Division of Water Resources
Cape Fear River Basin
Nutrients and Dissolved Oxygen Modeling Plan

Introduction

The DWR Modeling and Assessment Branch has developed this Modeling Plan for the middle Cape Fear River Basin to outline the modeling goals, spatial extent, parameters of concern, and monitoring needs.

Goals of Modeling

There are several modeling goals that have been identified:

1. The DWR Point Source Branch has identified the need for modeling tools to assist with nutrient permitting in the Cape Fear River Basin. Support NPDES permitting for nutrients.
2. Provide information on conditions associated with algal bloom frequency and duration.
3. Provide additional information on existing impaired waters.
4. Provide additional information for public water supplies.
5. Potentially support numeric nutrient criteria, as described in the North Carolina Nutrient Criteria Development Plan (NCDP).

Spatial Extent of Modeling

As currently designed, the modeling will support permitting below Randleman and Jordan Lakes down to Lock and Dam #1. Tools exist for Jordan, Harris Lake, and Lower Cape Fear. Randleman Lake and Jordan Lake have permitting strategies already in place. The spatial extent is further defined in the bullets below as well as in Figure 1.

- Jordan Lake – boundary loading only
- Rocky River – from headwaters to confluence with Deep River
- Deep River – from below Randleman Lake to confluence with Cape Fear River
- Cape Fear – from confluence with Deep River down to lock and dam #1 (excluding Harris Lake watershed). Harris Lake watershed will be excluded from model development as there already is a model for Harris Lake. The flow gage and monitoring station on Buckhorn Creek will be used to develop loads from Harris Lake watershed for input to middle Cape Fear River model.
- Lower Cape Fear – excluded

Figure 1. Cape Fear River Basin. Subwatersheds in gray (Lower Cape Fear, Jordan Lake, and Randleman Lake) are areas that have existing permitting tools and are excluded from this modeling project.

Not shown: Harris Lake watershed will be excluded from model development as there is already a model for Harris Lake. The flow gage and monitoring station on Buckhorn Creek will be used to develop loads from Harris Lake watershed for input to middle Cape Fear River model.

Parameters of Concern

Based on the above listed model goals, the following water quality parameters will be targeted as model endpoints. These endpoints may change as a result of the implementation of the nutrient criteria development plan.

- Nutrients (primarily nitrogen and phosphorus)
- Chlorophyll-a
- Dissolved Oxygen (DO)
- Turbidity – indirect modeling
- Algal blooms – indirect modeling
- Total Organic Carbon (TOC)

Modeling Plan

As shown above in Figure 1, there are three areas that will be targeted through this project: the Deep River (green shaded area), Rocky River (pink shaded area), and the middle Cape Fear River (yellow shaded area). It is likely that there will be separate models developed for each of these areas, with the Rocky River model connecting to the Deep River model and the Deep River model connecting to the Cape Fear River model. The selected modeling platforms may change as a result of stakeholder input and data availability.

Due to local stakeholder concerns regarding source contributions in the Deep and Rocky Rivers, the Soil and Water Assessment Tool (SWAT) is the preferred modeling platform to represent watershed loading. SWAT is a physically based watershed model, and has the capacity to assess the impact of point and non-point sources on nitrogen, phosphorus, sediment, and dissolved oxygen in watersheds up to two thousand square miles with varying land use and management conditions. The model has the capacity to divide heterogeneous watersheds into hundreds of sub basins. Each sub-basin can be characterized under eight major components; hydrology, weather, erosion/sedimentation, soil temperature, plant growth, nutrients, pesticides, and land management. The model is a continuous model that enables the user to simulate runoff and pollutant transport processes up to 100 years. A receiving water model may also be applied to the Deep and Rocky Rivers to better characterize in-stream processes. The Division has a draft WASP model https://www.epa.gov/exposure-assessment-models/water-quality-analysis-simulation-program-wasp already developed for these areas that is suitable for evaluation of dissolved oxygen and nutrients.

For the middle Cape Fear River, The Nature Conservancy has already developed a SWAT model that the Division plans to update for use in this effort. For the receiving water model, CE-QUAL-W2 is the preferred modeling platform, as described in the Western Wake Nutrient Modeling and Monitoring Plan (CH2M Hill, 2011).

> *"CE-QUAL-W2 is a 2-dimensional (in longitudinal and vertical directions) hydrodynamic and water quality model supported by the U.S. Army Corps of Engineers (USACE). It simulates multiple algal groups, including blue-greens. The model can be set up to simulate the impacts of hydraulic structures such as the Lock & Dams on the Cape Fear River. The model is flexible and well-documented, and can be simplified when the characteristics of the water body warrant or when data are limited. The model has been applied in North Carolina lakes and the Neuse River estuary."*

Turbidity impairments will be examined indirectly by determining relationships between turbidity and total suspended sediment as models do not predict turbidity.

Algal blooms (e.g. frequency, environmental conditions, etc.) will also be evaluated indirectly.

Additional parameters of concern may be identified through the NCDP process.

Monitoring Plan

The monitoring plan for this effort is described in a separate document.

Stakeholder Involvement

There will be opportunities for stakeholder involvement to include data and modeling review.

References

CH2M Hill, 2011. Western Wake Nutrient Modeling and Monitoring Plan.

Appendix A. Existing Monitoring Sites

Table – A.1. Existing Water Quality Monitoring Stations.

Model	Agency	Station	Description	USGS site?
ROCKY	UCFRBA	B5950000	ROCKY RIV AT US 64 NR SILER CITY	02101726
ROCKY	UCFRBA	B5980000	ROCKY RIV AT SR 2170 RIVES CHAPEL RD NR SILER CITY	
ROCKY	NCAMBNT	B6000000	ROCKY RIV AT NC 902 NR PITTSBORO	
DEEP	UCFRBA	B4770500	DEEP RIV US 220 BUS MAIN ST AT RANDLEMAN	
DEEP	UCFRBA	B4800000	DEEP RIV AT SR 2122 AT WORTHVILLE	
DEEP	UCFRBA	B4870000	HASKETT CRK AT ASHEBORO WWTP BRIDGE NR ASHEBORO	
DEEP	NCAMBNT	B4890000	HASKETT CRK AT SR 2128 NR CENTRAL FALLS	
DEEP	UCFRBA	B4920000	DEEP RIV AT SR 2261 OLD LIBERTY RD NR CENTRAL FALLS	
DEEP	UCFRBA	B5070000	DEEP RIV AT SR 2615 AT RAMSEUR	02100500
DEEP	UCFRBA	B5100000	DEEP RIV AT SR 2628 HINSHAW TOWN RD NR PARKS CROSSROADS	
DEEP	NCAMBNT	B5190000	DEEP RIV AT SR 1456 NR HIGH FALLS	
DEEP	UCFRBA	B5390800	COTTON CRK AT SR 1372 AUMAN RD NR STAR	
DEEP	NCAMBNT	B5480000	BEAR CRK AT NC 705 AT ROBBINS	
DEEP	UCFRBA	B5520000	DEEP RIV AT NC 22 AT HIGH FALLS	
DEEP	NCAMBNT	B5575000	DEEP RIV AT NC 42 AT CARBONTON	
DEEP	UCFRBA	B5685000	DEEP RIV AT DEEP RIVER PARK BRIDGE NR CUMNOCK	
DEEP	UCFRBA	B5820000	DEEP RIV AT US 15 AND 501 NR SANFORD	
DEEP	NCAMBNT/ UCFRBA	B6040300	DEEP RIV AT SR 1011 OLD US 1 NR MONCURE	close to - 02102000
CPF	NCAMBNT	B4050000	HAW RIV BELOW JORDAN DAM NR MONCURE	stage only - 02098198
CPF	UCFRBA	B4080000	HAW RIV AT SR 1011 OLD US 1 NR HAYWOOD	
CPF	MCFRBA	B6130500	LICK CRK AT SR 1500 NR CORINTH	
CPF	MCFRBA	B6160000	CAPE FEAR RIV AT NC 42 NR CORINTH	
CPF	MCFRBA	B6204000	BUCKHORN CRK BESIDE SR 1921 NR CORINTH	close to - 02102192
CPF	MCFRBA	B6230000	AVENTS CRK AT SR 1418 NR COKESBURY	
CPF	MCFRBA	B6252000	NEILLS CRK AT US 401 NR LILLINGTON	
CPF	MCFRBA	B6320000	KENNETH CRK AT SR 1441 CHALYBEATE SPRINGS RD NR ANGIER	
CPF	NCAMBNT/ MCFRBA	B6370000	CAPE FEAR RIV AT US 401 AT LILLINGTON	02102500
CPF	MCFRBA	B6485000	BUIES CRK AT KEITH HILLS GOLF COURSE MAINT SHOP AT BUIES CREEK	
CPF	MCFRBA	B6820050	UPPER LITTLE RIV AT SR 1222 NR BROADWAY	
CPF	NCAMBNT/ MCFRBA	B6830000	UPPER LITTLE RIV AT SR 2021 NR LILLINGTON	

Model	Agency	Station	Description	USGS site?
CPF	MCFRBA	B6840000	CAPE FEAR RIV AT NC 217 AT ERWIN	
CPF	NCAMBNT	B7245000	LOWER LITTLE RIV AT SR 2023 NR LOBELIA	
CPF	NCAMBNT	B7280000	LOWER LITTLE RIV AT SR 1451 AT MANCHESTER	02103000
CPF	MCFRBA	B7300000	LOWER LITTLE RIV AT NC 210 NR SPRING LAKE	
CPF	MCFRBA	B7319100	LOWER LITTLE RIV AT SR 1609 NR WALKERTOWN	
CPF	MCFRBA	B7480000	CAPE FEAR RIV AT HOFFER WTP INTAKE AT FAYETTEVILLE	
CPF	MCFRBA	B7500000	CAPE FEAR RIV AT I 95 BELOW FAYETTEVILLE	
CPF	MCFRBA	B7547000	CROSS CRK AT CROSS CREEK PARK AT FAYETTEVILLE	
CPF	MCFRBA	B7584000	BLOUNTS CRK AT US 301A PERSON ST AT FAYETTEVILLE	
CPF	MCFRBA	B7584800	UT TO CROSS CRK OFF ANNE ST AT FAYETTEVILLE	
CPF	MCFRBA	B7584900	UT TO CROSS CRK AT CROSS CREEK WRF AT FAYETTEVILLE	
CPF	MCFRBA	B7590000	CROSS CRK AT US 301 BUS AND I 95 BUS AT FAYETTEVILLE	
CPF	NCAMBNT	B7600000	CAPE FEAR RIV AT NC 24 AT FAYETTEVILLE	stage only - 02104000
CPF	MCFRBA	B7679300	ROCKFISH CRK AT US 401 BYPASS NR RAEFORD	02104220
CPF	NCAMBNT/ MCFRBA	B7700000	ROCKFISH CRK AT SR 1432 NR RAEFORD	
CPF	NCAMBNT	B8224000	ROCKFISH CRK AT SR 2350 NR CEDAR CREEK	
CPF	MCFRBA	B8230000	ROCKFISH CRK AT NC 87 NR FAYETTEVILLE	
CPF	MCFRBA	B8290000	CAPE FEAR RIV AT DUPONT WATER INTAKE	
CPF	NCAMBNT	B8300000	CAPE FEAR RIV AT WO HUSKE LOCK NR TAR HEEL	02105500
CPF	MCFRBA	B8302000	CAPE FEAR RIV AT POWER LINES NR TOLARSVILLE	
CPF	MCFRBA	B8305000	CAPE FEAR RIV AT SR 1316 AT TAR HEEL	
CPF	MCFRBA	B8306000	CAPE FEAR RIV AT RM 80 NR RUSKIN	
CPF	MCFRBA	B8315000	HARRISON CRK AT SR 1320 AT BURNEY	
CPF	MCFRBA	B8320000	CAPE FEAR RIV AT US 701 AT ELIZABETHTOWN	
CPF	NCAMBNT	B8321000	TURNBULL CRK AT SR 1509 NR JOHNSONTOWN	
CPF	MCFRBA	B8339000	CAPE FEAR RIV ABOVE LOCK AND DAM 2	
CPF	NCAMBNT	B8340000	CAPE FEAR RIV AT LOCK 2 NR ELIZABETHTOWN	
CPF	LCFRP	B8340050	BROWNS CRK AT NC 87 NR ELIZABETHTOWN	
CPF	MCFRBA	B8340100	TURNBULL CRK AT US 701 NC 53 AND NC 41 NR ELIZABETHTOWN	
CPF	MCFRBA	B8340130	CAPE FEAR RIV AT RM 70 NR ELIZABETHTOWN	
CPF	LCFRP	B8340200	HAMMOND CRK AT SR 1704 NR MOUNT OLIVE	

Model	Agency	Station	Description	USGS site?
CPF	MCFRBA	B8340650	CAPE FEAR RIV AT RM 55 NR BLADEN SPRINGS	
CPF	MCFRBA	B8348000	CAPE FEAR RIV AT SR 1730 ELWELL FERRY RD NR CARVERS	
CPF	MCFRBA	B8349000	CAPE FEAR RIV ABOVE LOCK AND DAM 1 NR EAST ARCADIA	
CPF	NCAMBNT	B8350000	CAPE FEAR RIV AT LOCK 1 NR KELLY	02105769
CPF	LCFRP	B8360000	CAPE FEAR RIV AT NC 11 NR EAST ARCADIA	

Table – A.2. Existing USGS flow gage sites not co-located with a water quality monitoring station.

Model	Agency	USGS Station	Description
ROCKY	USGS	02101800	Tick Creek nr Mount Vernon Springs
ROCKY	USGS	0210166029	Rocky River nr Crutchfield Crossroads
CPF	USGS	02102908	Flat Creek nr Inverness