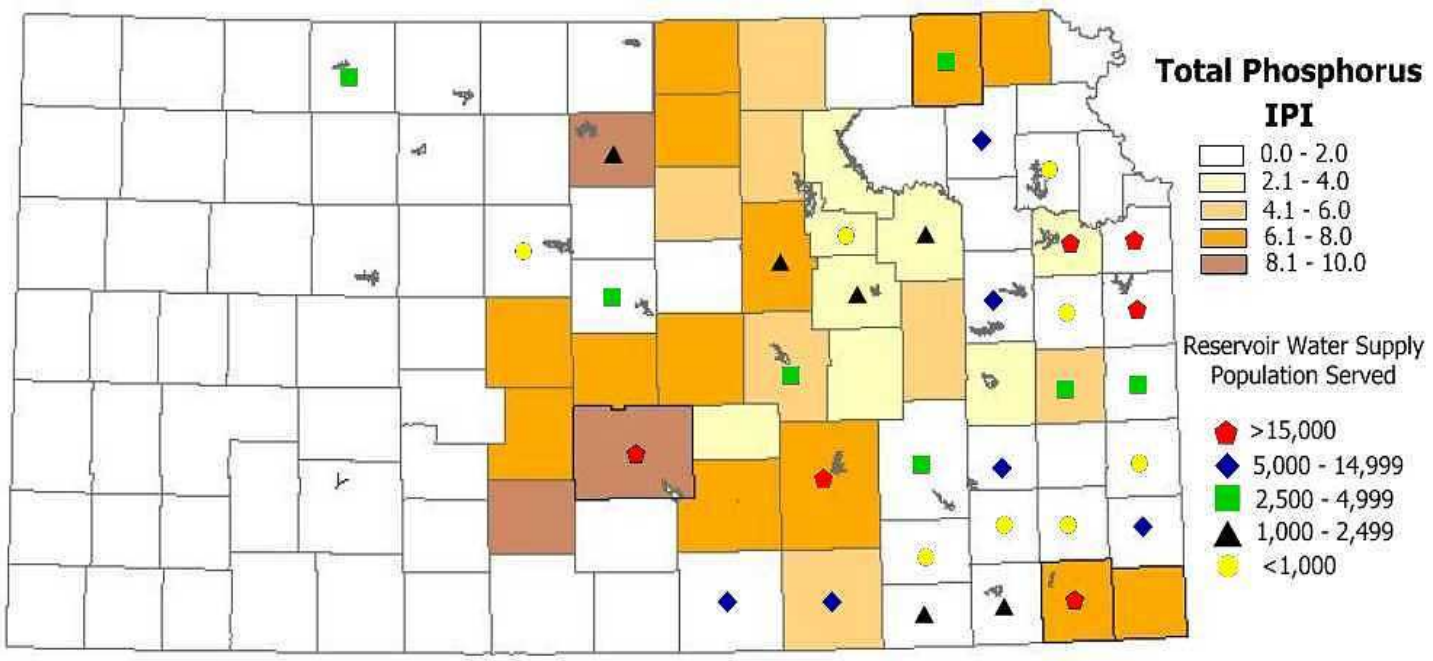
- Total Nitrogen
  - Assign values to counties
    - Scale 1-5 for
      - Excess manure nitrogen
      - Nitrogen fertilizer use
      - Nitrogen transport %
    - Combine - composite value
      - TN IPI
- Total Phosphorus
  - Assign values to counties
    - Scale 1-5 for
      - Excess manure phosphorus
      - Phosphorus fertilizer use
      - Proximity to Surface Water
    - Combine - composite value
      - TP IPI

Improvement Potential Index - TN



Darker colors indicate counties with greatest potential to reduce TN

Improvement Potential Index - TP



Darker colors indicate counties with greatest potential to reduce TP

KS Nutrient Reduction Plan '08

- Plant performance is good
  - More plants doing better, particularly <5 MGD
  - Overall state average increasing a bit
    - Mainly because of a handful of large plants
- 303d listings/TMDLs for nutrient impairments
  - Based on biotic index, pH and DO fluctuation, and eutrophication
  - Proposed listings for TP>0.2 mg/L
    - 3X highest Ecoregion criterion
- Numerous WRAPS projects addressing nutrients

KS Nutrient Reduction Plan

- Permit Schedules of Compliance
  - 18 issued
  - Modified to include three levels of treatment

Level	TN (mg/L)	TP (mg/L)
BNR	8	1.5
ENR	5	0.5
LOT	3	0.3

    - Rationale – EPA and others looking at LOT as BAT
  - Nutrient reduction POTWs being built

BNR Scoreboard – Jan 2008

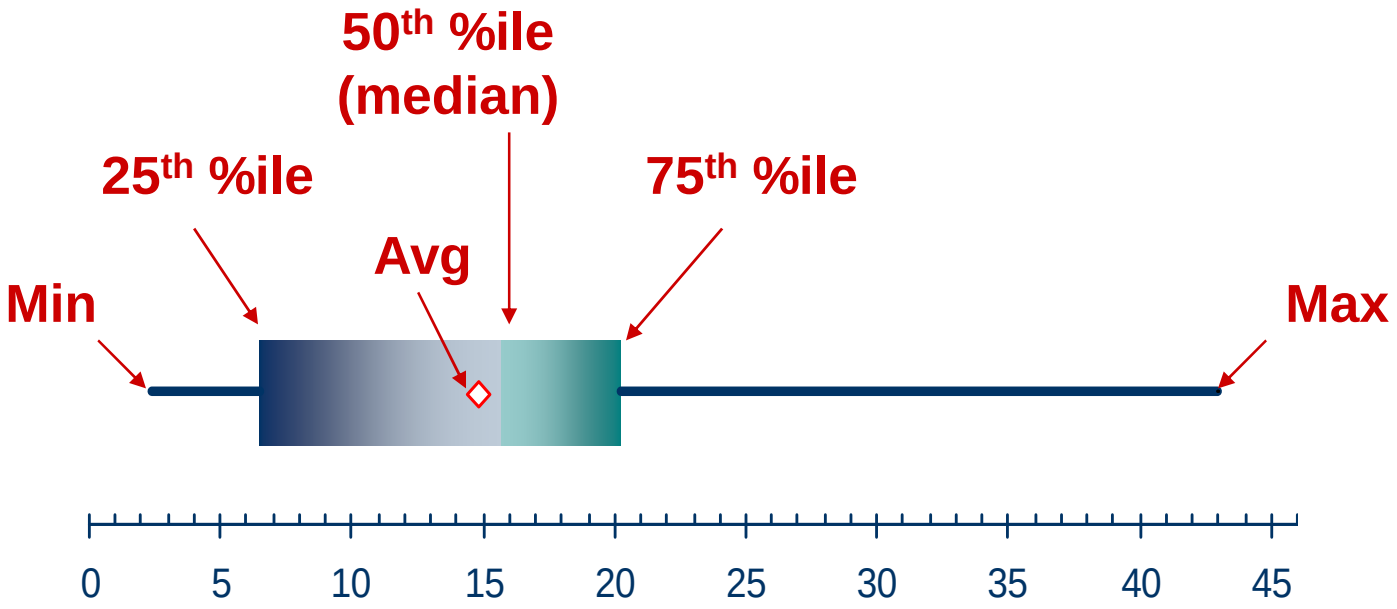
	Built	Operat		/A	Total
Nitrification	0	50	3	6	59
De-Nitrification	4	31	4	2	59
P-Reduction	3	18			59

Ought to be Experimenting

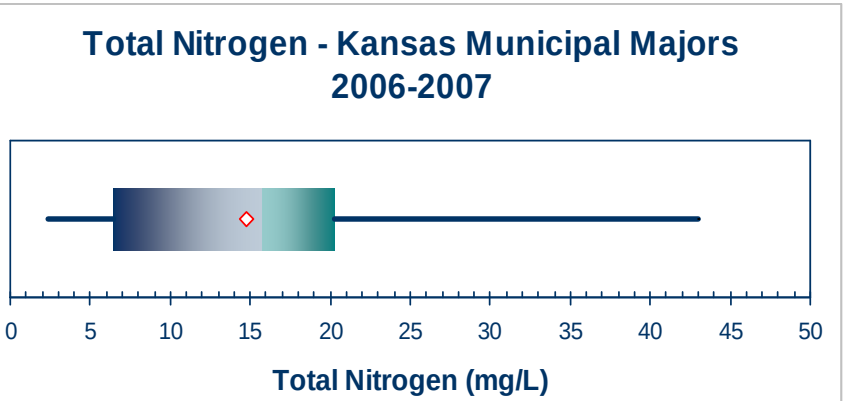
90% Nitrify now or will soon
60% Denitrify now or will soon
37% Operated to reduce TP now or will so

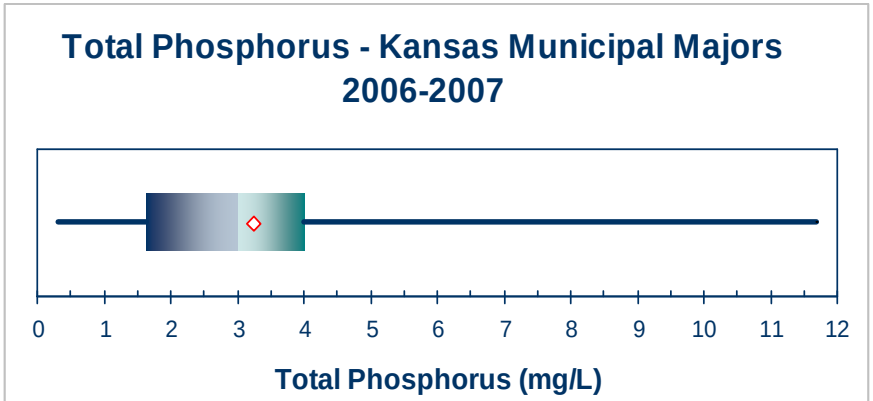
Nutrient Specialty Conference
Aug 25 and 26, 2008
Topeka

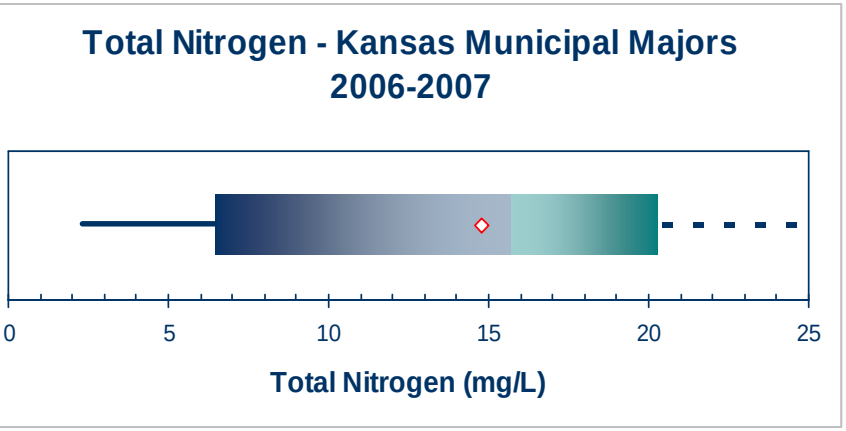
Bar and Whisker Chart

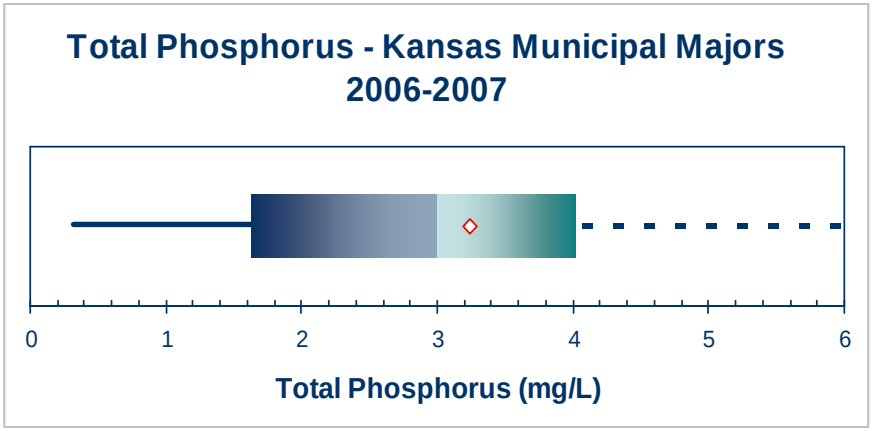


Nutrient Performance









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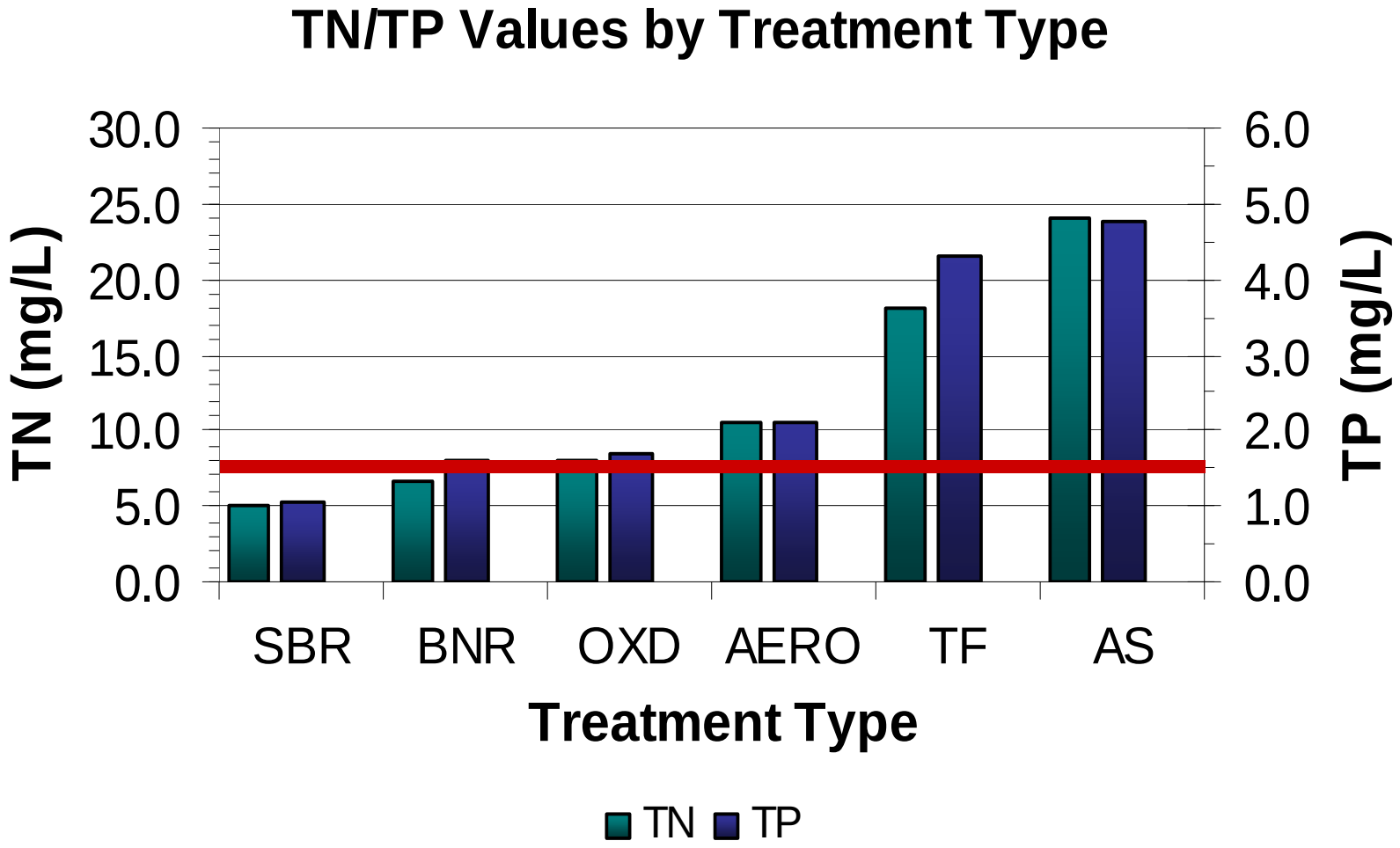
Performance by Type



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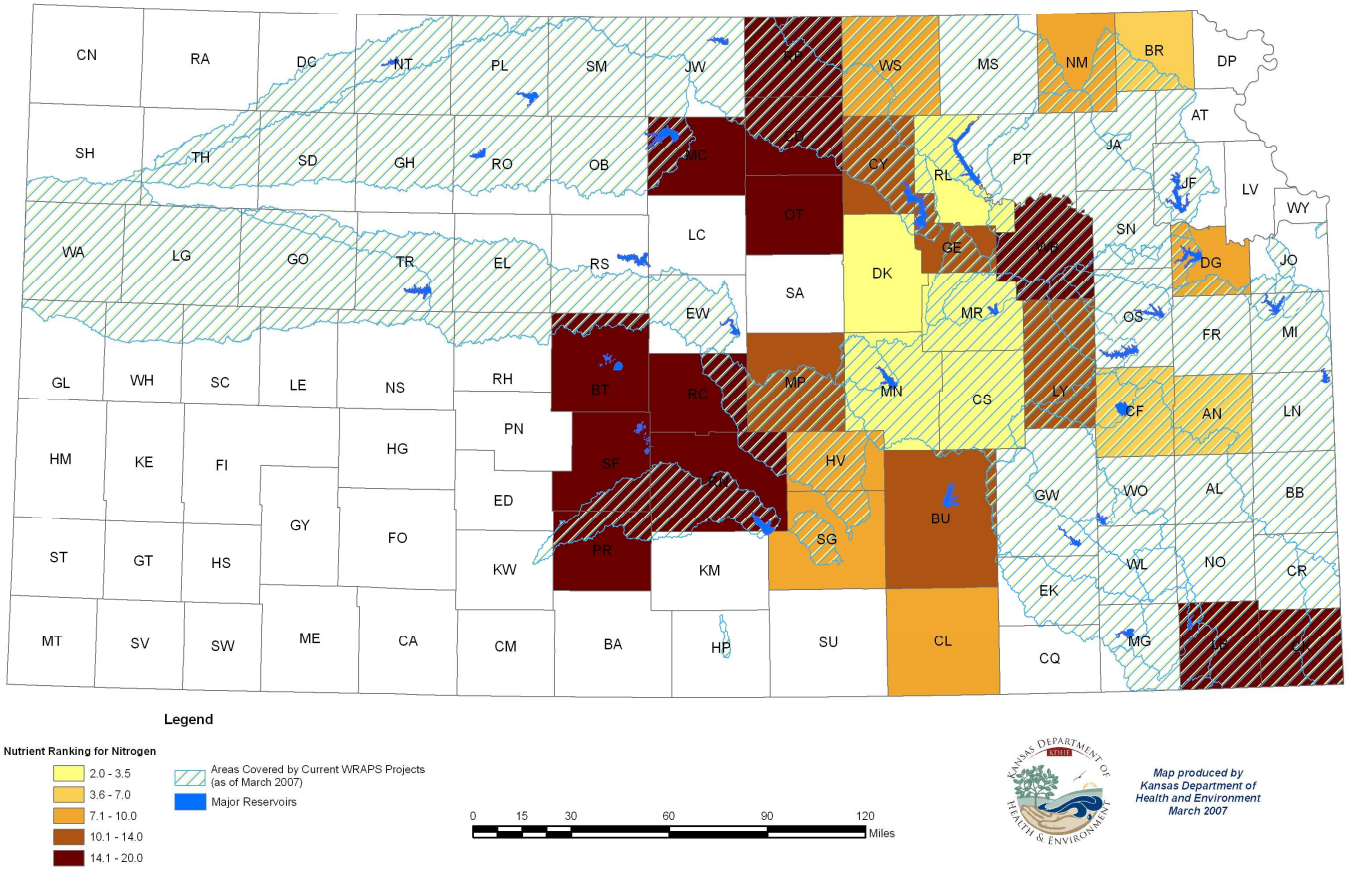
WRAPS/Nitrogen IPI

Areas Covered by Current Watershed Restoration and Protection Strategies (WRAPS), and County Nutrient Rankings for Nitrogen



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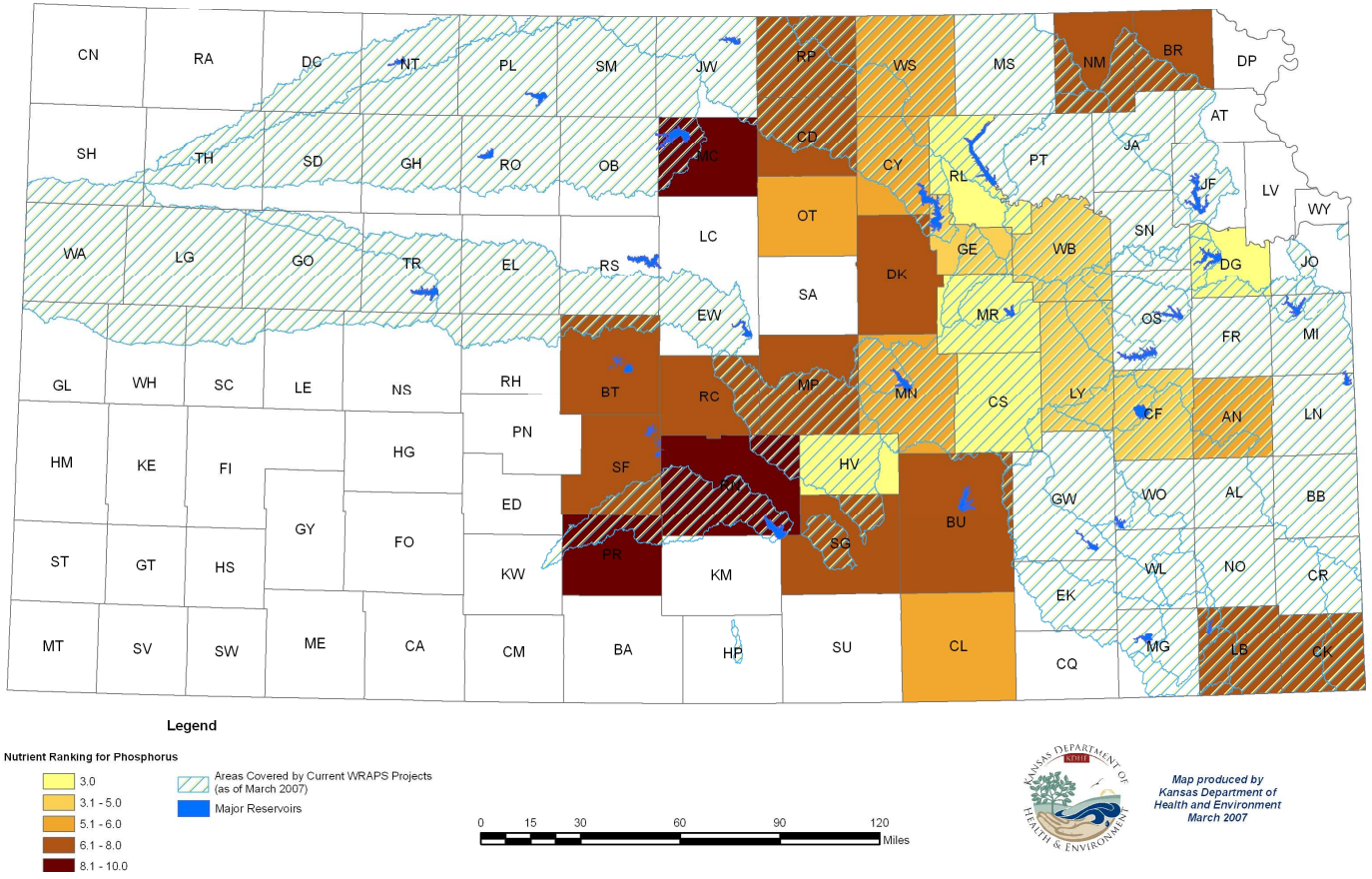
WRAPS/Phosphorus IPI

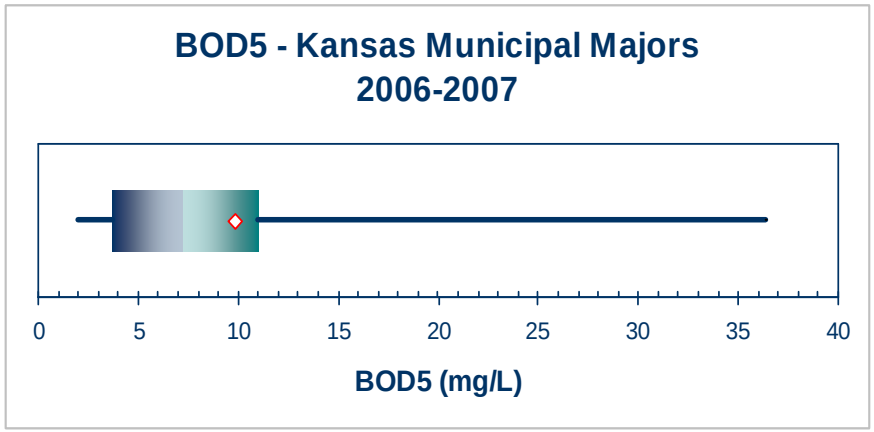
Areas Covered by Current Watershed Restoration and Protection Strategies (WRAPS), and County Nutrient Rankings for Phosphorus

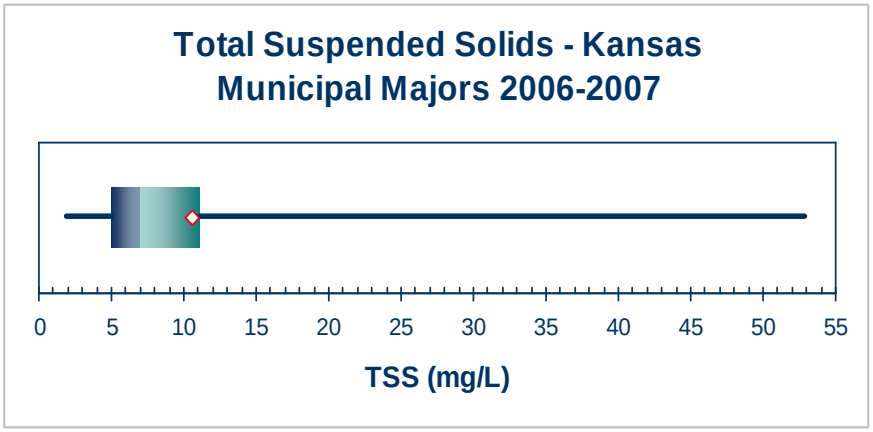


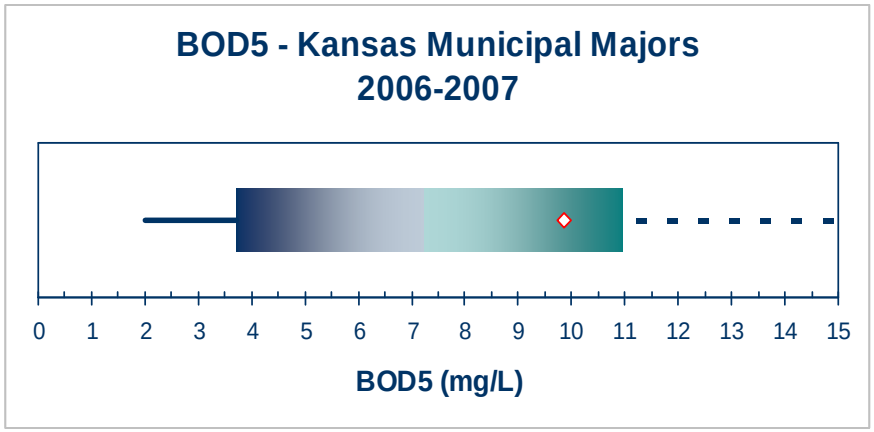
NRDC Petition/Technology-Based Treatment

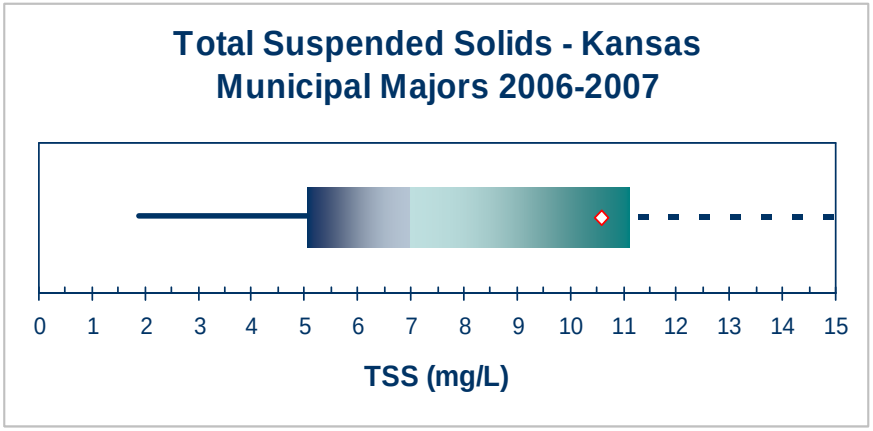
- Redefine Secondary Treatment
- Establish Technology Basis for Nutrient Removal

What is Typical Treatment in '08?









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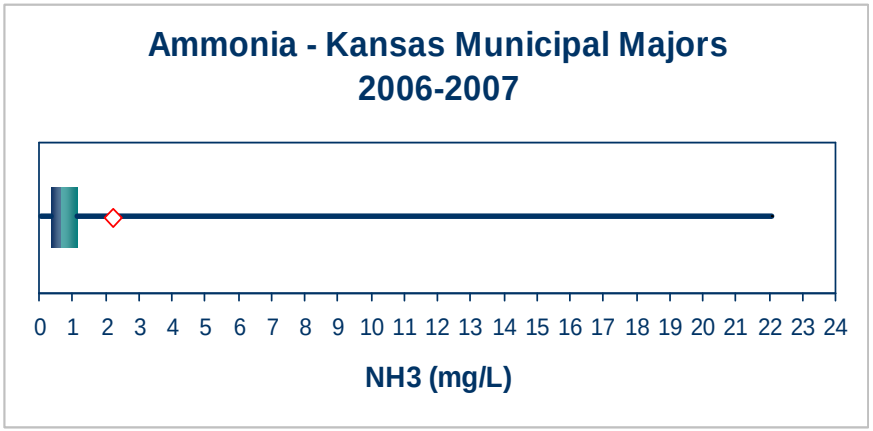
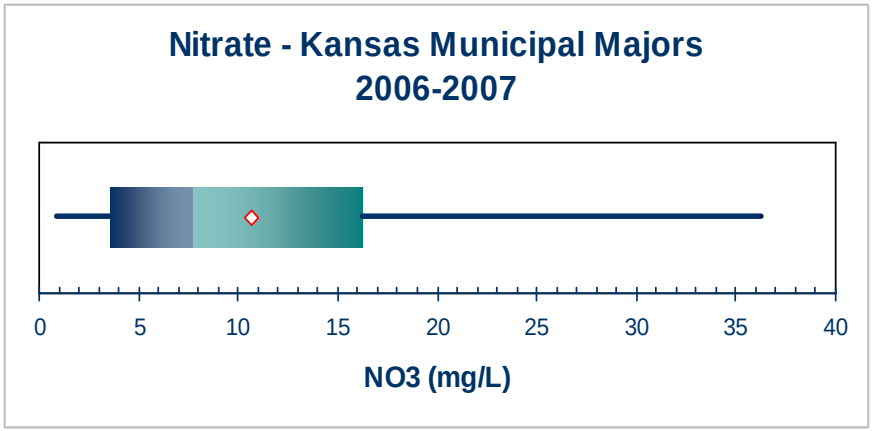
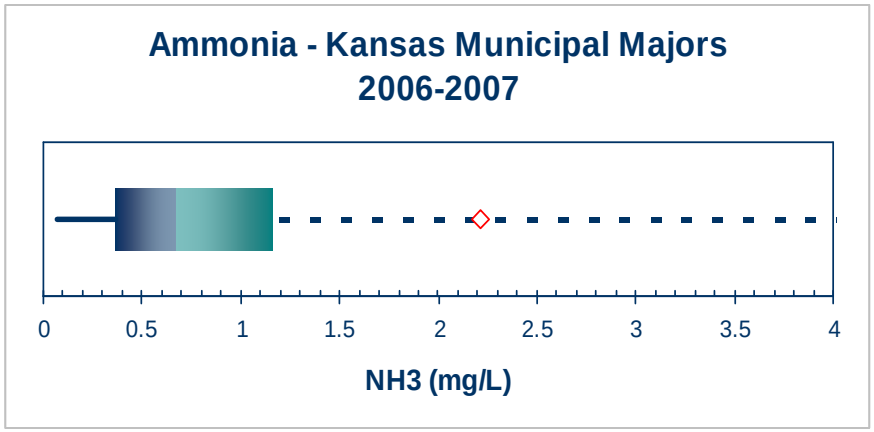
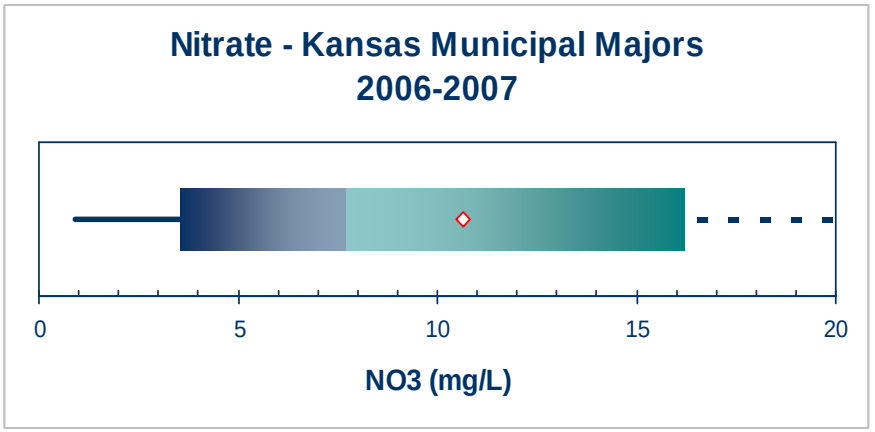




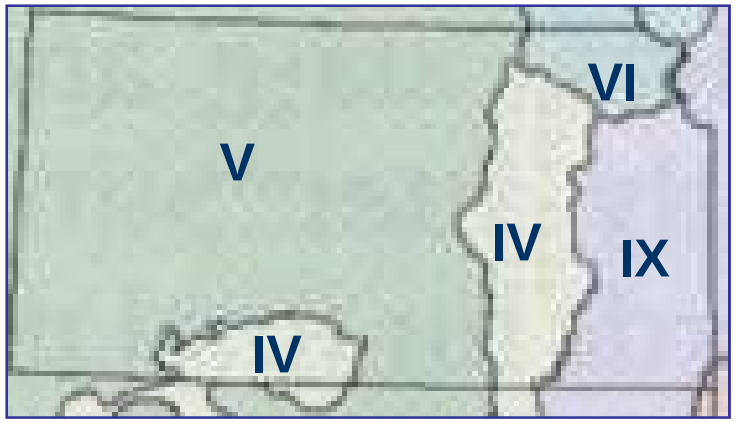


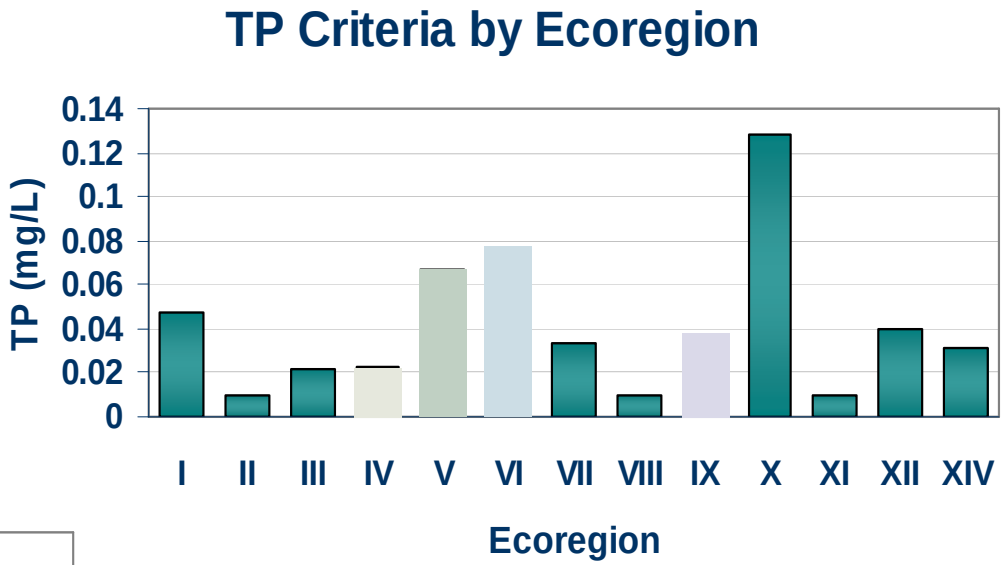


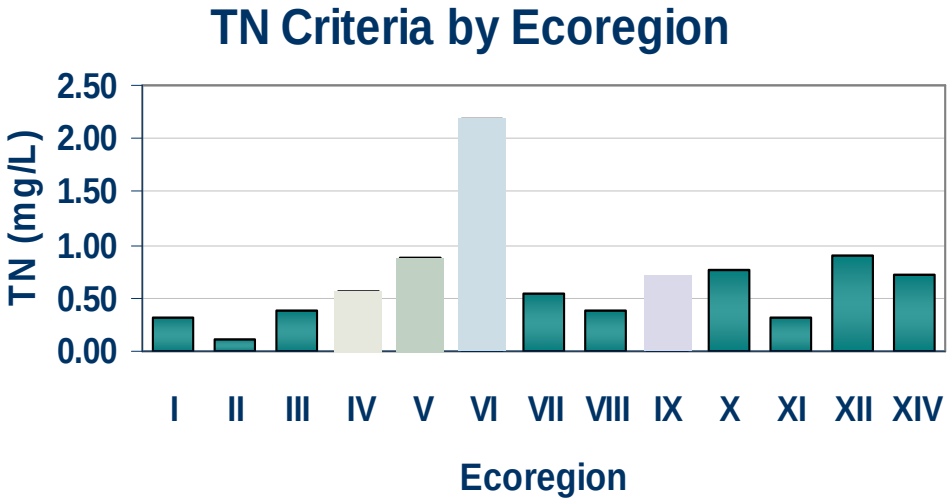
New “Secondary” Trt. – Pros/Cons

- Pros
  - CWA suggests periodic re-look [§304(d)]
  - Concentrated waste brought to a point
    - Nutrients in effluent much higher than stream
  - Better treatment easier to attain than in the past
    - Better trt. processes
    - Stable processes
  - Provide point sources a hard target
    - Ultimately, water quality based limits only other option

EPA Ecoregional Criteria







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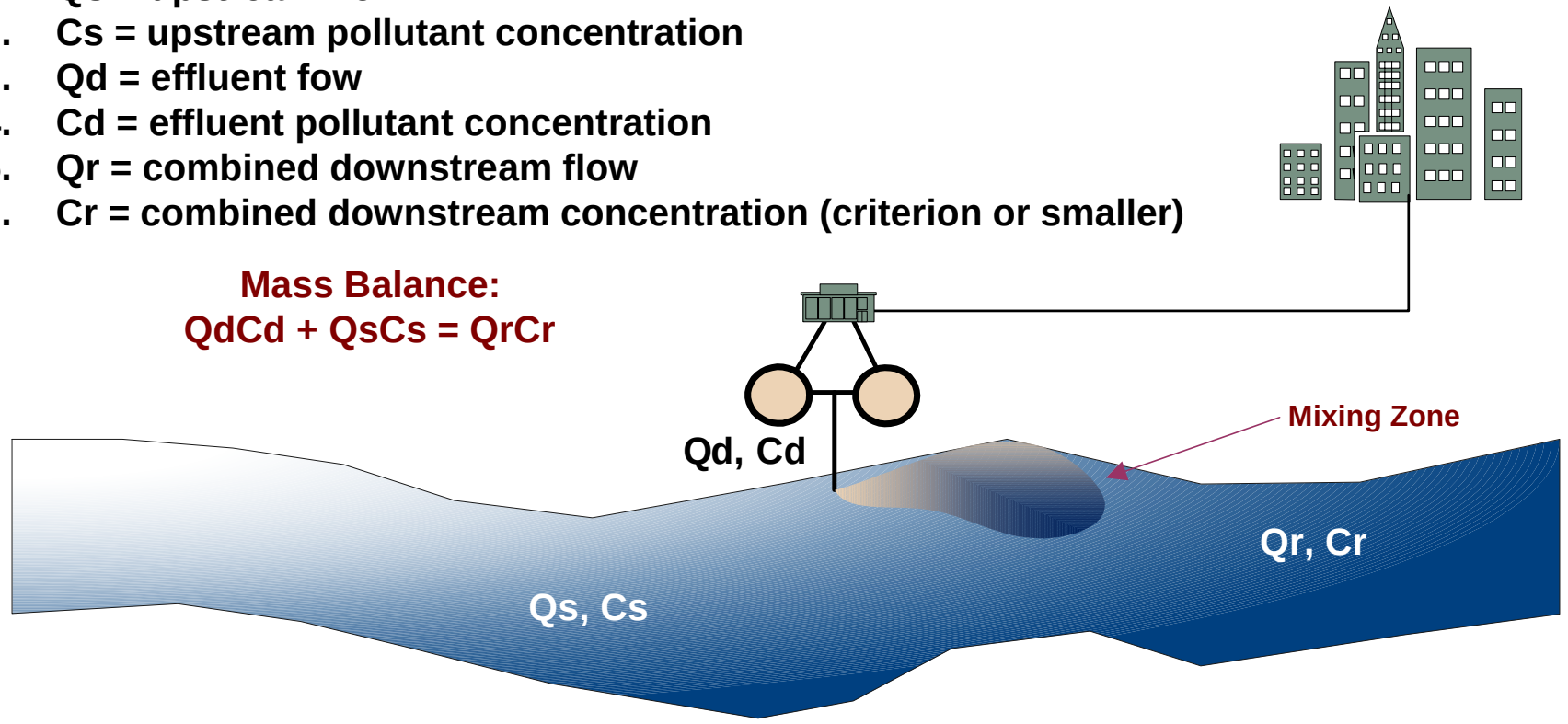
Water Quality Based Permit Limits

1. Qs = upstream flow
2. Cs = upstream pollutant concentration
3. Qd = effluent fow
4. Cd = effluent pollutant concentration
5. Qr = combined downstream flow
6. Cr = combined downstream concentration (criterion or smaller)

Mass Balance:
QdCd + QsCs = QrCr

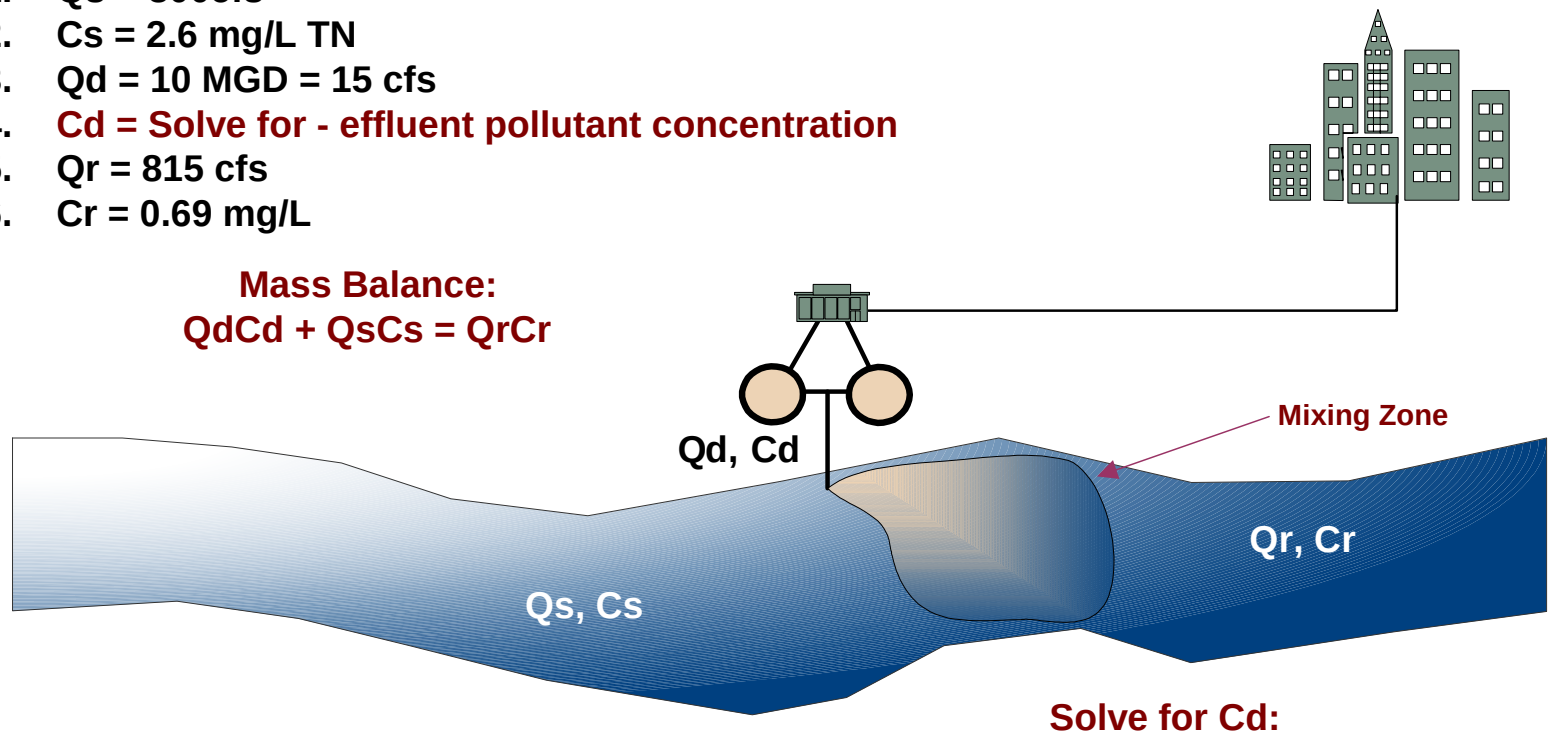


Solve for Cd:
Cd = (QrCr - QsCs) / Qd

Water Quality Based Permit Limits

1. Qs = 800cfs
2. Cs = 2.6 mg/L TN
3. Qd = 10 MGD = 15 cfs
4. Cd = Solve for - effluent pollutant concentration
5. Qr = 815 cfs
6. Cr = 0.69 mg/L

Mass Balance:
QdCd + QsCs = QrCr



Solve for Cd:

Cd = (QrCr - QsCs) / Qd
Cd = (815*0.69 - 800*2.6)/15

Cd = -101 mg/L

New Secondary Trt. – Pros/Cons

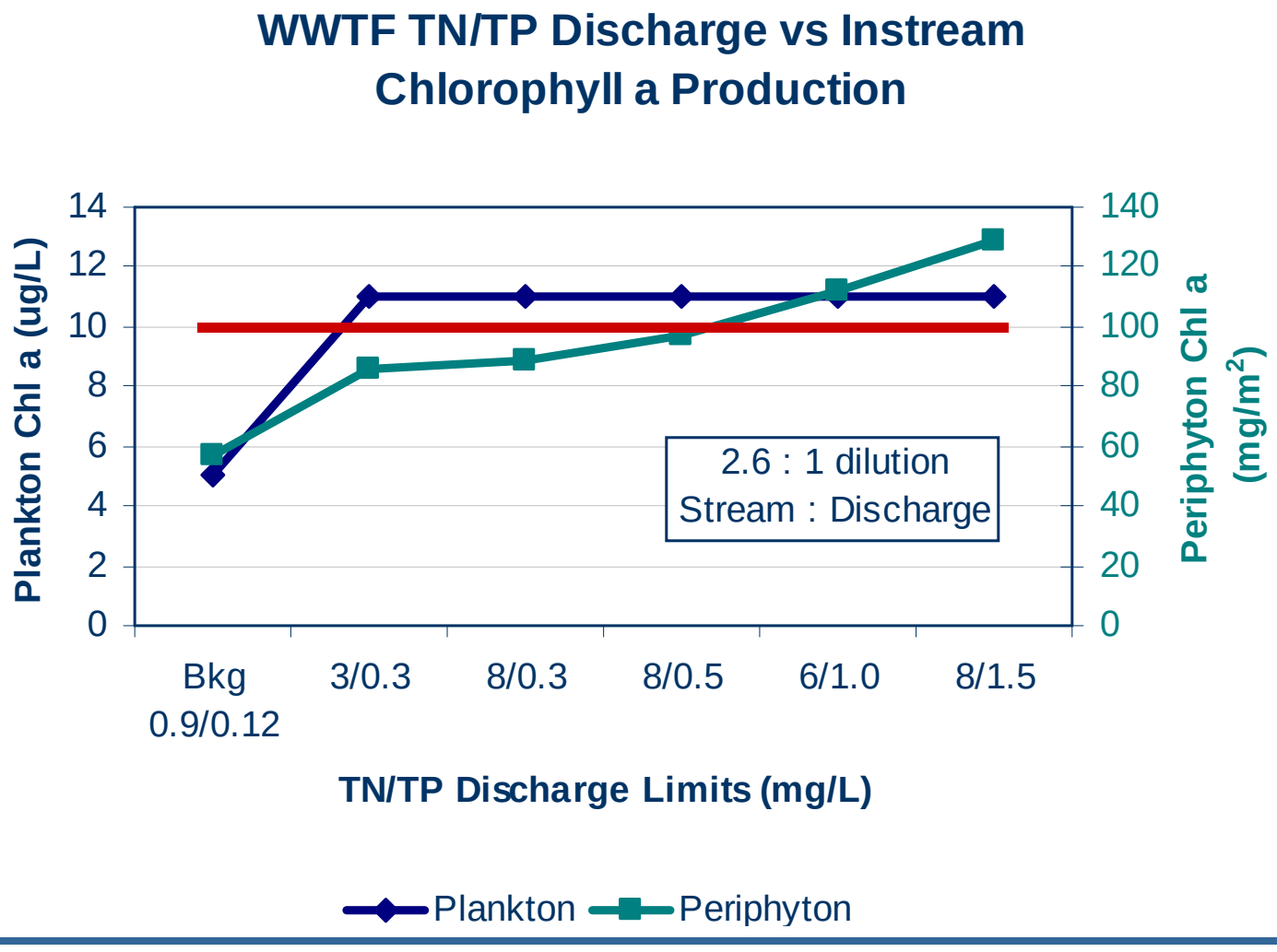
- Cons
  - Nutrient removal is costly
  - Point source nutrient removal will not result in tangible environmental benefits
  - CWA currently make allowance for lagoons, trickling filters, and ditches
    - This would not

Algal - Nutrient Response

Plankton Algae – Floating
Measured as Chlorophyll a
concentration (ug/L)

Periphyton Algae – Attached Growth
Measured as Chlorophyll a
mass (mg/m^2)

Point Sources Aren't a Problem?



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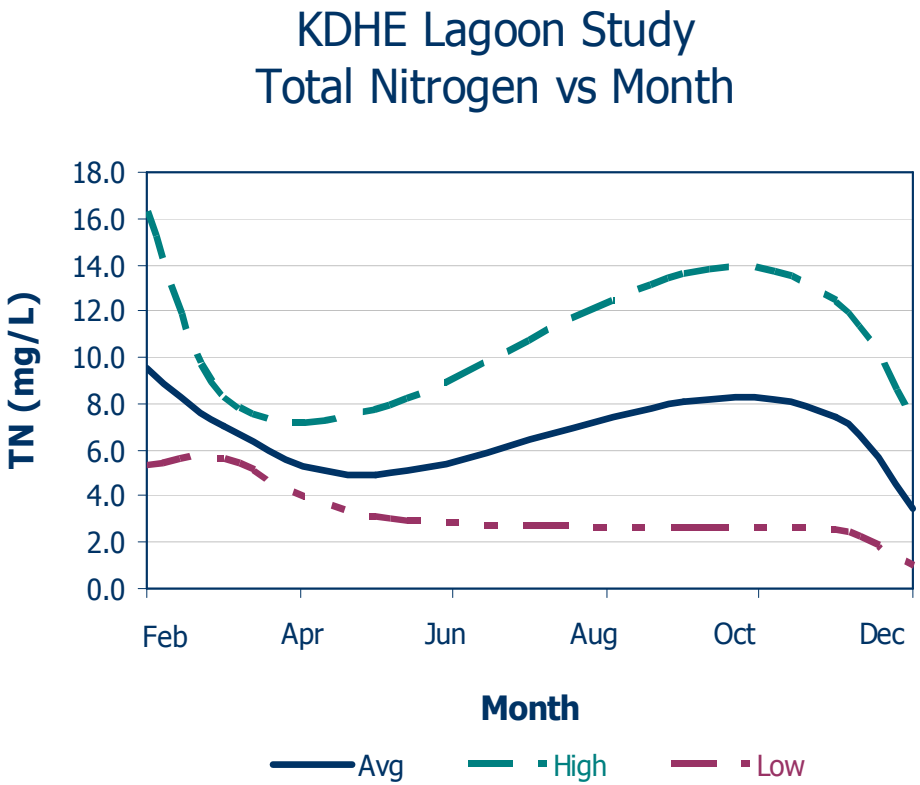
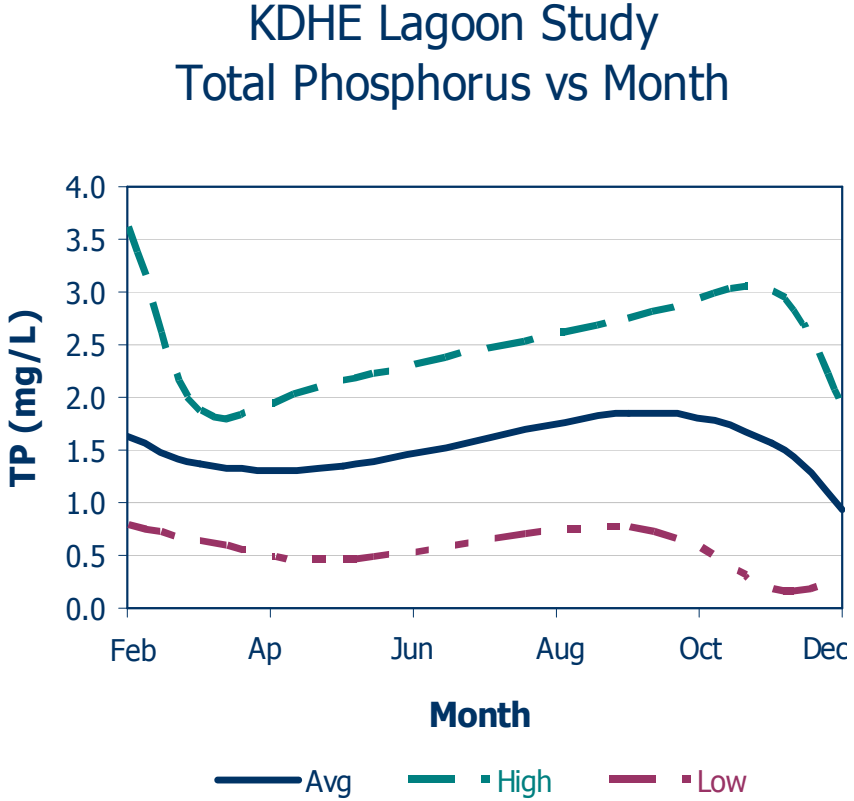
Lagoon Treatment





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My Ideal

- Nutrient WQS and NPDES work together
  - TN/TP unlike other pollutants we have dealt with
    - In R7, point sources generally can't solve the problem
      - Can help to a degree
      - Can't solve like it primarily did for DO, NH_3, metals, etc.
- How would I accomplish
  - Criteria for ambient water
  - Technology-based limits for NPDES dischargers
  - TMDL brings it all together

My Ideal

- Mechanical Plants
  - Base limits on population equivalent
    - Economy of scale plays a large role
      - Lower population, less stringent limits
      - Higher population, more stringent limits

My Ideal

- *Sustainable, Low GHG Footprint* Lagoons
  - Non-discharge are preferred
    - Cost out if in western ½ of state
  - <3000 population, discharge lagoon OK
    - Assumes
      - Meeting minimum design standard
      - Well maintained and operated
      - No high-strength industrial waste
      - May need to be controlled discharge
  - Between 3000 and 7500 cost out options
    - Controlled discharge at a minimum

Final Thought

Trash Receptacle at The Great Mosque Xi'an China

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