Nutrient Scientific Advisory Board

Status Update for Falls Lake Stage I Alternative Implementation and Stage II Re-examination

December 3, 2021

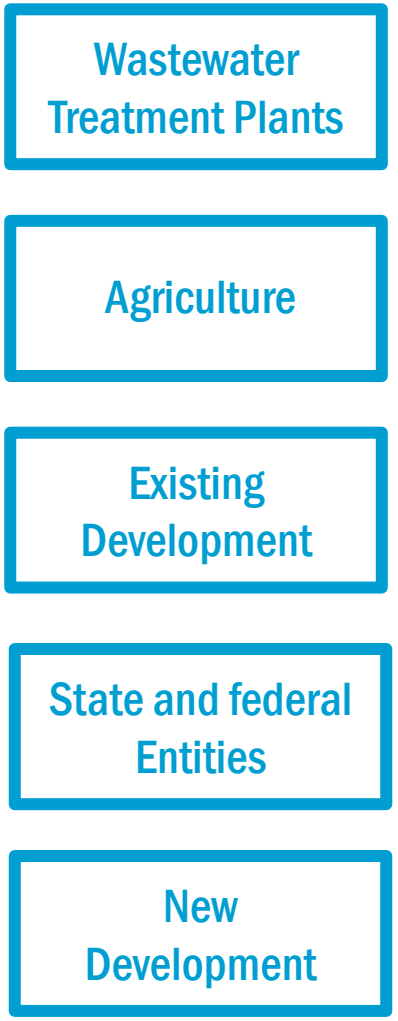
Status Update: Stage I Implementation

Falls Lake Regulatory Framework

- Falls Lake Nutrient Management Strategy was passed 2011
  - Includes two stages of nutrient reductions
  - Rules are structured by regulated sector
  - Anticipated to cost over $1.5 billion
  - Regulated sectors are siloed
  - Allows local governments to work together toward existing development requirements
  - Allows point and non-point sources to work together to meet load reduction requirements

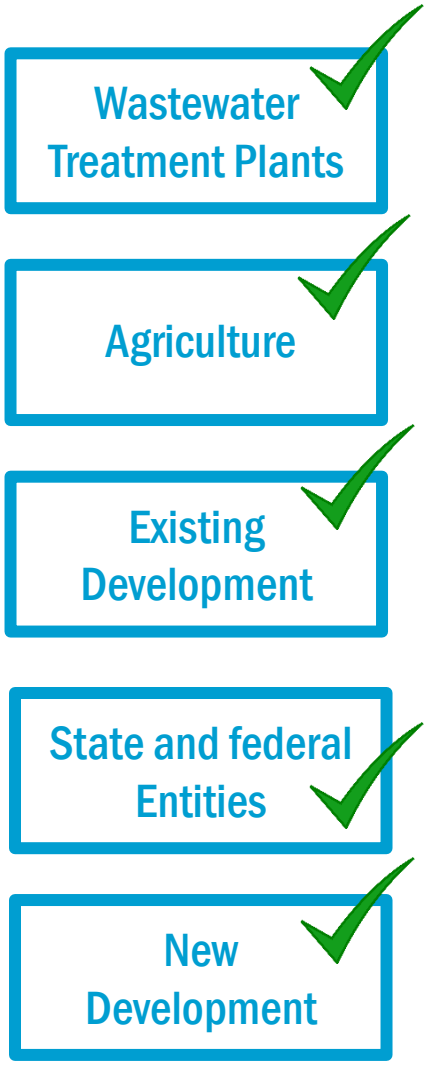
Stage I Requirements

- Wastewater treatment plants (WWTPs) and agriculture to reduce loading from 2006 levels
  - Nitrogen (N) 20 percent
  - Phosphorus (P) 40 percent
- Loads from existing development reduced to 2006 levels
- State agencies like Department of Transportation to install projects each year
- New development permitted after 2007 to include SCM's to limit nutrient loading from the site
  - 2.2 lb-N/ac/yr
  - 0.33 lb-P/ac/yr

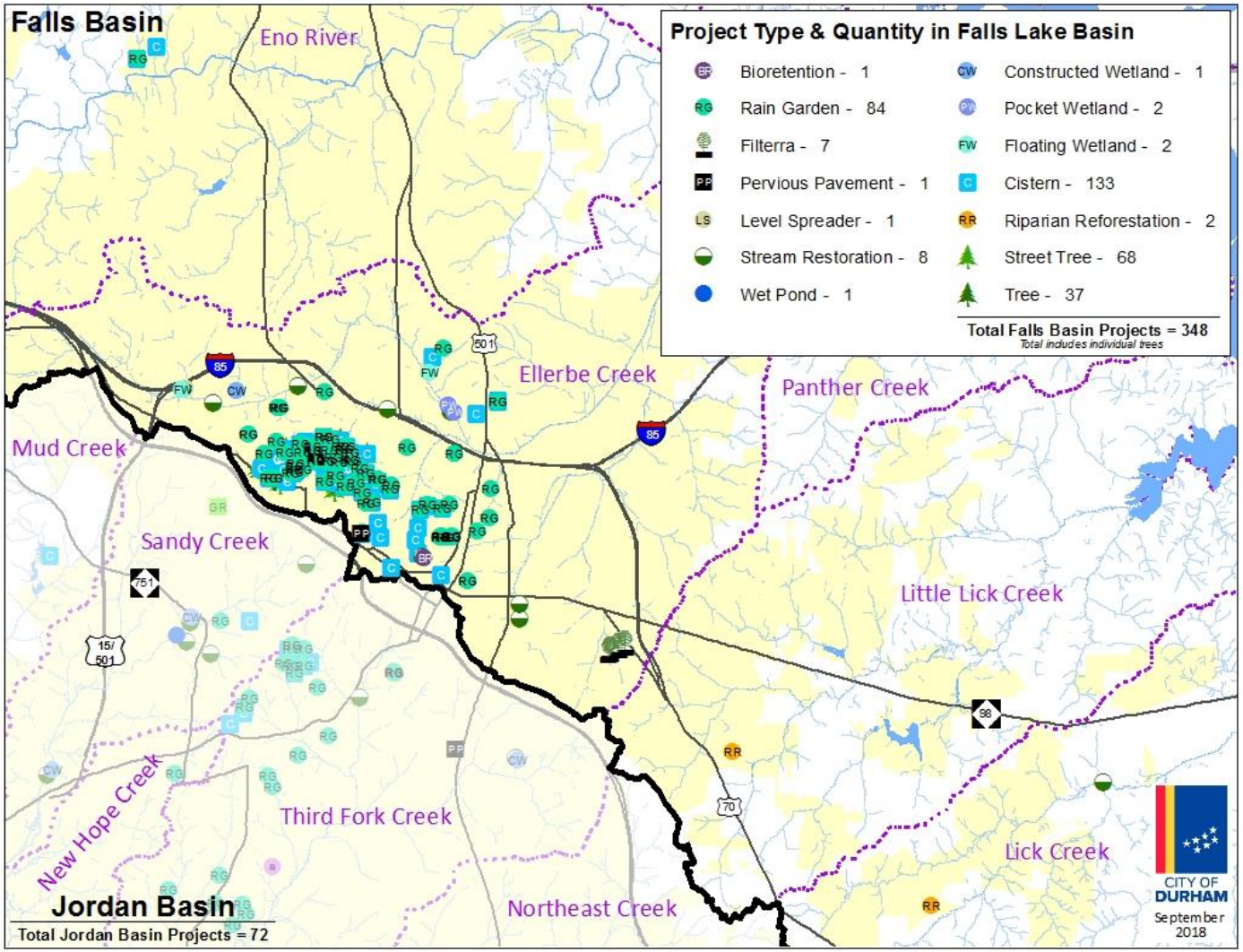


Stage I Implementation Status

- Regulated sectors have made progress toward the implementation of Stage I Rules
  - New development rule is being implemented
  - Stage I reductions have been met for agriculture
- Wastewater treatment plants (WWTPs) have reduced loading beyond Stage I requirements, resulting in temporary credits
  - 50,000 pounds of nitrogen per year
  - 9,700 pounds of phosphorus per year
- Existing development
  - Several obstacles have limited implementation
  - Some local governments have installed retrofits (see examples next slide)
  - Load reduction requirements are much less for existing development than the WWTP credits



Examples of Existing Development Retrofits (City of Durham)



Stakeholders Cooperatively Developed an Alternative Approach for Stage I Existing Dev.

- **Innovative** concept originated by NGOs in March 2018
- Developed over three years by UNRBA as an **alternative** to Stage I Rules for Existing Development
- Focuses on investment and implementation of projects to **improve water quality** – does not focus on counting pounds
- Provides more **flexibility** and **promotes cooperation** - expands eligible practices and actions, removes regulatory silos, and encourages joint ventures
- **Voluntary** program – members may choose to implement individual local programs under current rules or the IAIA
- **Interim** until the Stage II re-examination is complete (pilot)

Stage I Existing Development Interim Alternative Implementation Approach (IAIA)

- DWR included this approach in their revised model program for the Falls Lake Nutrient Management Strategy in 2020
- The Environmental Management Commission approved the revised model program and the IAIA in January 2021
- The UNRBA revised their Bylaws to allow for the program and formally adopted it in June 2021
- All local government members of the UNRBA are participating in the program which began in July 2021
- Program results in $1.5 million of investments in eligible projects

Reporting Tool to Track Compliance

- Developed to assist the IAIA participants in tracking eligible projects and compliance with the Program
- The draft tool has been reviewed by the IAIA Reporting Workgroup:
  - Sandi Wilbur and Lance Fontaine, City of Durham
  - Terry Hackett, Town of Hillsborough
  - John Huisman, DWR
- DWR provided additional content including “additional benefits” that could be included in the project descriptions

Eligible Projects for IAIA

- All State-approved practices with established nutrient credits
- Green infrastructure and best management practices that include water quality and quantity improvements
- Illicit discharge detection and elimination
- Stream and riparian buffer restoration and enhancement
- Land conservation in high priority areas
- Greenways, parks, and projects with water quality and quantity benefits
- Programmatic measures exceeding baseline levels
  - Fertilizer application education for businesses and homeowners
  - Onsite wastewater treatment system inspection, maintenance tracking, and tank pump-out programs
  - Pet-waste education and waste management stations
- Additional activities as approved by DWR

Example FY2021 Projects

- Person County Land Conservation Project
  - Person County Board of Commissioners voted to proceed with moving forward with utilizing the undeveloped 300 acre “County Farm” site for IAIA compliance
  - Alternative use of this area was timbering
- Orange County Hydrilla Eradication Project
  - Orange County has requested approval from DWR to include an expanded Hydrilla eradication project as part of their eligible investments
  - Request for approval includes information about water quality benefits associated with Hydrilla eradication

Status Update for Stage II Re-examination

Regulatory Framework – Stage II

- Nutrient reductions are the most stringent passed in NC
  - State agencies (DOT) to install projects
  - Existing development, WWTPs, and agriculture to decrease from baseline
    - Nitrogen (N) 40 percent
    - Phosphorus (P) 77 percent
- Adaptive management provisions in the Rules were based on UNRBA Consensus Principles
  - Acknowledged the uncertainty with the original models and data used to build them
  - Required at least 3 years of additional data collection with DWR approval of plans
  - Revised models with DWR approval of plans

Challenges with Stage II—Existing Development

- Requirements are not technically feasible or financially viable
  - Reductions from existing development exceed limits of technology
  - Areas that are already built out are difficult to impossible to retrofit
  - Local governments are restricted by law from placing stormwater controls on existing owners and cannot exercise eminent domain for stormwater retrofits
  - Cost estimates exceed $1 billion
  - Falls Lake is a non-natural reservoir and the upper half is wide, shallow, and conducive to algal growth
- Approximately 60 percent of the watershed is forested, so areas for implementation are condensed
- Land used for agriculture has already declined significantly
- Development and increased population growth will continue to place demands on Falls Lake

Other Stage II Challenges

- Reduction levels for Stage II are beyond technology for WWTPs
- Requiring 77% P and 40% N reduction on agricultural land use will be a challenge (BMPs and nutrient management plans are already implemented on many farms)
- Application of reductions to DOT, government and institutional land use will be difficult to accomplish
- The water quality standard for chlorophyll-a is not appropriate for Falls Lake and establishes an objective that likely isn't achievable

Looking to the Future: Recommendations for Management of Existing Development in the Revised Rules

- Potential application of an investment approach in the future
- Potential cooperation between different categories of land use within the watershed
- Using cost or BMP installation as a compliance tracking approach
- Setting limitations on different types of projects
- Projecting water quality benefits using this approach
- Tracking water quality changes to document maintenance of lake quality and improvement

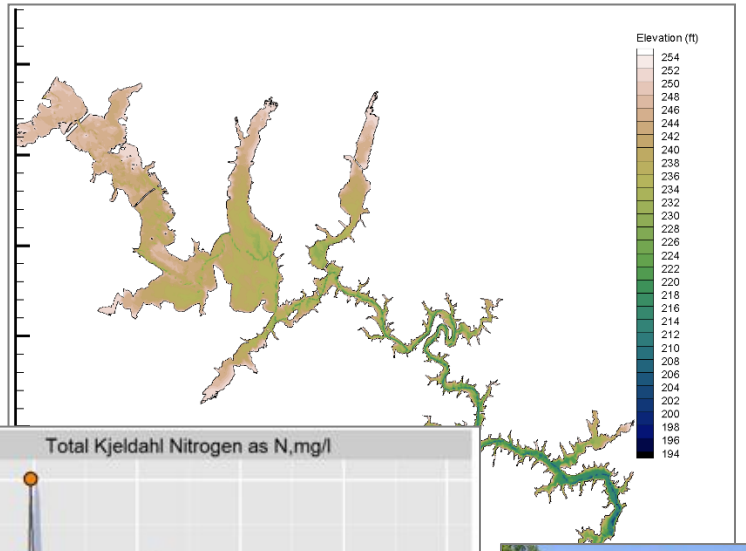
Re-examination of Stage II

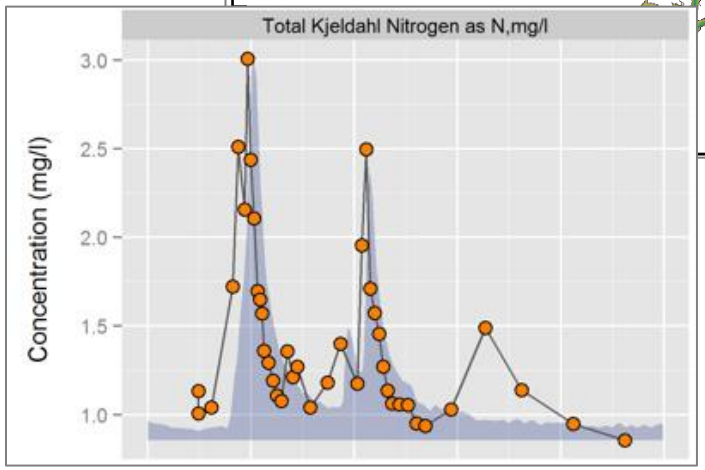
- The UNRBA began planning for the re-examination in 2011
- DWR approved the following UNRBA documents as required by the Falls Lake Rules
  - UNRBA Monitoring Plan
  - UNRBA Monitoring Quality Assurance Project Plan
  - UNRBA Description of the Modeling Framework
  - UNRBA Modeling Quality Assurance Project Plan (the detailed Modeling Framework)

The UNRBA is following the re-examination process described by the Falls Lake Nutrient Management Strategy.

Four Year UNRBA Monitoring Program

- $3.5 million program designed to support model development
- Routine monitoring
  - 38 stations in the watershed
  - Supplemental data in the lake
- Watershed special studies
  - High flow grab sampling
  - Storm event sampling
- Lake special studies
  - Light extinction data
  - Sediment quality
  - Bathymetry and sediment mapping
  - Constriction point study

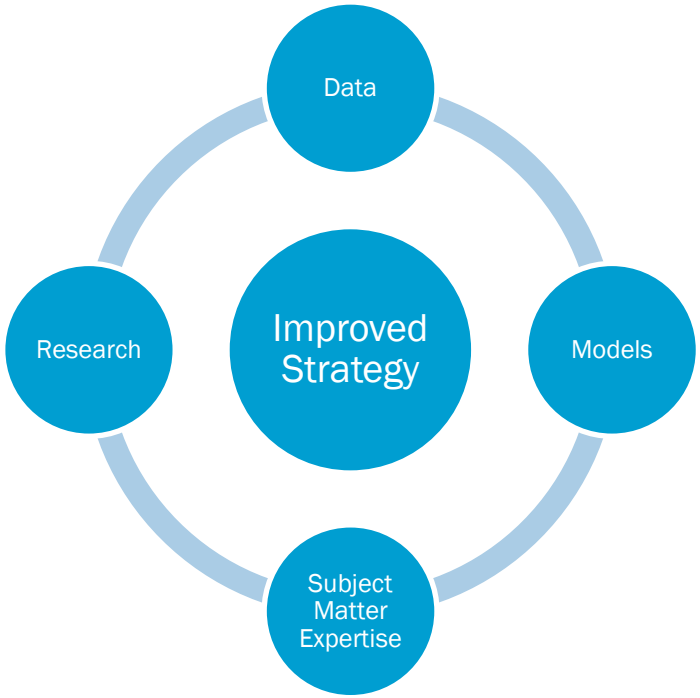




Final UNRBA Monitoring Report for Supporting Re-Examination of the Falls Lake Nutrient Strategy

Coordination Between the UNRBA and the UNC Collaboratory

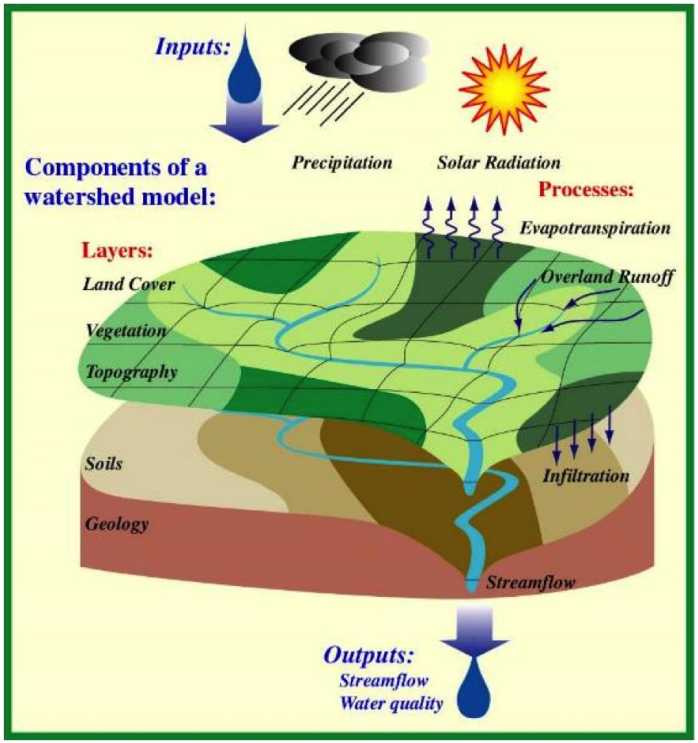
- Data and information sharing
- Coordination on potential Collaboratory studies
  - 3rd party review
  - Model inputs and parameters, e.g., onsite wastewater treatment systems
  - Site specific criteria for chlorophyll-a
- Routine working meetings
  - Research status
  - Modeling updates
  - Future studies
- Collaboratory research status updates at UNRBA meetings



Modeling Effort
Stage II Re-examination

Watershed Modeling Approach
Watershed Analysis Risk Management Framework (WARMF)

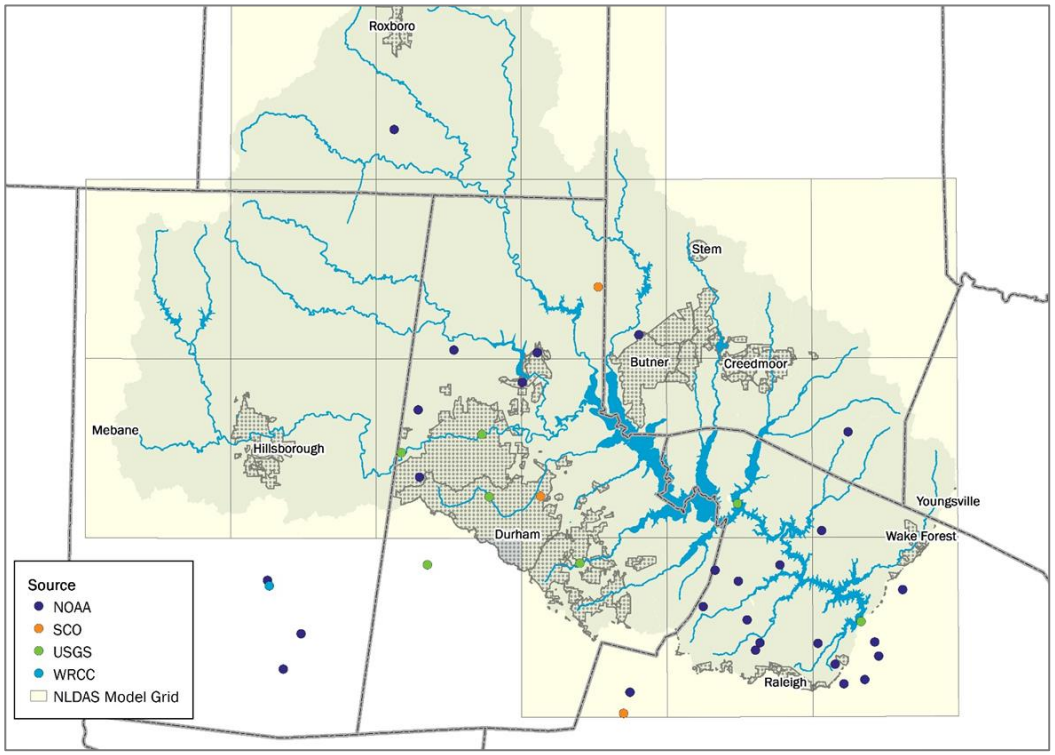
- Inputs
  - Meteorology
  - Land Use
  - Soils
  - Nutrient application
  - Topography
  - Hydrologic network
- Biogeochemical processes (this model does not assign runoff concentrations, groundwater concentrations, or loading rates by source)
  - Catchments
  - Streams
  - Impoundments
- Outputs: stream flow and water quality



https://scwrs.files.wordpress.com/2016/04/model-components.png

Sources of Meteorology Data for the Modeling

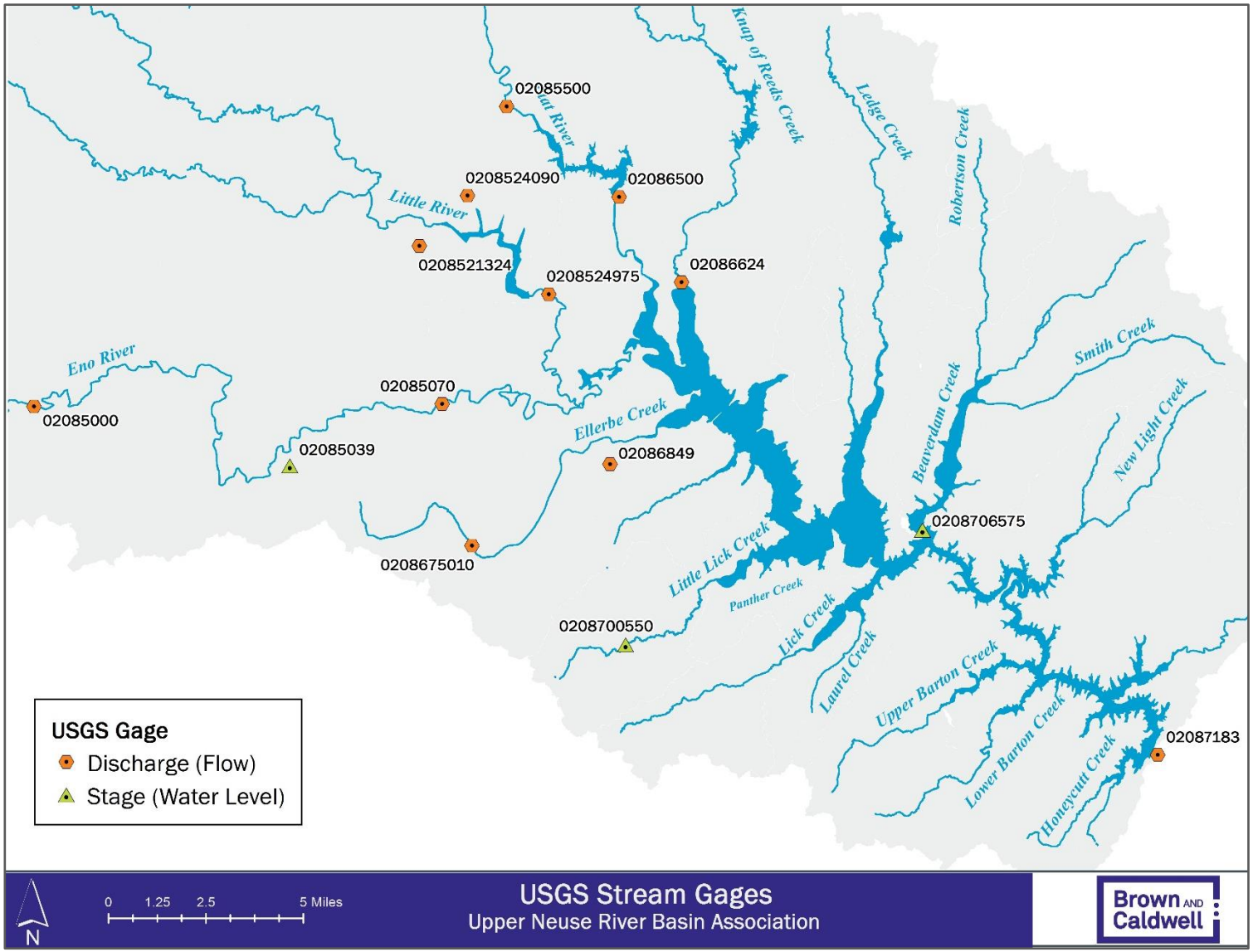
- North American Land Data Assimilation System (NLDAS)
- Western Regional Climate Center (WRCC)
- National Climatic Data Center (NCDC)
- State Climate Office of North Carolina: NEXRAD Radar Data
- USGS rainfall gages



NEXRAD Precipitation Data

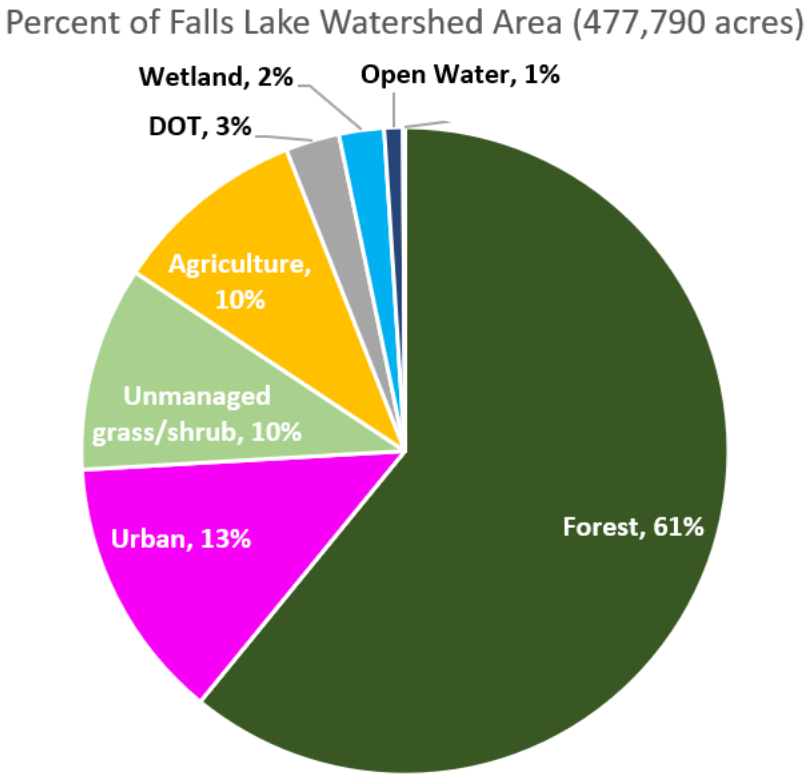
- NOAA operates the Next Generation Weather Radar (NEXRAD) system
- Comprised of 160 regional radar sites in the US
- **NC DOT and the State Climate Office generated time series files for ~80 locations in the watershed**

Location of USGS Gages



Land Use Data

- Base data from USGS National Land Cover Data
- Integrated with data from state agencies (NC Departments of Agriculture (NLEW data), Transportation, and Wildlife Resources Commission) and local governments
- Affects
  - Hydrologic response
  - Soil detachment
  - Vegetative processes
  - Management practices



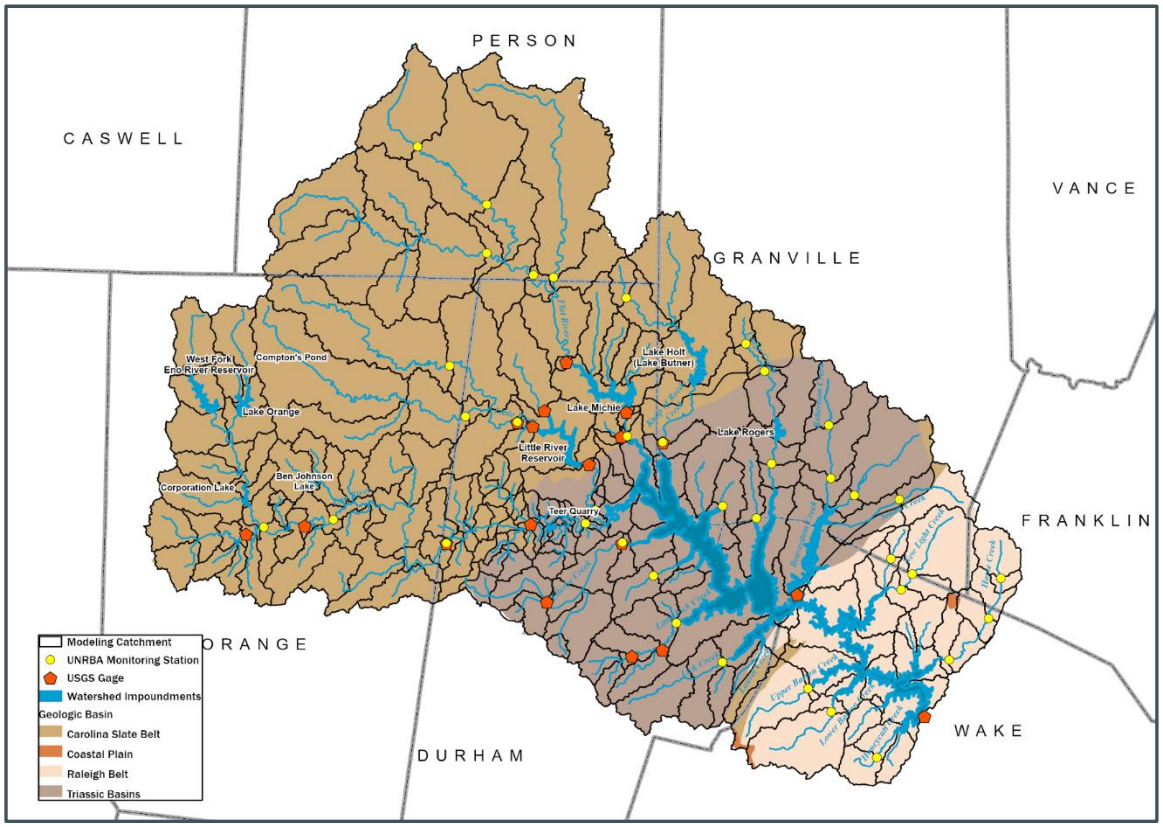
Soils Data Primarily from USDA

- Describes soil erosivity, soil fractions, chemistry, infiltration
- Hydrology parameters:
  - Hydrologic soil group
  - Depth to bedrock
  - Drainage class
  - Hydric classification
- Chemistry parameters (NCSS):
  - Base saturation for hydrogen (H), ammonium (NH4), aluminum (Al), calcium (Ca), magnesium (Mg), potassium (K), and sodium (Na)
  - Adsorption isotherms for phosphate (PO4, mg/kg), sulfate (SO4, L/kg), and dissolved organic carbon (DOC, L/kg)
  - Cation-exchange capacity (CEC)

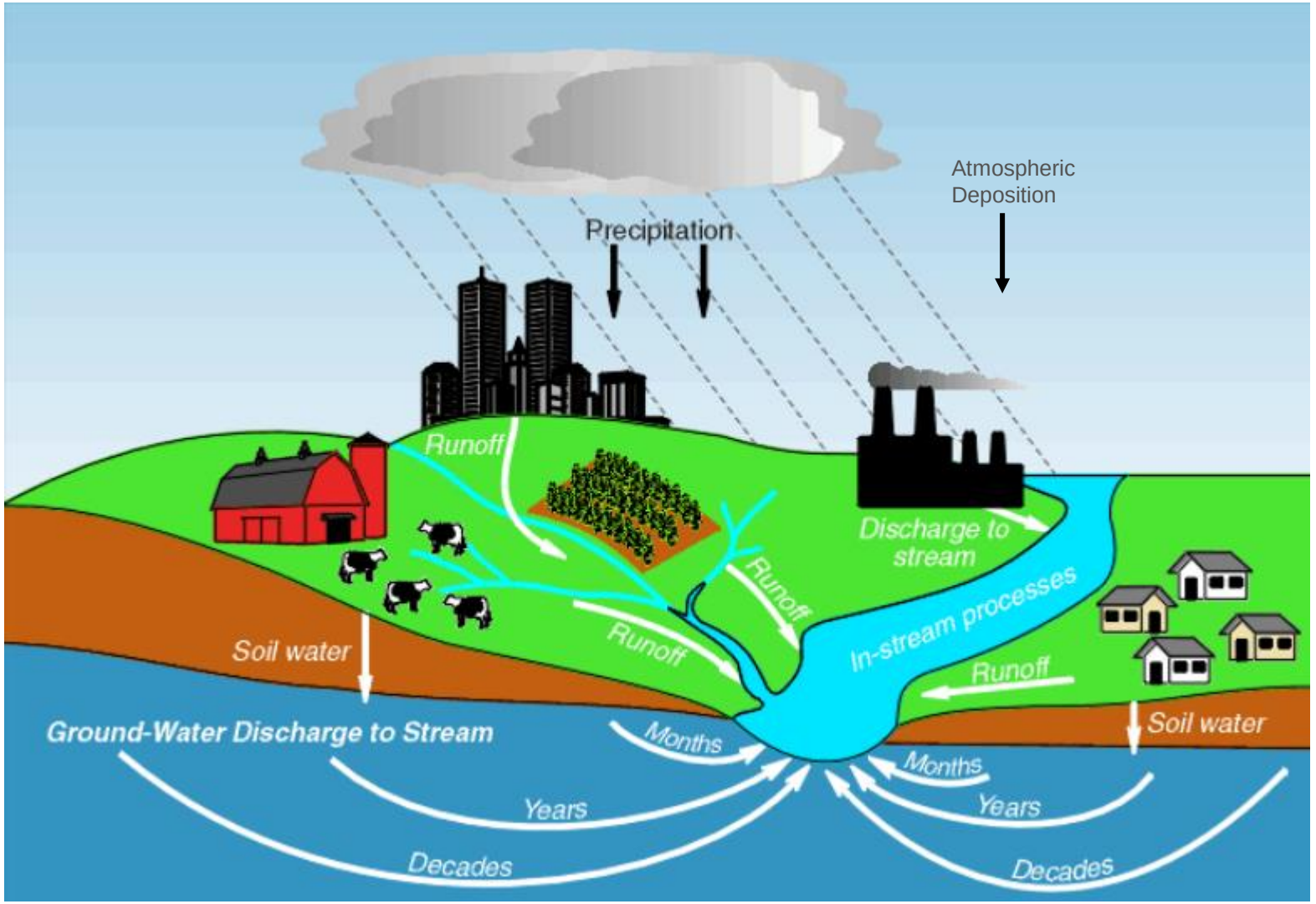
USDA National Cooperative Soil Survey (NCSS)

Modeling Catchments (264)

- UNRBA watershed monitoring stations
- County lines when feasible
- Topography
- Stream network
- Impoundments
- USGS stream gages



Sources of Loading



https://pubs.usgs.gov/fs/fs15099/

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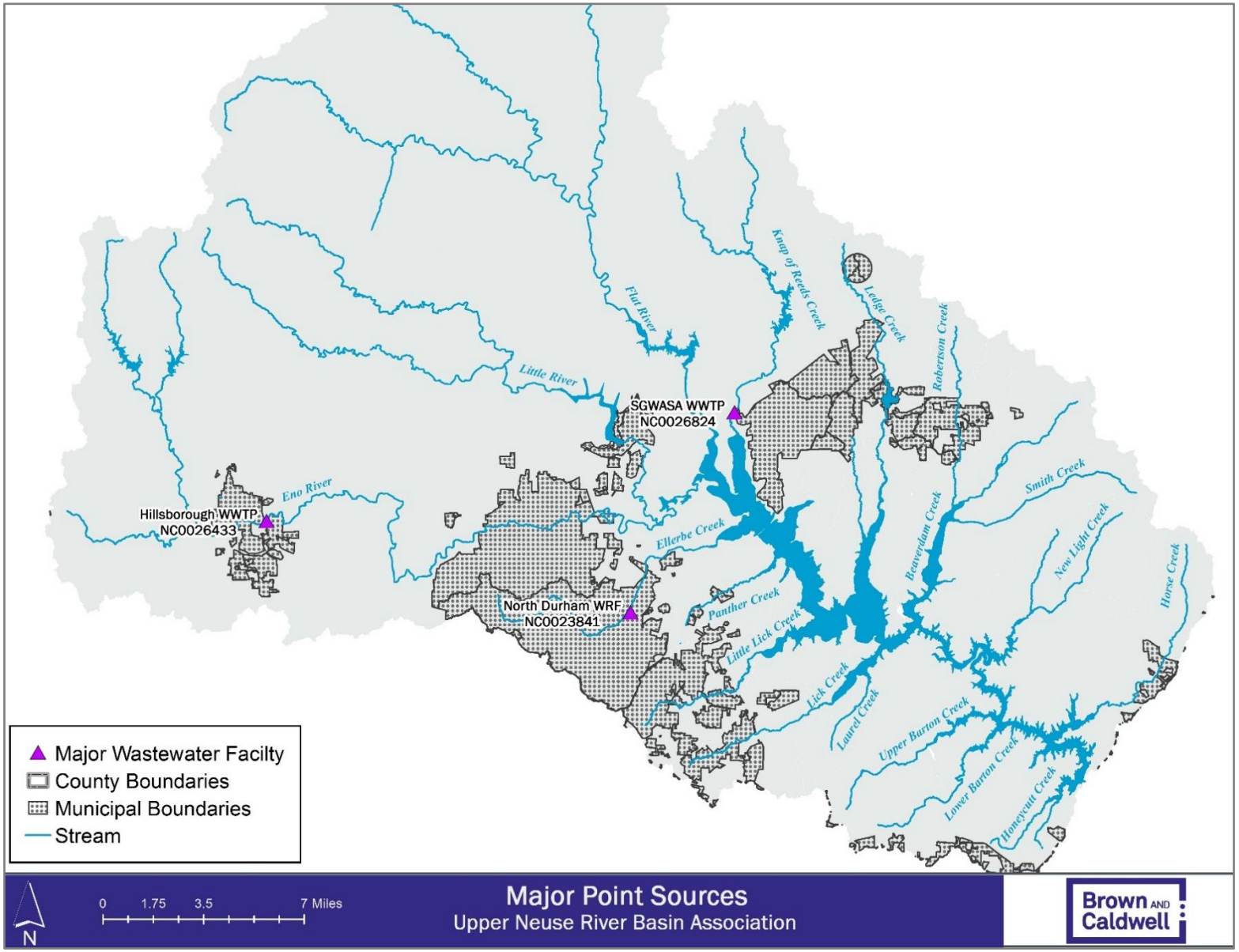
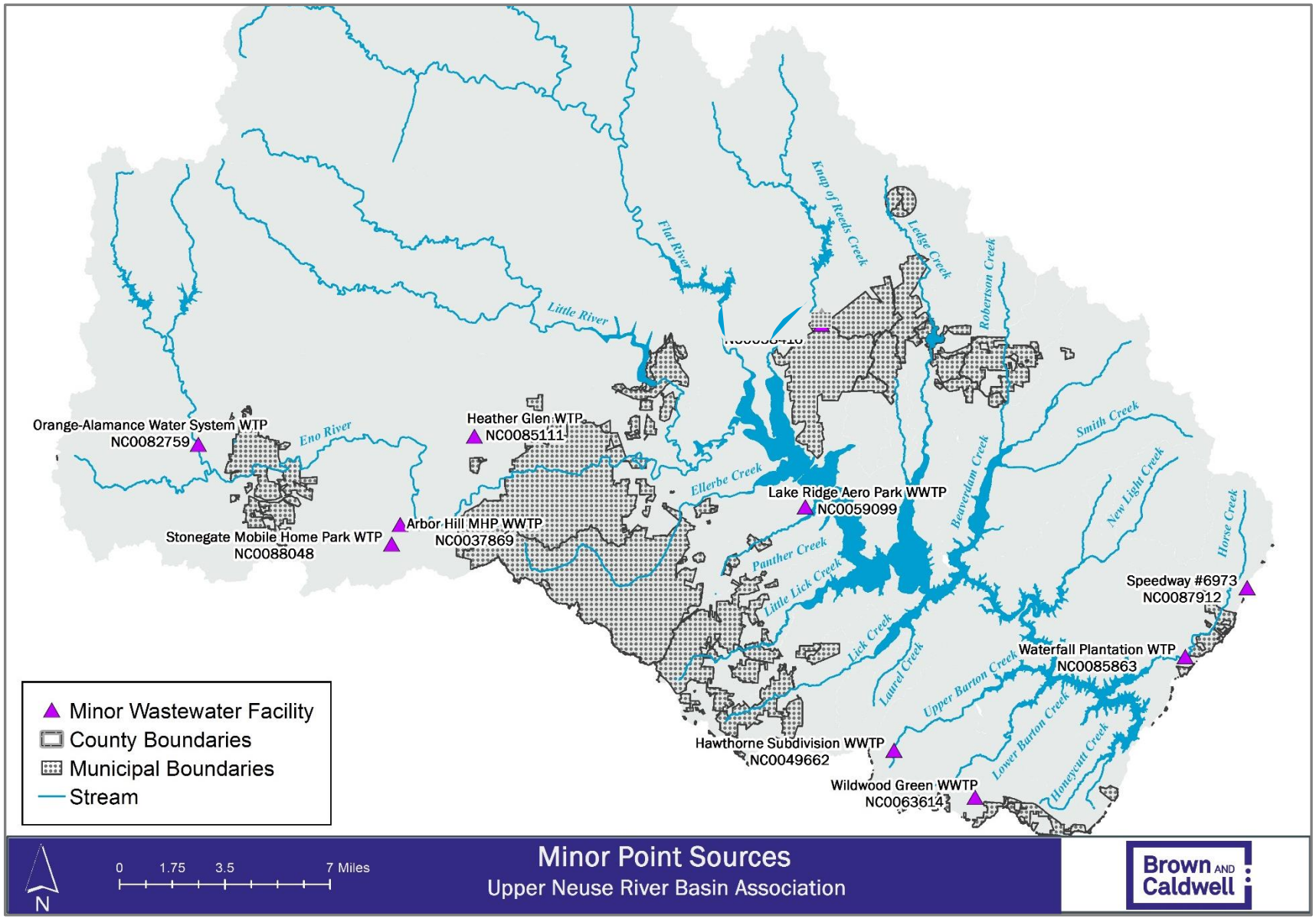
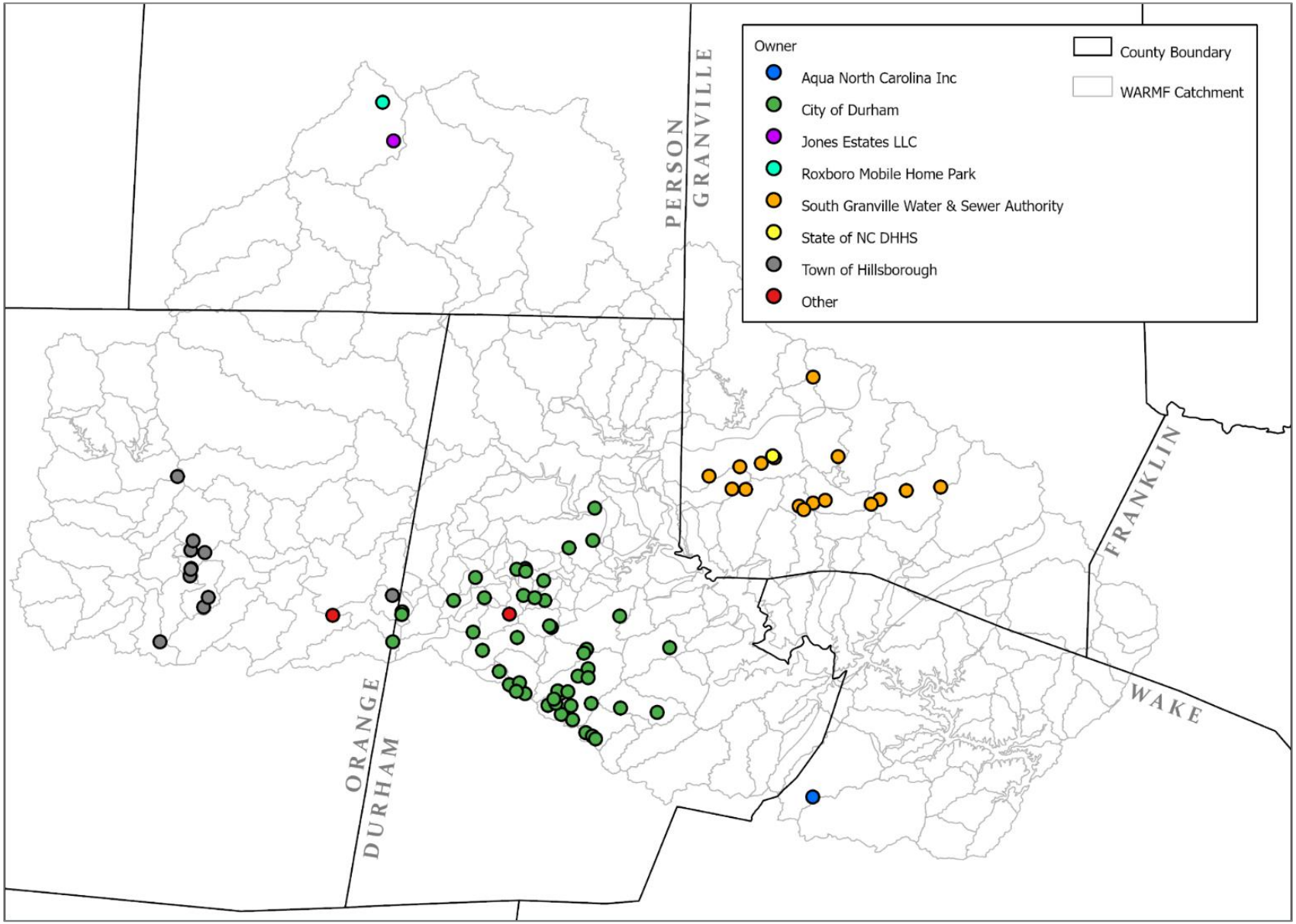
Major Wastewater Facilities



Minor Facilities

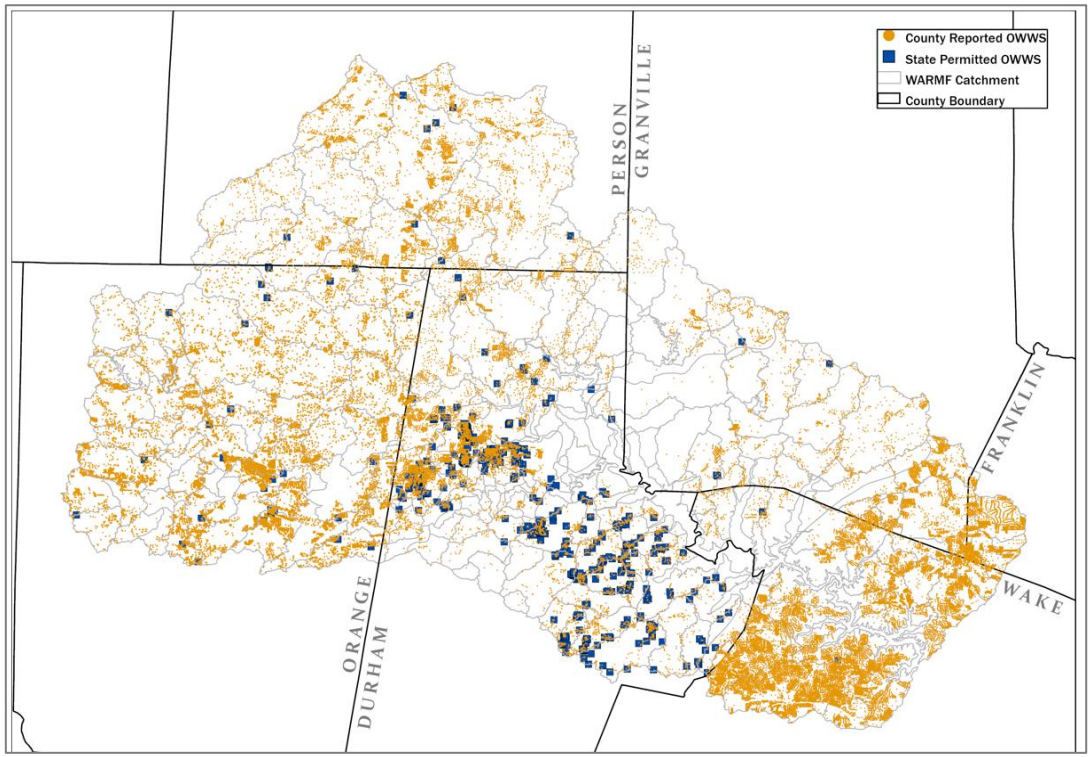


Sanitary Sewer Overflows



Onsite Wastewater (Septic) Systems

- Location, types, failure rates: Local governments, state agencies
- Collaboratory researchers: person capita flow rates and system effluent concentrations by type and function



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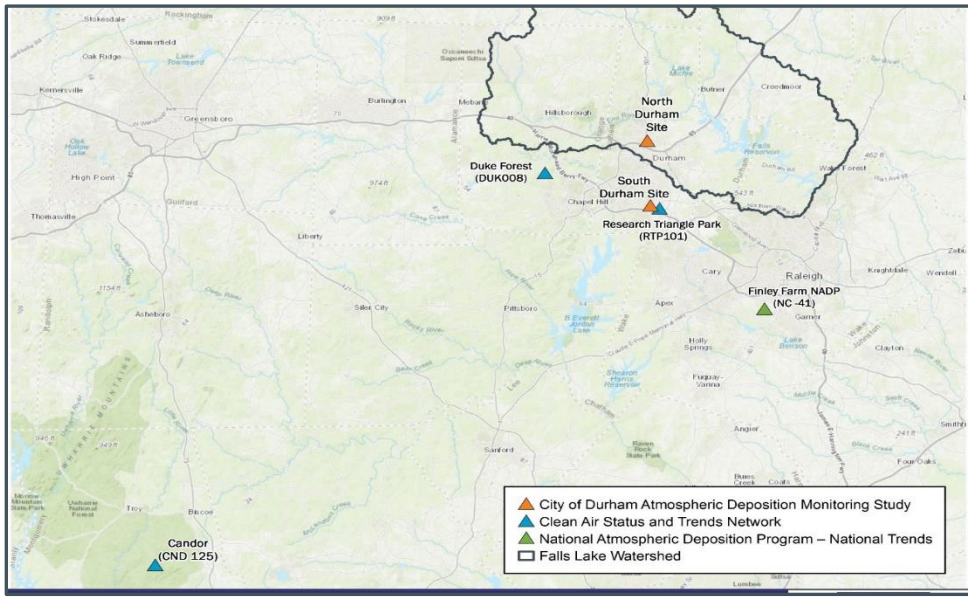
Land Application of Nutrients and Harvesting

- Commercial fertilizer, manure, and biosolids composition and application rates to agriculture and urban areas
- Source: NC Department of Agriculture, researchers, agricultural representatives, literature
- Quantify the loads applied to each land use by month
- Values can vary spatially across the watershed, or can be uniform, based on available data
  - NC Department of Agriculture provided monthly application rates by crop type and county
  - Pervious urban areas do not vary spatially, but do with density based on two local surveys
- WARMF also accounts for nutrient uptake by plants and harvesting

Sources of Air Quality Data

- National Atmospheric Deposition Program (NADP)
- Clean Air Status and Trends Network (CASTNET)
- Community Multi-Scale Air Quality (CMAQ) Modeling System for Air Quality Management
- City of Durham Atmospheric Deposition Monitoring Study
- Published research



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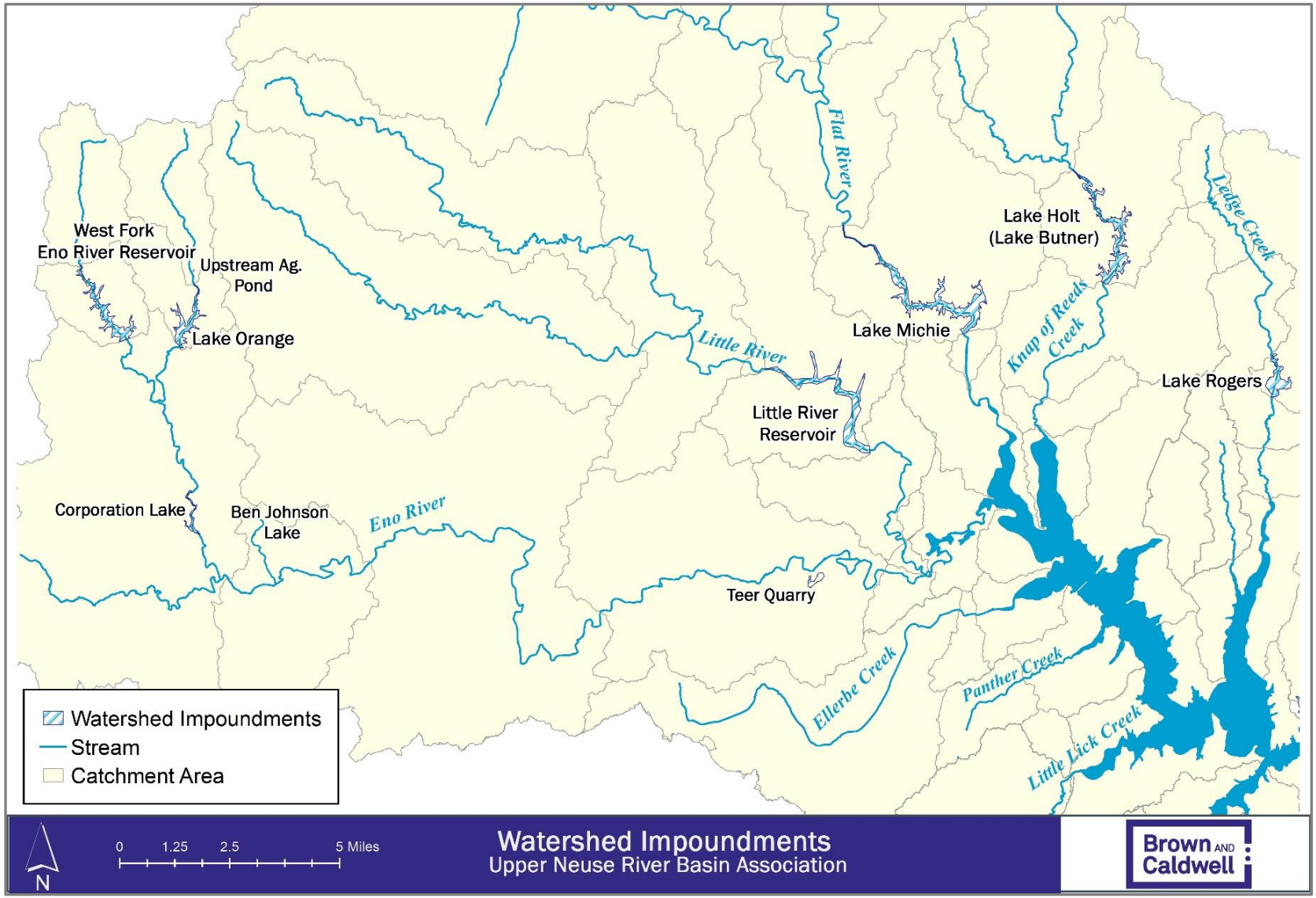
Significant Impoundments



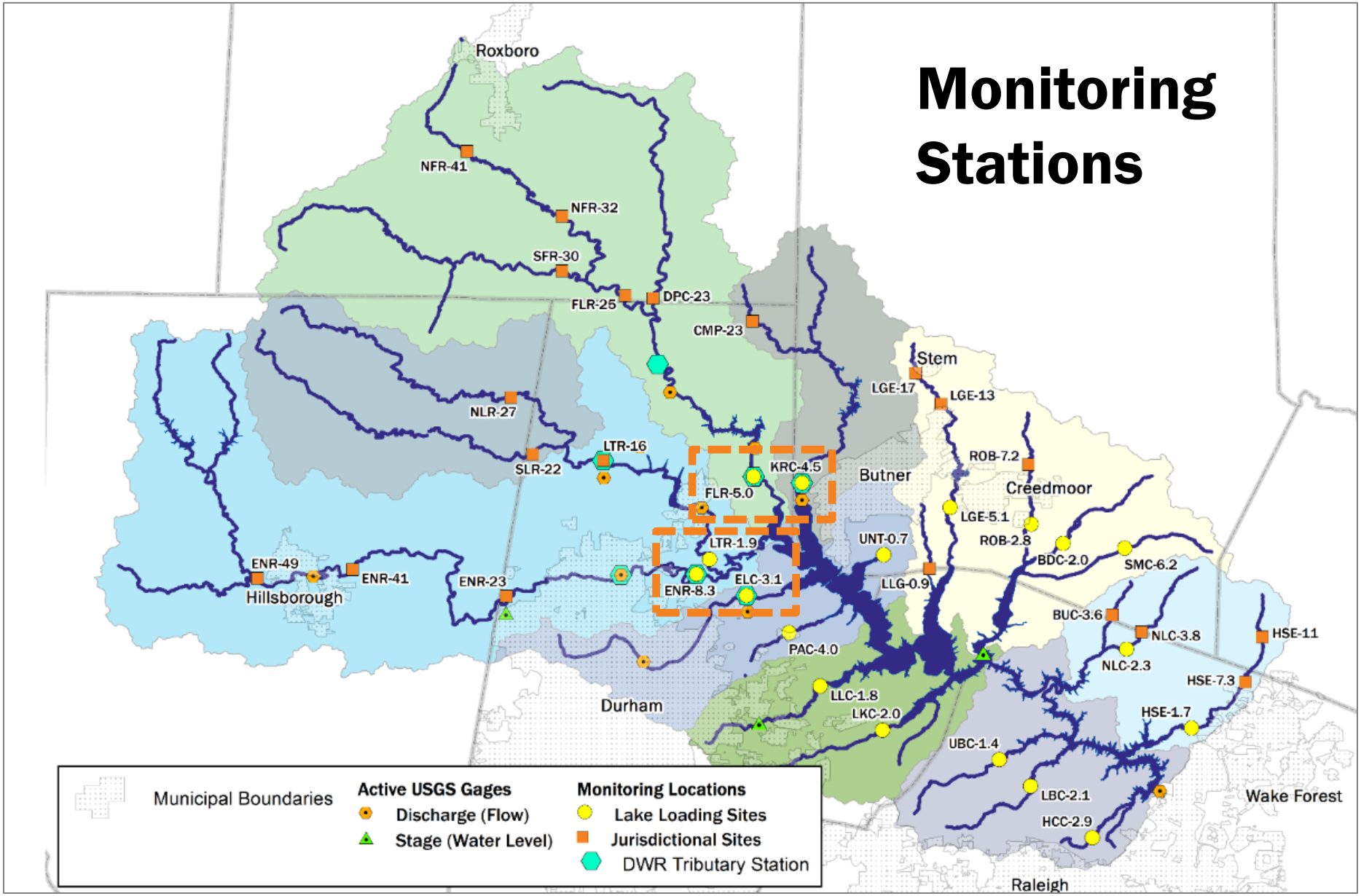
Water Quality Model Performance Criteria

- The UNRBA Modeling QAPP includes the following guidance for water quality calibration (Table A.7-2 from QAPP) for concentrations
- The DWR (2009) watershed modeling report only provided performance criteria for flow, not water quality
- Loading comparisons to other estimates are included in this presentation for context
  - Are not required by the QAPP
  - Are useful for ensuring loads from big five are reasonably represented as well as other tributaries (when comparing total load to Falls Lake)

Table A.7-2 General Watershed Model Calibration Guidance

Parameter	Percent Bias Criteria		
	Very Good	Good	Fair
Sediment	< ± 20	± 20-30	± 30-45
Water Temperature	< ± 7	± 8-12	± 13-18
Water Quality/Nutrients	< ± 15	± 15-25	± 25-35
Flow (Total Volume)	≤ 5%	5-10%	10-15%

Monitoring Stations



Gaged Stream Flow Comparisons
(Total Volume)

- Model performance is very good to good at each gage

Model Performance for Gaged Tributaries Near Falls Lake (2015 to 2018)

ELLERBE CREEK AT CLUB BOULEVARD (USGS 0208675010)	ELLERBE CREEK NEAR GORMAN, NC (USGS 02086849)	ENO RIVER AT HILLSBOROUGH, NC (USGS 02085000)	ENO RIVER NEAR DURHAM, NC (USGS 02085070)	FLAT RIVER AT BAHAMA,NC (USGS 02085500)	FLAT RIVER AT DAM NEAR BAHAMA, NC (USGS 02086500)	KNAP OF REEDS CREEK NEAR BUTNER, NC (USGS 02086624)	LITTLE RIVER AT SR1461 NEAR ORANGE FACTORY, NC (USGS 0208521324)
1%	3%	-3%	5%	-9%	-9%	-3%	-4%

Other statistics have been summarized elsewhere.

Performance Summary for Lake Loading Stations on "Big 5" Tributaries (2015-18)

Parameter	Ellerbe	Eno	Flat	Knap	Little
Temperature	Very good	Good	Good	Good	Good
TSS	Low	Fair	Low	Fair	Good
Ammonia	Very good	High	Very good	Very good	High
Nitrate	Very good	Fair	Fair	Fair	Very good
TKN	Fair	Very good	Good	Very good	Fair
TN	Very good	Very good	Very good	Good	Good
TP	Very good	Very good	Good	Low	Very good
TOC	Very good	Very good	Very good	Very good	Very good
Chlorophyll-a	Low	Good	Very good	Very good	Very good

- Performance rankings are based on numeric criteria specified in the UNRBA Modeling Quality Assurance Project Plan
- TSS performance compared to laboratory measurements that exclude suspended organic material (total minus volatile suspended solids)

Importance of Precipitation for Loading

- Load is a function of concentration and flow
- Nutrient loads are highly variable from year to year based on precipitation because flow is a key driver of loading
- TN, TP, TOC loads in 2018 were 2-3 times higher than 2017
- Precipitation in 2018 was ~ 15 inches higher than 2017

Year	Annual Precipitation at RDU (in) [ratio to 2017]	TN (lb/yr) [ratio to 2017]	TP (lb/yr) [ratio to 2017]	TOC (lb/yr) [ratio to 2017]
2015	57.1 [1.25]	1,560,000 [1.88]	123,000 [1.44]	9,000,000 [1.42]
2016	51.3 [1.13]	1,270,000 [1.53]	130,000 [1.52]	8,470,000 [1.34]
2017	**45.6 [1.00]**	**830,000 [1.00]**	**85,700 [1.00]**	**6,340,000 [1.00]**
2018	60.3 [1.32]	1,850,000 [2.23]	257,000 [3.00]	16,530,000 [2.61]

Status of the Watershed Modeling

- The UNRBA Modeling and Regulatory Support Workgroup and Path Forward Committee approved
  - Calibration of the model for stream flow and water quality
  - Use of the model to develop the lake models
- Subject matter experts and third-party reviewers are reviewing the source load allocations from the model
  - Modelers are running different hydrologic conditions (e.g., 2007 and 2017 by itself) to compare loading rates to previous studies that occurred during dryer periods
  - Modelers are testing developed subwatersheds without accounting for BMPs/SCMs for comparison to other studies where existing development retrofits are not required
- Watershed modeling report is being drafted to include discussion of loads by source

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Status of the Lake Models

- WARMF Lake and EFDC Lake models are being developed and calibrated for water quality
- Statistical/Bayesian lake model is being developed
  - Using local and national data
  - Interviews with local resource experts are being conducted regarding tracking metrics for satisfaction with designated uses
- A Scenario Screening Workgroup is developing recommendations on which scenarios to evaluate with the models
- Scenarios will be evaluated along with cost benefit information to understand the impacts of actions
- The evaluation of the existing strategy for Stage II will include regulatory options like a site specific chlorophyll-a criteria

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Multi-year UNRBA Stage II Re-examination Timeline

★ In progress
✓ Completed

Coordination with the UNC Collaboratory and Extensive Communication Efforts

NCEMC adopts Falls Lake Nutrient Management Strategy NCAC.2B.0275

Planning for the Re-examination ✓

Developed and Submitted Monitoring QAPP ✓

Began Monitoring August 2014 ✓

Continued Monitoring ✓

Developed Modeling QAPP ✓

Modeling QAPP Approved February 2018 ✓

Completed Monitoring Program ✓

Compiling Data and Configure Models ✓

Calibrate Watershed Model ✓

Calibrate Lake Models ★

Evaluate Scenarios, Costs/Benefits, Management Actions

Propose Revised Strategy

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

1 Planning

2 Monitoring

3 Modeling

4 Developing New Strategy

Additional Information

- Comprehensive website - https://www.unrba.org/
- General information website - https://upperneuse.org/
- Reference documents
  - UNRBA Infographic
  - UNRBA Fast Facts
  - Overview of the Work of the UNRBA
- Comprehensive UNRBA Monitoring Data Report
- UNC Collaboratory Falls Lake Study website - https://nutrients.web.unc.edu/resources/

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