Total Maximum Daily Load Revision
Charleston Harbor, Cooper, Ashley, and Wando Rivers

Stations MD-115, MD-264, CSTL-102, MD-049, RT-032046,
MD-052, RO-09363, CSTL-085, and MD-152
HUC Code: 03050201
Dissolved Oxygen

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Charleston Harbor, Cooper, Ashley, and Wando Rivers
Dissolved Oxygen TMDL

Abstract

§303(d) of the Clean Water Act (CWA) and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water bodies that are included on the §303(d) list of impaired waters. A TMDL is the maximum amount of pollutant a waterbody can assimilate while meeting water quality standards for the pollutant of concern. All TMDLs include a wasteload allocation (WLA) for all National Pollutant Discharge Elimination System (NPDES)-permitted discharges, a load allocation (LA) for all nonpoint sources, and an explicit and/or implicit margin of safety (MOS).

This dissolved oxygen (DO) TMDL revises and combines the existing 2002 Cooper River-Wando River-Charleston Harbor TMDL (“Cooper TMDL”) and the 2003 Ashley River TMDL (“Ashley TMDL”). The revised TMDL is for Charleston Harbor, Cooper, Ashley, and Wando Rivers DO TMDL (“Charleston Harbor TMDL”). The basis for this revision is a new 3-Dimensional Environmental Fluid Dynamics Code model (EFDC model) covering the entire system completed in 2008, a revised DO standard as amended in the South Carolina Pollution Control Act in 2010 (adoption in South Carolina Regulation 61-68 pending), and subsequent reallocation of the TMDLs led by the Berkeley-Charleston-Dorchester Council of Governments (BCDCOG).

Ambient monitoring stations MD-115, MD-264, CSTL-102, MD-049, RT-032046, MD-052, RO-09363, CSTL-085, and MD-152 currently are designated as not supporting aquatic life use due to low DO. These sites are covered by the existing Cooper and Ashley TMDLs and are included in Appendix B (SC Waters with an Approved TMDL) of the 2012 §303(d) list to EPA (draft pending EPA approval). Many of the waters in the Charleston Harbor area are known to experience naturally low DO levels that do not attain established numeric criteria. Inclusion of these sites in Appendix B of the §303(d) list as not supporting the aquatic life use has been based on the reasonable potential that antidegradation requirements under South Carolina Regulation 61-68 (S.C. R.61-68), Section D.4.a, are not maintained due to impacts from point sources or other activities causing more than 0.1 mg/L DO depression.

The WLA is for continuous non-stormwater dischargers. Currently available data and modeling indicate that regulated and unregulated stormwater and nonpoint sources do not contribute to the allowable DO depression on the mainstem segments including Charleston Harbor and the Cooper, Ashley, and Wando Rivers at existing conditions. If,

at a later date, a significant non-continuous source is identified, the TMDL will be revised to account for this source.

In this event, should it occur, for SCDOT and existing and future NPDES MS4 permittees, compliance with terms and conditions of its NPDES permit would be effective implementation of the WLA to the Maximum Extent Practicable (MEP) and would demonstrate consistency with the assumptions and requirements of the TMDL. For existing and future NPDES Construction and Industrial stormwater permittees, compliance with terms and conditions of its permit would be effective implementation of the WLA. Required load reductions in the LA portion of this TMDL could be implemented through voluntary measures and would be eligible for CWA §319 grants.

This TMDL revises the WLA for ultimate oxygen demand (UOD), defined here as the stoichiometric sum of carbonaceous biochemical oxygen demand (CBOD) and ammonia, due to its impact on DO levels in the affected waters. Laboratory analyses for the new model determined more accurate stoichiometric coefficients (F-Ratios) relating effluent five-day CBODs (CBOD5s) to UODs. As a result, UODs in the 2003 Ashley and 2002 Cooper TMDL documents are not directly comparable to UODs in this TMDL.

The previous and revised TMDLs can be compared on a percent reduction basis. The Cooper TMDL required an interim reduction of 58 percent (Phase 1) and a final reduction 69 percent (Phase 2) from pre-TMDL permitted UOD; the Ashley TMDL required a reduction of 32 percent from pre-TMDL permitted UOD. This TMDL applies a more accurate water quality model in addition to more accurate laboratory characterization of the wastewater. Based on this new information, the revised TMDL is equivalent to an additional 2 percent reduction below the Phase 1 level for the Cooper. The revised TMDL for the Ashley is equivalent to a 15 percent reduction from the pre-TMDL permitted UOD.

The revised TMDL allows additional loading compared to the previous TMDLs due in part to a more accurate model. The new model more accurately represents estuarine circulation in Charleston Harbor and the Cooper River and freshwater inflow to the upper Ashley River resulting in higher predicted dilution and allowable effluent loading throughout the system. In addition, the change in the DO standard from 0.10 mg/L to 0.1 mg/L allowable impact allowed some additional loading compared to the previous TMDLs.

This TMDL includes final limits for continuous NPDES permitted dischargers in the system; however, the revised Charleston Harbor TMDL is not a fixed number. The total WLA may vary depending on the locations of the individual loads in relation to the critical segments. A “TMDL Calculator” spreadsheet tool was developed based on the EFDC model. The TMDL Calculator computes the DO depression at the critical locations in the estuary in response to various combinations of individual NPDES wastewater loads. The BCDCOG used the calculator to facilitate the wasteload allocation process. The BCDCOG approved allocation included in this TMDL is one possible combination of individual WLAs shown by modeling to achieve the TMDL target of 0.1 mg/L allowable DO depression. Future reallocations, and changes in the total WLA, are possible without further revision of the TMDL provided the TMDL target is maintained as shown by the EFDC model and/or TMDL Calculator.

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1. Introduction

1.1. Background

Water quality in the Charleston Harbor estuary has been widely studied. Targeted research, intensive monitoring, and major modeling projects have been conducted as part of the Charleston Harbor Project or through the Berkeley-Charleston-Dorchester Council of Governments (BCDCOG). The S.C. Department of Health and Environmental Control (the Department) conducts regular ambient water quality monitoring throughout the estuary, and the BCDCOG and the U.S. Geological Survey (USGS) maintain a network of continuous monitors at key locations.

Much of the attention on water quality has been directed at dissolved oxygen (DO). Charleston estuary waters frequently experience DO levels that do not meet the established numeric criteria. These waters have long been considered to be both naturally low in DO and further impacted by NPDES wastewater discharges. In naturally low DO waters, the South Carolina Pollution Control Act Section 48-1-83 as amended March 30, 2010 (adoption in South Carolina Regulation 61-68 pending) allows an additional depression of 0.1 mg/L DO due to point sources and other activities.

Total Maximum Daily Loads (TMDLs) have been established previously. The 2002 Cooper River-Wando River-Charleston Harbor TMDL ("Cooper TMDL") and the 2003 Ashley River TMDL ("Ashley TMDL") required reductions for ultimate oxygen demand (UOD), defined here as the stoichiometric sum of carbonaceous biochemical oxygen demand (CBOD) and ammonia, due to its impact on DO levels in the affected waters. This TMDL for Charleston Harbor, Cooper, Ashley, and Wando Rivers ("Charleston Harbor TMDL") revises and combines the Cooper and Ashley TMDLs.

The basis for this revision is new modeling covering the entire system completed in 2008, a revised DO standard as amended in the South Carolina Pollution Control Act in 2010 (adoption in South Carolina Regulation 61-68 pending), and subsequent reallocation of the TMDL led by the BCDCOG.

Laboratory analyses for the new model determined more accurate stoichiometric coefficients (F-Ratios) relating effluent five-day CBODs (CBOD5s) to UODs. As a result, UODs in the Ashley and Cooper TMDL documents are not directly comparable to UODs in this TMDL. The previous and revised TMDLs can be compared on a percent reduction basis. The Cooper TMDL required an interim reduction of 58 percent (Phase 1) and a final reduction 69 percent (Phase 2) from pre-TMDL permitted UOD; the Ashley TMDL required a reduction of 32 percent from pre-TMDL permitted UOD. As described below, this TMDL applies a more accurate water quality model in addition to more accurate laboratory characterization of the wastewater. Based on this new information, the revised TMDL is equivalent to an additional 2 percent reduction below the Phase 1 level for the Cooper. The revised TMDL for the Ashley is equivalent to a 15 percent reduction from the pre-TMDL permitted UOD.

The revised TMDL allows additional loading compared to the previous TMDLs due in part to a more accurate model. The new model more accurately represents estuarine circulation in Charleston Harbor and the Cooper River and freshwater inflow to the upper Ashley River resulting in higher predicted dilution and allowable effluent loading throughout the system. In addition, the change in the DO standard from 0.10 mg/L to 0.1 mg/L allowable impact allowed some additional loading compared to the previous TMDLs.

Initial Phase 1 reductions have been implemented in all but two of the NPDES permits. Final Phase 2 reductions were held off while the new modeling work was completed. The Ashley TMDL was not phased and has been fully implemented in NPDES permits.

1.2. Charleston Harbor Estuary Description

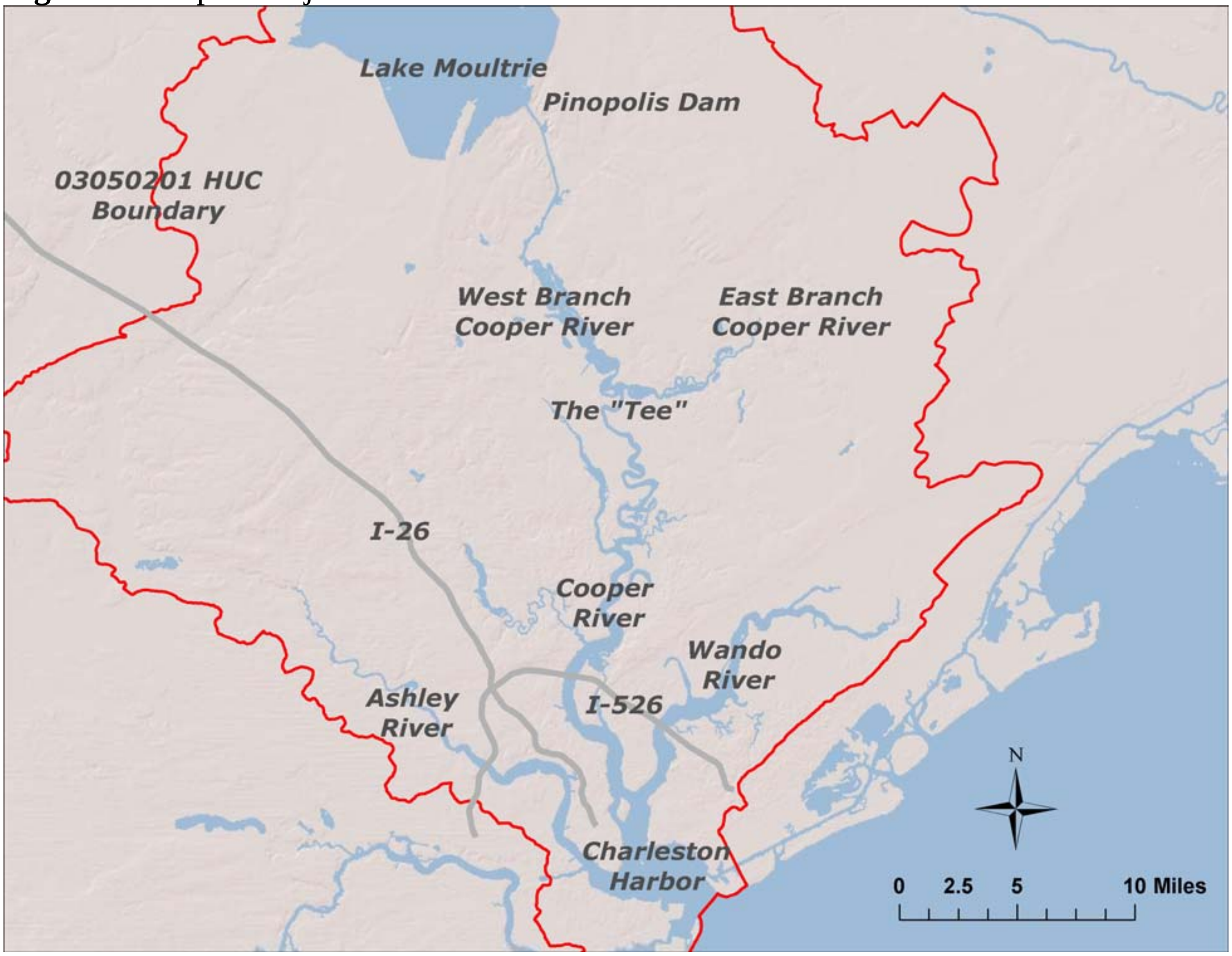
The Charleston Harbor estuary is centrally located along the coast in the South Carolina Lowcountry. The estuary includes the Ashley, Cooper, and Wando Rivers, Charleston Harbor, parts of the Intracoastal Waterway, numerous tidal creeks and tributary streams, and extensive saltwater and freshwater wetlands. Historic downtown Charleston is situated on the peninsula between the Ashley and Cooper Rivers. Charleston is a major port, with shipping terminals located in the harbor area and along the Cooper and Wando Rivers. An area map and map of the major features are shown in Figures 1 and 2.

The watershed is confined to the coastal plain, pinched between the Edisto River to the south and the Santee River to the north. The Cooper, Ashley, and Wando Rivers are naturally long tidal sloughs diverging from the harbor area and pushing up into headwater swamps and wetlands with little freshwater inflow compared to the much larger adjacent watersheds. Today, the Ashley and Wando Rivers remain tidally dominated, with local rainfall and groundwater sources providing the freshwater inputs.

Following the completion of the Santee-Cooper Hydroelectric Project in 1942, large flows of freshwater were diverted from the Santee River into the Tailrace Canal at Pinopolis Dam and on into the head of the Cooper River near Moncks Corner. In the mid-1980s most of the water was rediverted back into Santee River near St Stephen to alleviate excess shoaling in Charleston Harbor. Prior to rediversion, flow from Pinopolis Dam to the Cooper River averaged about 14,000 cfs. Since rediversion in the mid-1980s, flows average about 4500 cfs which is the weekly flow target designed to minimize shoaling in Charleston Harbor while maintaining the freshwater supply in the West Branch Cooper and Back River Reservoir.

Figure 1. Map of the Charleston Area (Bing Maps copyright 2011 Microsoft Corporation)

Figure 2. Map of Major Features



2. Water Quality Assessment

Many coastal waters in South Carolina have DO levels below the established DO criteria. Wastewater dischargers and other anthropogenic influences may contribute to low DO in coastal waters. Natural factors such as organic loading and reduced oxygen levels from wetlands and marshes and estuarine dynamics in the mixing zone where freshwater and saltwater come together can create naturally low DO conditions. The waters in and around Charleston Harbor are considered to be both naturally low in DO and further impacted by wastewater dischargers.

2.1. Water Quality Standard

Water classifications for the TMDL segments and applicable DO numeric criteria as designated in S.C. R.61-68 and R.61-69 are shown in Table 1. Some segments, including Charleston Harbor and the saltwater portion of the Cooper River, only have the 4.0 mg/L minimum DO requirement while the rest of the system has both the minimum and the 5.0 mg/L daily average requirements.

Table 1. Classifications DO Numeric Criteria

Waterbody	Class	Location	Daily average not less than 5.0 mg/L	Not less than 4.0 mg/L
ASHLEY RIVER	FW	From its beginning at Hurricane Branch to Bacon Bridge	yes	yes
ASHLEY RIVER	SA	That portion from Bacon Bridge to Church Creek	yes	
ASHLEY RIVER	SA*	That portion from Church Creek to Orangegrove Creek (D.O. not less than 4 mg/l)	no	
ASHLEY RIVER	SA	That portion from Orangegrove Creek to Charleston Harbor	yes	
CHARLESTON HARBOR	SB	From Battery to Atlantic Ocean	no	
COOPER RIVER	FW	That portion of the stream from U.S. 52 to a point approximately 30 miles above the junction of the Ashley and Cooper Rivers	yes	
COOPER RIVER	SB	That portion below a point approximately 30 miles above the junction of the Ashley and Cooper Rivers to the junction of the Ashley and Cooper Rivers	no	
WANDO RIVER	SFH	That portion from its headwaters to a point 2.5 miles north of its confluence with the Cooper River	yes	
WANDO RIVER	SA	That portion from a point 2.5 miles north of its confluence with the Cooper River to its confluence with the Cooper River	yes	

In South Carolina, waters that do not meet numeric criteria for DO due to natural conditions are covered by antidegredation requirements in S.C. R.61-68, Section D.4 as follows:

> *4. Certain natural conditions may cause a depression of dissolved oxygen in surface waters while existing and classified uses are still maintained. The Department shall allow a dissolved oxygen depression in these naturally low dissolved oxygen waterbodies as prescribed below pursuant to the Act, Section 48-1-83, et seq., 1976 Code of Laws:*
>
> > *a. For purposes of section D. of this regulation, the term "naturally low dissolved oxygen waterbody" is a waterbody that, between and including the months of*

March and October, has naturally low dissolved oxygen levels at some time and for which limits during those months shall be set based on a critical condition analysis. The term does not include the months of November through February unless low dissolved oxygen levels are known to exist during those months in the waterbody. For a naturally low dissolved oxygen waterbody, the quality of the surface waters shall not be cumulatively lowered more than 0.1 mg/l for dissolved oxygen from point sources and other activities; or

b. Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable water quality standard established for that waterbody, the minimum acceptable concentration is 90 percent of the natural condition. Under these circumstances, an anthropogenic dissolved oxygen depression greater than 0.1 mg/l shall not be allowed unless it is demonstrated that resident aquatic species shall not be adversely affected pursuant to Section 48-1-83. The Department may modify permit conditions to require appropriate instream biological monitoring.

c. The dissolved oxygen concentrations shall not be cumulatively lowered more than the deficit described above utilizing a daily average unless it can be demonstrated that resident aquatic species shall not be adversely affected by an alternate averaging period.

2.2. Water Quality Data

The Department conducts ambient water quality monitoring throughout the Charleston Harbor estuary using surface grab sampling collected once per month at randomly selected sites or once every other month at base sites. This ambient data is assessed and used to develop the Department's 303(d) list. In addition, the U.S. Geological Survey (USGS) and BCDCOG and other cooperators conduct continuous DO monitoring at a number of locations using 15-minute data collection at mid-depth. This continuous data has been used in model development and to evaluate conditions in the estuary for the purpose of TMDL development.

The Department assessed 28 ambient mainstem sites in Charleston Harbor and the Cooper, Ashley, and Wando Rivers for DO for the 2012 303(d) list (draft pending EPA approval). A total of 9 sites were identified as not supporting the designated aquatic life use due to low DO. These sites are covered by the existing Cooper and Ashley TMDLs and are included in Appendix B (SC Waters with an Approved TMDL) of the 2012 §303(d) list to EPA (draft pending EPA approval).

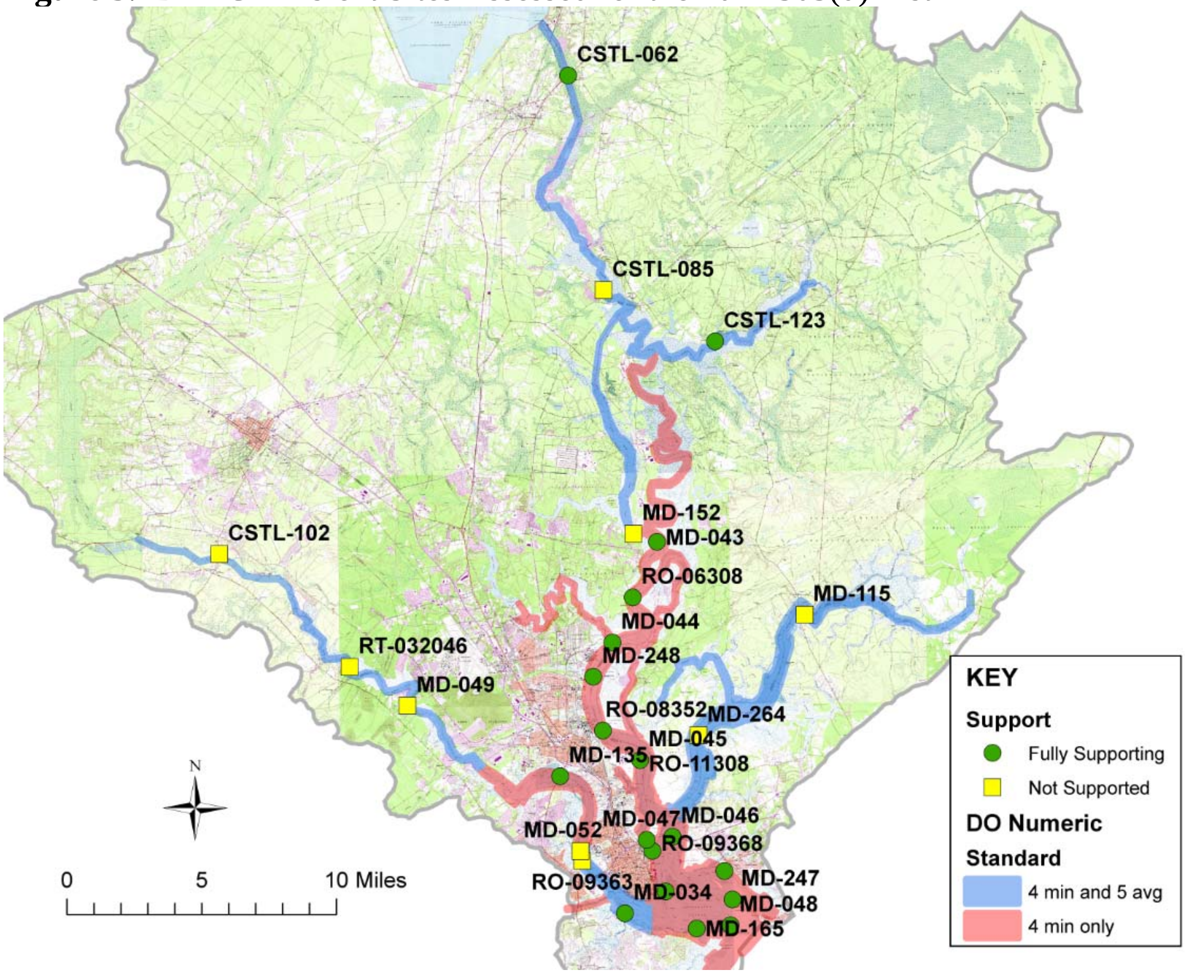
Many of the waters in the Charleston area are known to experience naturally low DO levels that do not attain established numeric criteria. Inclusion of these sites in the

§303(d) list, Appendix B as not supporting the aquatic life use has been based on the reasonable potential that antidegradation requirements under S.C. R.61-68, Section D.4.a are not maintained due to impacts from point sources or other activities causing more than 0.1 mg/L DO depression. The sites not supporting designated uses are listed in Table 2. Site locations are shown in Figure 3.

Table 2. DHEC Ambient Sites Not Supporting Aquatic Life Use Due to Low DO

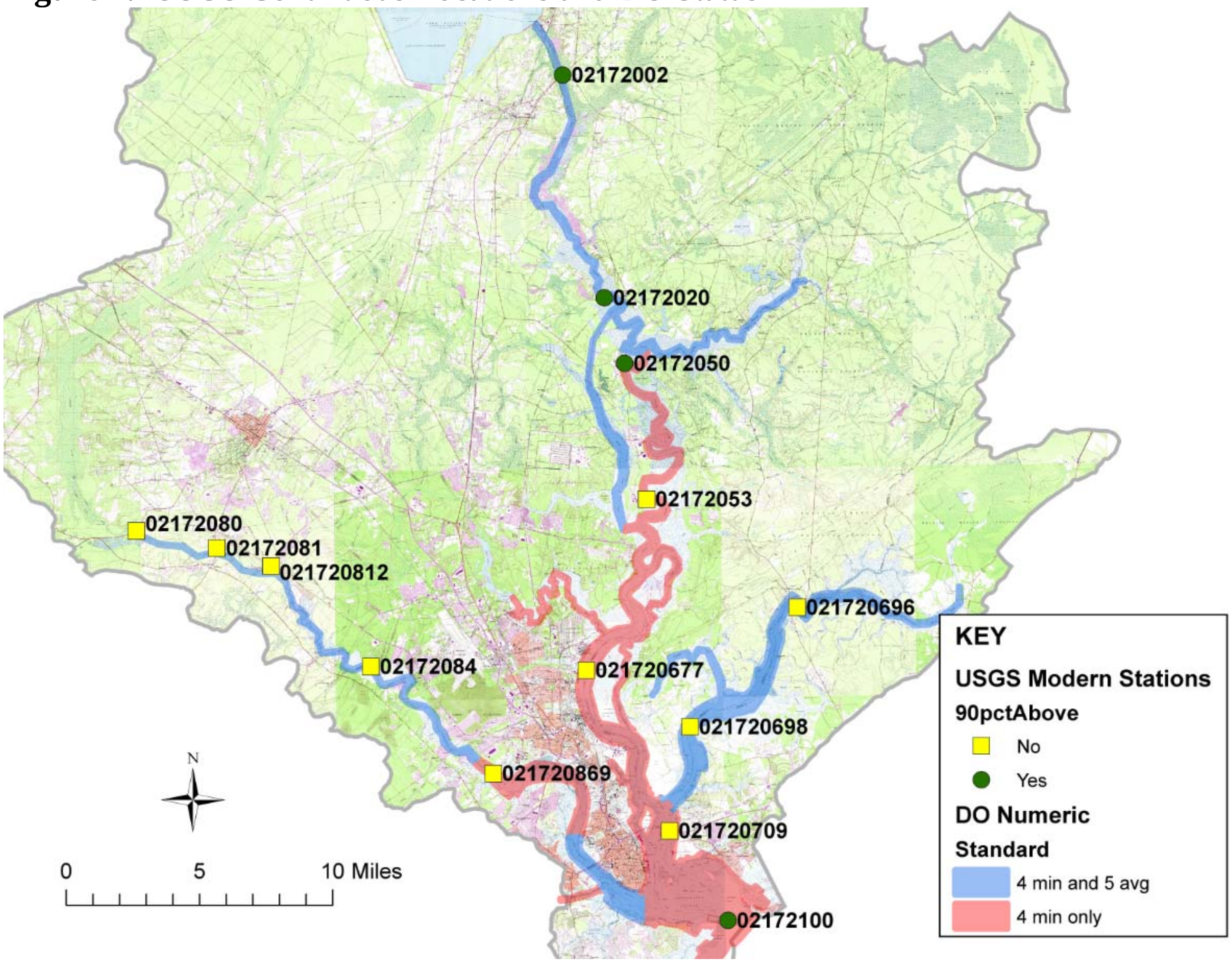
BASIN	12-DIGIT HUC	DESCRIPTION	STATION	COUNTY	USE	CAUSE	USE SUPPORT
SANTEE	030502010402	WANDO RVR AT SC 41	MD-115	BERKELEY	AL	DO	Not Supporting
SANTEE	030502010402	WANDO RIVER AT I-526 MARK CLARK EXPRESSWAY (09B-15)	MD-264	CHARLESTON	AL	DO	Not Supporting
SANTEE	030502010602	ASHLEY RVR AT SC 165 4.8 MI SSW OF SUMMERVILLE	CSTL-102	DORCHESTER	AL	DO	Not Supporting
SANTEE	030502010604	ASHLEY RVR AT MAGNOLIA GARDENS	MD-049	CHARLESTON	AL	DO	Not Supporting
SANTEE	030502010604	ASHLEY RV 1.8 MI NW RUNNYMEDE PLANTATION	RT-032046	CHARLESTON	AL	DO	Not Supported
SANTEE	030502010605	ASHLEY RVR AT SALRR BRDG	MD-052	CHARLESTON	AL	DO	Not Supporting
SANTEE	030502010605	ASHLEY RIVER BETWEEN OLDTOWN CREEK AND THE ASHLEY RIVER MEMORIAL BRIDGE NEAR MIDCHANNEL	RO-09363	CHARLESTON	AL	DO	Not Supporting
SANTEE	030502010701	PIER IN WEST BRANCH COOPER RVR AT END OF RICE MILL RD IN PIMLICO	CSTL-085	BERKELEY	AL	DO	Not Supporting
SANTEE	030502010704	COOPER RVR AT S-08-503 6.2 MI ESE OF GOOSE CK	MD-152	BERKELEY	AL	DO	Not Supporting

Figure 3. DHEC Ambient Sites Assessed for the 2012 303(d) List



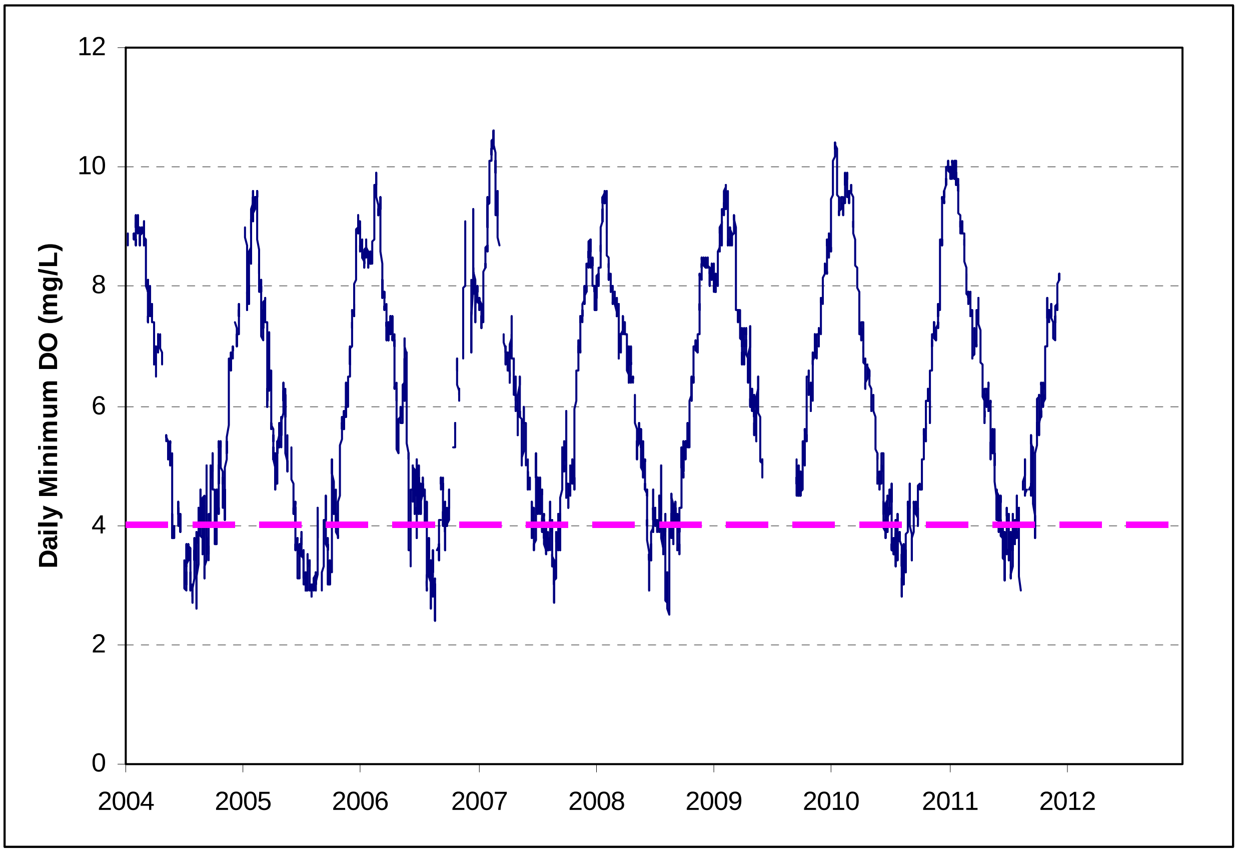
The USGS continuous DO data were evaluated for modeling and TMDL development purposes. Reported daily minimum and daily average values were evaluated against applicable numeric criteria. The period March through October was evaluated, consistent with S.C. R.61-68, Section D.4.a, and the 90th percentile of available data was used for comparison to the criteria consistent with the 303(d) list methodology. Since 2000, a total of 14 locations have been monitored for varying periods. The period 2000 through 2009 was evaluated. Of the 14 locations, 10 locations had 90th percentile DO levels less than the applicable criteria. Figure 4 shows the monitoring locations along with the applicable DO criteria and evaluation results.

Figure 4. USGS Continuous Locations and DO Status



The USGS, the BCDCOG and the wastewater dischargers, along with other cooperators, maintain ongoing DO monitoring at five of the original sites including stations 021720869 Ashley River at I-526, 021720677 Cooper at I-526, 021720698 Wando at I-526, 02172050 upper Cooper, and 021720709 Cooper at U.S. 17. Monitoring results for station 021720677 in the critical area for the TMDL are shown in Figure 5. Data from the other four stations is shown in Appendix A.

Figure 5. Daily Minimum DO at 021720677 Cooper River at I-526



Based on available monitoring data, much of the system does not attain the numeric criteria for DO at some time during the warmer months including the Ashley, Cooper, and Wando Rivers and parts of Charleston Harbor. This conclusion is consistent with the findings in 2002 Cooper and 2003 Ashley TMDLs which included analysis of the extensive data set collected through the Charleston Harbor Project during 1992 through 1995 (see 2002 Cooper TMDL, Appendix B and 2003 Ashley TMDL, Appendix A).

The Department's ambient monitoring data is collected at the surface, while the USGS continuous data is measured at mid-depth. In addition, the continuous data would include the daily minimum concentrations which may not be captured in the Department's ambient data.

3. Source Assessment

3.1. Relationships between Modeled and Monitored Parameters

The parameters considered in this TMDL are those that directly reduce DO levels through microbial oxidation including carbonaceous and nitrogenous biochemical oxygen demand (CBOD and NBOD). The EFDC water quality model parameters used to represent the CBOD and NBOD are total organic carbon (TOC) and ammonia, respectively. The model study included ambient and effluent data for both CBOD and TOC; however, routine ambient and effluent monitoring does not include TOC, so translation between TOC and CBOD is necessary. The total CBOD is split and input to labile and refractory organic carbon (LOC and ROC) model compartments with fast and slow reaction rates. In addition, the TMDL is in terms of UOD which is calculated from CBOD and ammonia. The relationships between the parameters are shown below:

$$LOC = TOC * f_{labile}$$

$$ROC = TOC * f_{refractory}$$

$$TOC = LOC + ROC$$

$$CBODu = TOC*2.7$$

$$CBOD5 * F\text{-ratio} = CBODu$$

$$UOD = CBODu + 4.57 * ammonia$$

where f_{labile} and $f_{refractory}$ are the labile and refractory fractions, and the F-ratio is the ratio of ultimate CBOD to 5-day CBOD. Analyses used to determine these parameters are described in the 3-D Model Report (Tetra Tech and Jordan, Jones, and Goulding, 2008). The values 2.7 and 4.57 are stoichiometric factors relating the amount of oxygen consumed by complete oxidation of TOC and ammonia, respectively.

3.2. Potential Sources

Potential sources of oxygen demand loading that were considered include NPDES wastewater discharges (continuous point sources), NPDES stormwater discharges (non-continuous point sources), non-point sources, and natural background sources.

3.2.1. NPDES Wastewater Discharges

Domestic and industrial wastewater discharges are significant contributors of CBOD and ammonia to the Charleston Harbor System. A total of 17 individual wastewater permits were identified in the 2002 Cooper and 2003 Ashley TMDLs. Three of the original permits have been inactivated (SC0021041, SC0021385, and SC0021911), one new permit has been added by reallocation (SC0048950), and one permit is included in the aggregate load (SC0039063) so there are 14 NPDES wastewater permits identified in this revised TMDL. The 2003 Ashley TMDL and the interim Phase 1 of the 2002 Cooper TMDL have been implemented in 12 of the current permits. The remaining two NPDES wastewater permits were appealed, and the resolution will be effected with this revision of the 2002 Cooper TMDL.

The Ashley and Cooper TMDLs were based on book values for wastewater characteristics, that is, the F-Ratios and instream oxidation rates. These parameters were measured in the laboratory for the new 3-D model. Results showed higher F-Ratios and two-component instream oxidation rates, which were incorporated into the model. As a result, the UODs given in the previous TMDL reports are not comparable to the revised UODs in the new study.

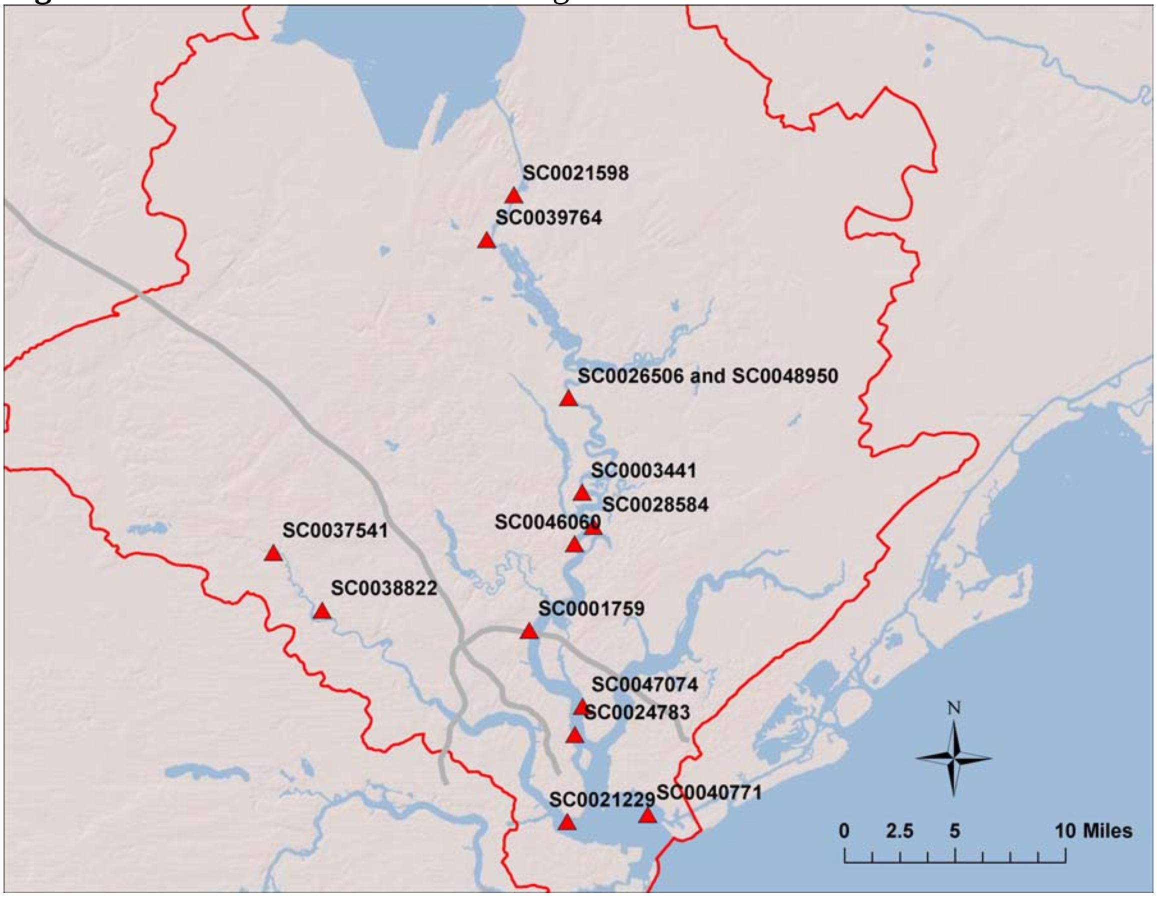
For the revised TMDL, the starting point for the reallocation process was existing permits, most of which had implemented the interim Phase 1 limits. Table 3 shows existing limits for the current NPDES wastewater permits. Permits SC0021229 and SC0024783 were reissued but did not go into effect because of the appeals, and are shown at their interim Phase 1 allocations.

Table 3. NPDES Wastewater Discharges at Existing Limits

Discharge	NPDES	Location	Flow	CBOD5	F-ratio	CBODu	Ammonia	UOD
Name	Permit No.	waterbody	MGD	lbs/day		lbs/day	lbs/day	lbs/day
Summerville	SC0037541	Ashley	10	417	3.8	1,585	67	1,890
DCPW/Lower Dorchester	SC0038822	Ashley	10	467	2.22	1,037	53	1,281
Moncks Corner	SC0021598	WB Cooper	3.2	801	4.11	3,291	534	5,730
BCWSA/Central Berkeley	SC0039764	WB Cooper	3	250	1.5	375	167	1,138
DAK Americas Dupont	SC0026506 SC0048950	Cooper	1.32	345	6.99	2,409	13	2,466
Sun Chemical	SC0003441	Cooper	2.33	821	4.03	3,309	1,111	8,387
BP Amoco	SC0028584	Cooper	4.19	716	6.5	4,656	17	4,736
BCWSA/Lower Berkeley	SC0046060	Cooper	22.5	3,686	3.8	14,008	550	16,520
MeadWestvaco	SC0001759	Cooper	25.6	4,617	8.7	40,168	335	41,700
CPW/Daniel Island	SC0047074	Cooper	4	167	1.5	250	33	403
NCSD/Felix Davis	SC0024783	Cooper	34	5,671	4.43	25,123	851	29,011
CPW/Plum Island	SC0021229	Harbor	36	6,005	3.18	19,095	901	23,212
Mount Pleasant/CS	SC0040771	Harbor	3.7	926	3.18	2,944	364	4,609
Mount Pleasant/RR	SC0040771	Harbor	6	1,501	3.18	4,774	591	7,475
TOTAL				26,390		123,024	5,587	148,557

Most of the discharges, and most of the load, are to the Cooper and Harbor segments. The Ashley discharges are located in the upper reaches of the river. The locations of the discharges are shown in Figure 6.

Figure 6. NPDES Wastewater Discharge Locations



NPDES facilities with continuous discharges to the mainstem segments that were not included during model development due to their small loadings are accounted for in the TMDL model as an aggregate load estimated at 752 pounds per day UOD representing existing conditions. Cooling water discharges were not considered sources of CBOD or ammonia and are excluded. If additional data become available that identifies other contributing NPDES facilities, then the TMDL Calculator and/or model can be rerun to account for these loads in the WLA.

Existing NPDES discharges at current loading to tributaries are considered part of the background watershed loadings. Future expansions and proposed new facilities will have to demonstrate that their permitted loading is equivalent to the background UOD concentration at the point of entry to the mainstems.

3.2.2. Non-continuous Sources

NPDES stormwater discharges (non-continuous point sources), non-point sources, and natural background sources are aggregated in the watershed load inputs. Watershed loads were calculated using flows generated by the LSPC model and concentrations calculated based on regression models developed from wet-weather sampling data using percent developed and percent forest land cover as the independent variables. Results of the regression analysis indicated oxygen demand loads delivered to the mainstems from developed areas are equivalent to or less than natural background levels under current conditions.

4. Modeling Approach

The implementation plan for the 2002 Cooper TMDL allowed for additional data collection and development of a new model. The new work addressed stakeholder concerns over several areas of uncertainty in the original TMDL model. Enhancements included 3-dimensional transport, a watershed model, additional measurements for rate parameters and waste characteristics, multiyear simulation, and additional instream data for model calibration. Model development and application for the revised TMDL are summarized below. The following is not intended as a full technical discussion of the model. Model development is fully documented in the 3-D Modeling Report (Tetra Tech and Jordan, Jones, and Goulding, 2008). The model report is provided with the public distribution of this TMDL.

4.1. Quality Assurance Project Plan

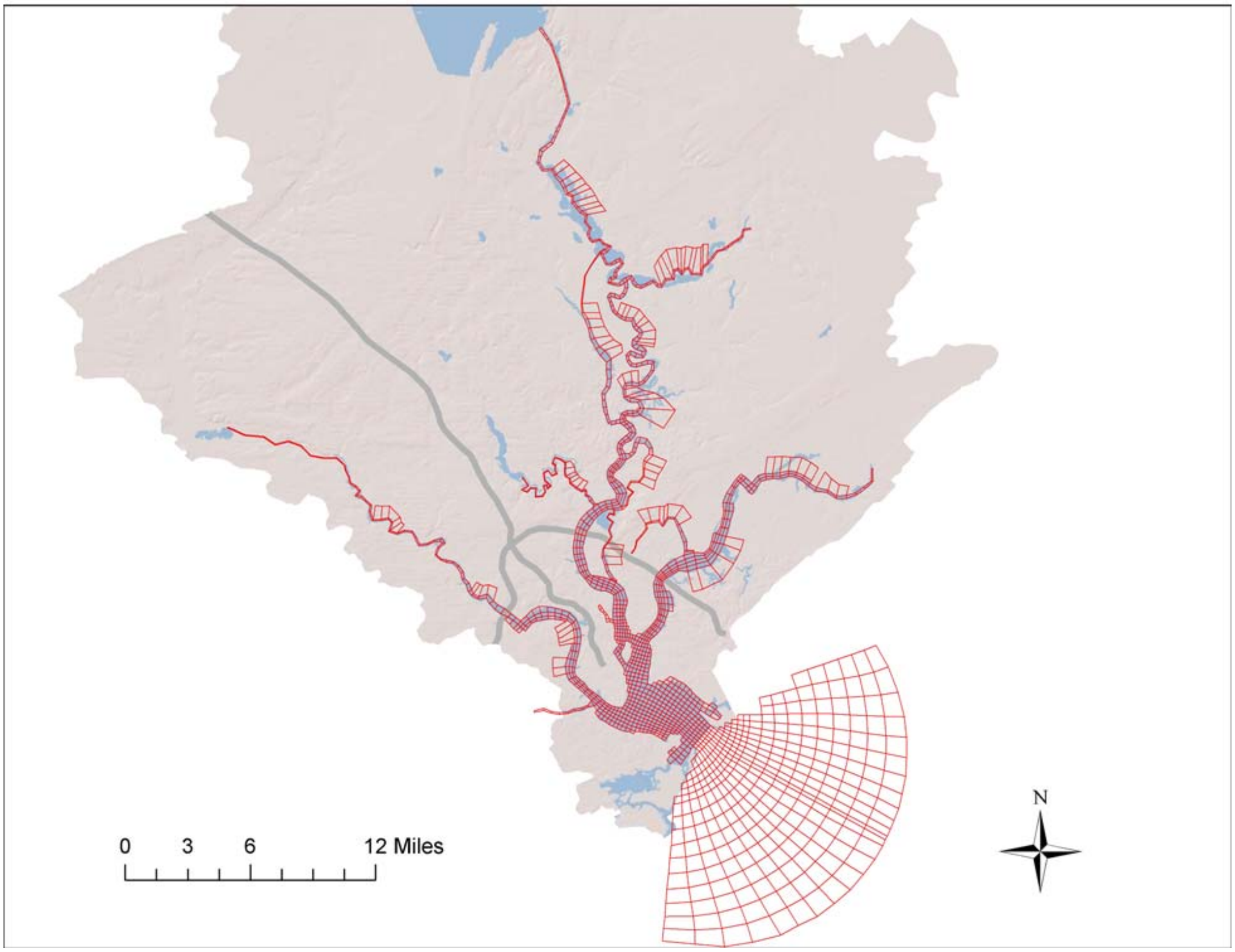
A Quality Assurance Project Plan was prepared by Jordan, Jones & Goulding, Inc. and Tetra Tech, Inc. on behalf of the BCDCOG to ensure the data would meet regulatory requirements and would support the goals of the modeling project. Participants in the plan development included staff from DHEC, the U.S. Geological Survey, EPA Region 4, the GEL Group, HydrO2, Seaus, and MACTEC.

4.2. Model Development

The modeling platform is the Environmental Fluid Dynamics Code (EFDC) model for both hydrodynamics and water quality. The EFDC hydrodynamic model is part of the EPA Region 4 modeling toolbox (Hamrick, 1992; Park et al., 1995). The EFDC water quality model is based on water quality kinetics from the Chesapeake Bay Water Quality model, also known as CE-QUAL-ICM (Cerco and Cole, 1993).

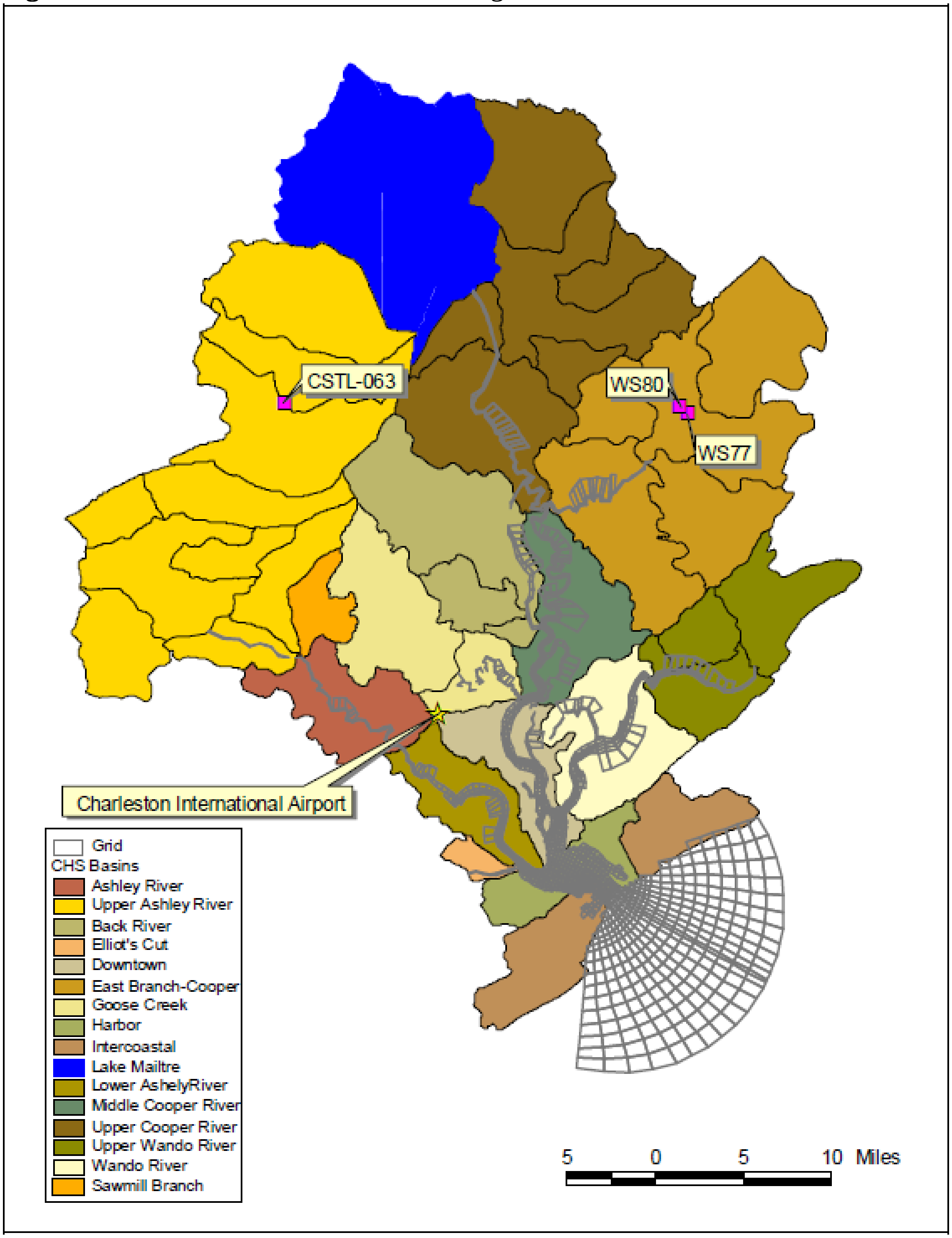
The Charleston EFDC model grid extends up the Ashley River to the headwaters in Cypress Swamp at Slands Bridge near Summerville, up the Wando River to the headwaters in Francis Marion National Forest, and up the Cooper River to Pinopolis Dam near Moncks Corner. The grid also includes the East Branch Cooper River up to Quinby Plantation. The offshore boundary is approximately 10 miles outside the harbor inlet and Fort Sumter. Four vertical layers are used throughout the model domain, with the layers varying in thickness along with changing water depth. Marsh areas and remnant rice impoundments along the upper reaches are represented in the grid as water storage areas. Figure 7 shows the Charleston EFDC model grid.

Figure 7. Charleston EFDC Model Grid



The Loading Simulation Program in C++ (LSPC) watershed model was used to establish watershed and overland flows and loads to the Charleston Harbor system. Sub-watersheds were grouped into contributing areas for input to the EFDC model. Watershed flows were predicted by LSPC. Watershed loads were determined using predicted flows and constituent concentrations determined from regression models with concentration as the dependent variable and percent urban and forest landuse as the independent variables. The constituent regressions were developed from wet weather stream sampling data. Flows and constituent loads from contributing areas were input to the EFDC model grid at discrete points representing aggregate totals from the sub-watersheds in each area. The sub-watersheds and contributing areas are shown in Figure 8.

Figure 8. Subwatersheds and Contributing Areas in the LSPC Model



The Charleston EFDC water quality model was set up to simulate one algal class, total refractory and labile organic carbon, nitrogen, and phosphorus, orthophosphate (PO4), ammonia (NH3), nitrite-nitrate (NO2-NO3), and dissolved oxygen (DO). The EFDC sediment model was not used; nutrient fluxes and sediment oxygen demand (SOD) were determined from field measurements collected by HydroO2, Inc. Based on measured chlorophyll-a levels and measured water column production and respiration, it was determined a single algae class could be used in the model and that while algal dynamics have some impact on DO levels in poorly flushed areas such as the upper Ashley and Wando Rivers, there is little effect on the Cooper or the system as a whole. Algae were left on in all model simulations to account for the effect on DO.

EFDC simulates organic carbon rather than BOD. Model setup included measured data for both parameters and stoichiometric conversion of CBOD to organic carbon. Instream and wastewater long-term BODs were used to determine fast and slow reaction rates in the system as well as effluent F-ratios and effluent partitioning into fast and slow compartments. Detailed analysis is found in Appendix A of the 3-D Modeling Report.

Intensive monitoring for model calibration was conducted in 2004 including continuous data for physical parameters and DO and discrete monitoring for water quality parameters. The calibration period was April through October. The model was validated using the 1996 dataset collected for the previous modeling effort.

The model was calibrated and validated to daily average DO concentrations and was accepted by DHEC and EPA Region 4 for the purpose of predicting DO change in response to pollutant loads to evaluate the “0.1 Rule” under S.C. R.61-68, Section D.4.a. Additional modeling work would be needed to predict absolute DO levels for the purpose of demonstrating larger DO impacts could be allowed under S.C. R.61-68, Section D.4.b.

4.3. TMDL Model Application

Once the model was calibrated for the 2004 period, only the wastewater inputs were adjusted for the TMDL scenarios. The background scenario was created by removing the continuous point source loads from the calibrated model. Various loading scenarios were developed for effluent CBOD, ammonia, and DO. Scenarios are listed below:

- Background—2004 calibration scenario with wastewater loads for CBOD, ammonia, and effluent DO removed.

- 2004 Permits—permit limits at the start of the 3-D model project prior to implementation of the 2003 Ashley and 2002 Cooper TMDLs;

- Phase 1—permit levels in the 2003 Ashley TMDL and interim Phase 1 of the 2002 Cooper TMDL;

- Phase 2—permit levels in the 2003 Ashley TMDL and final Phase 2 of the 2002 Cooper TMDLs;

- TMDL—final BCDCOG allocation scenario as approved April 29, 2010 and the aggregated minor NPDES loads representing the revised TMDL. Approval letter included in Appendix B.

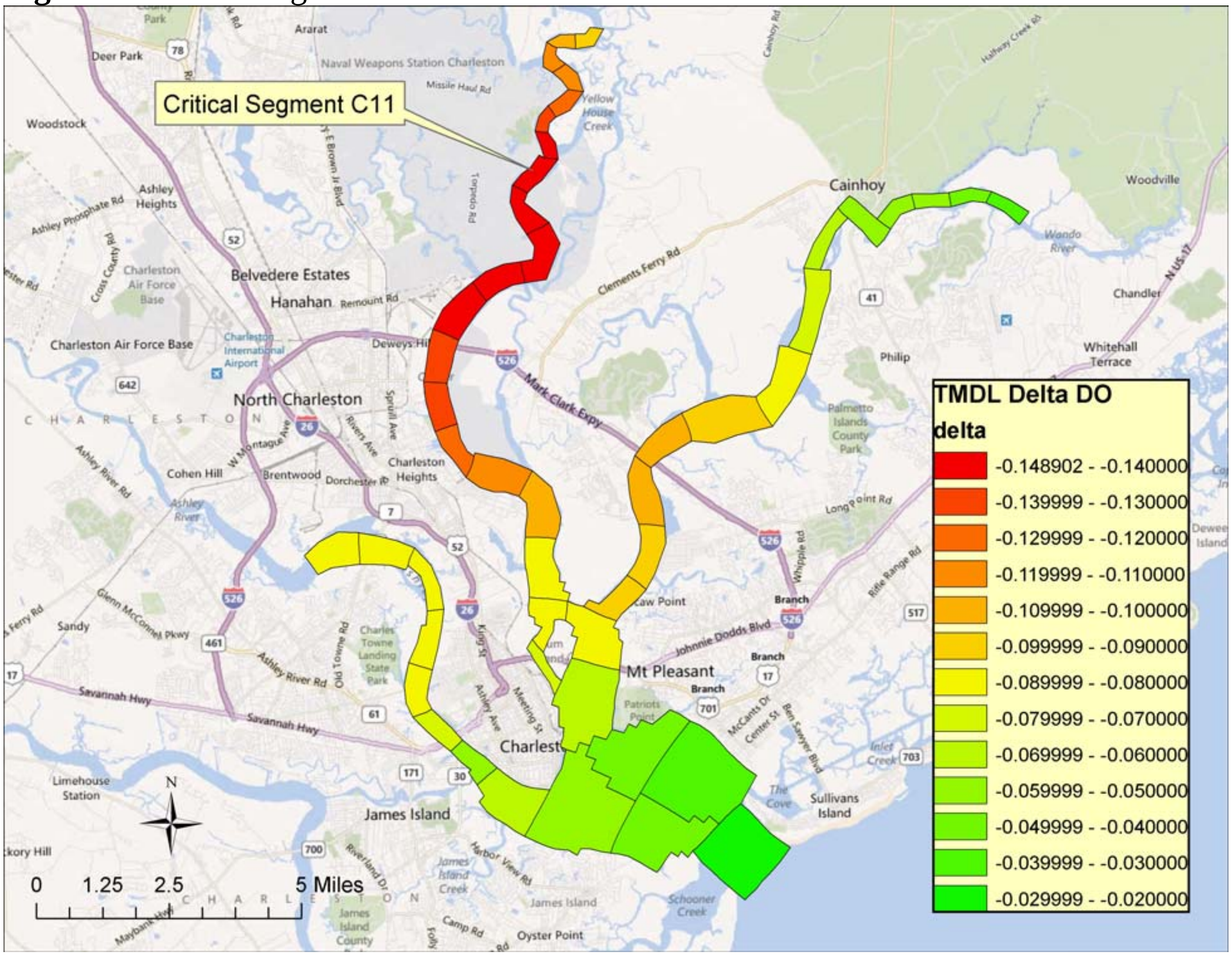
The allowable 0.1 mg/L DO impact is evaluated by calculating the delta DO defined as the background DO concentration subtracted from the DO concentration in the loading scenario. A single EFDC hydrodynamic model setup was used for all scenarios which included no effluent flows for the Cooper and Harbor discharges but did include effluent flows for the upper Ashley dischargers. Williams Steam Station cooling water discharge and heat load were included. Cooper and Harbor discharges were input as zero in the background scenario, while the upper Ashley discharges were input at loadings equivalent to background concentrations in the background scenario.

4.3.1. TMDL Segments

Tetra Tech developed an efficient post-processing program to process EFDC water quality model output files for evaluation. The program computes volume-weighted average constituent concentrations as daily average values over user defined segments. Results for the background run are subtracted from the various load runs to give daily average delta DO for each TMDL segment for the simulation period.

The TMDL segments were defined to represent average conditions across river width, vertically through the water column, and along river segments roughly determined as twice the river width. Gradients in the unsegmented output were inspected and considered during delineation. Oxygen deficits due to wastewater constituents occur over time and are mixed within the TMDL segments. The TMDL segments used to apply the 0.1 mg/L target are shown in Figure 9. Note the controlling segment for the Cooper and Harbor discharges in the TMDL is Cooper River segment C11. The controlling segment for the Ashley discharges is A43 located in between SC0037541 and SC0038822.

Figure 9. TMDL Segments and Delta DO in the Harbor Area



4.3.2. Critical Conditions

Representative Year. The TMDL model period is March through October, the critical months for DO as defined by S.C. R.61-68, Section D.4.a. The calibration year 2004 was selected for critical conditions as discussed below.

Assimilative capacity in the Charleston Harbor System is, on the whole, relatively stable with low variability from year to year. It is governed to a large degree by tightly controlled flow releases at Pinopolis Dam, which have both minimum and maximum flow constraints, and regular tidal cycle forcing from the ocean, although the use of actual water surface elevations can introduce irregular meteorological effects. Rainfall over the watershed varies annually, but rainfall patterns do not appreciably alter flow, dilution, or assimilative capacity conditions on the lower Cooper River. High flows diverted from the Santee River that were previously sent down the Cooper River and into Charleston Harbor were routed back to the Santee River beginning in the 1980s.

The Ashley River, particularly the upper Ashley, is influenced by local rainfall patterns. Sustained periods of dry weather reduce inflows from Cypress Swamp and other sources allowing salt water to intrude up the Ashley River creating poor flushing conditions for continuous wastewater discharges. During wet conditions, salt water and effluent are pushed downstream and out of the system.

A 7-year EFDC model simulation representing 2000-2006 was used to evaluate year to year variability. Constant effluent dye was simulated to evaluate annual variability in available dilution throughout the system. Wastewater effluent flows were set to an arbitrary 100 mg/L dye, and background was set at 1 mg/L. Results for the Cooper River are shown in Figure 10. Dye concentrations in the critical segment for all years varied ±6 percent compared to the mean. Dilution on the upper Ashley was more variable, as shown in Figure 11.

Figure 10. Dilution in Cooper River During 2000-2006

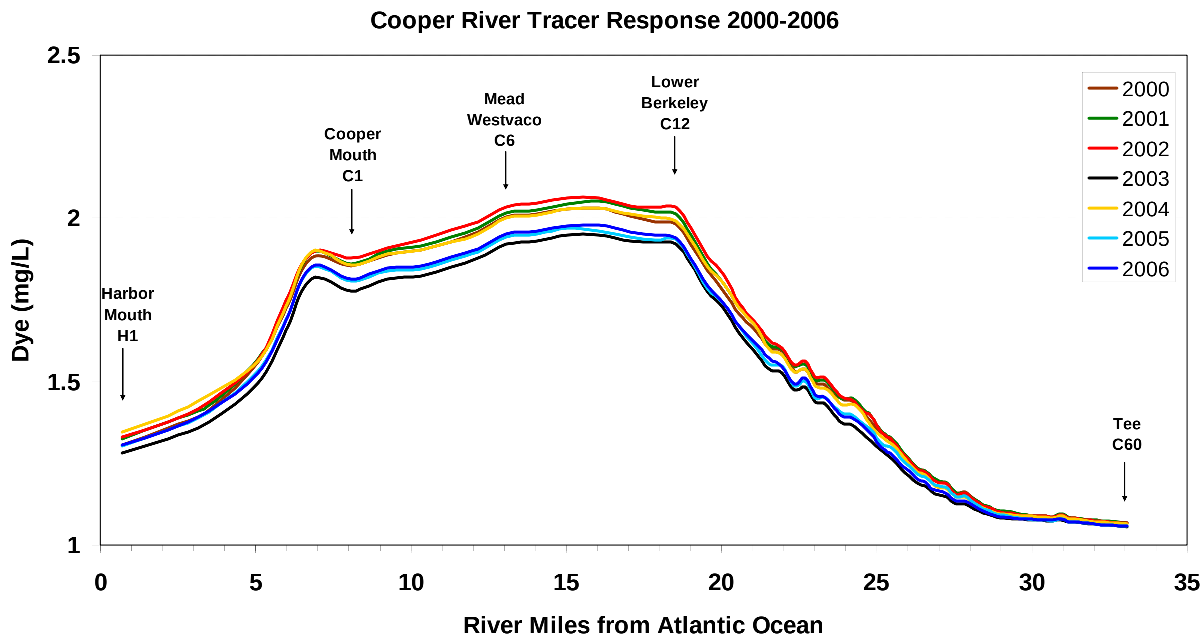
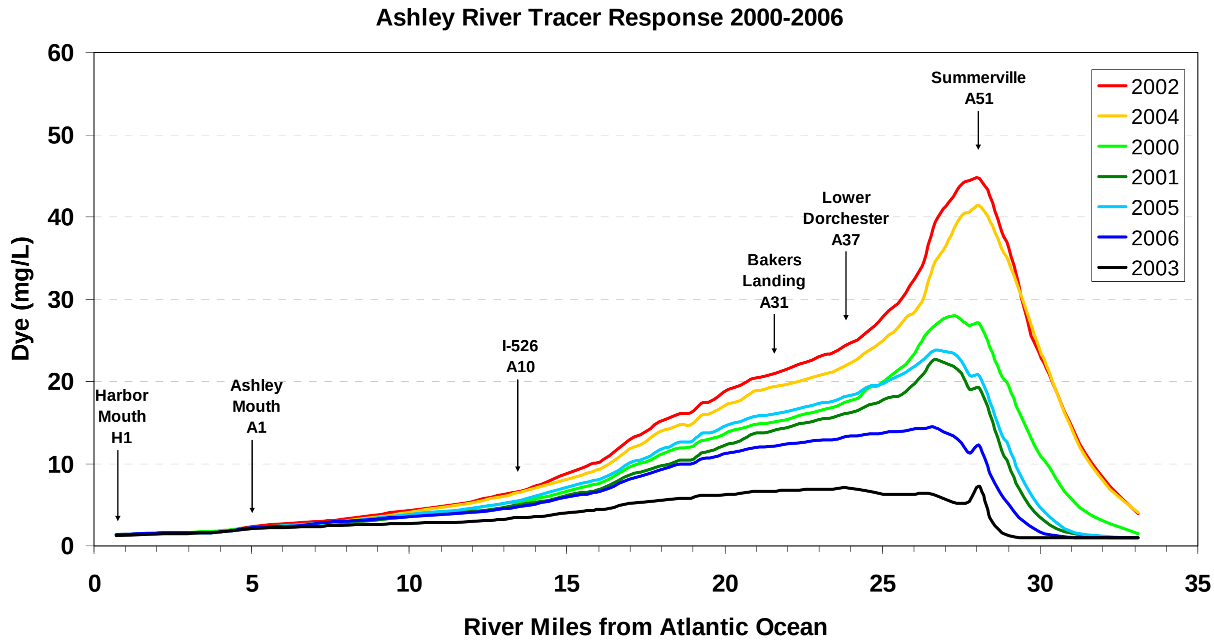


Figure 11. Dilution in Ashley River During 2000-2006

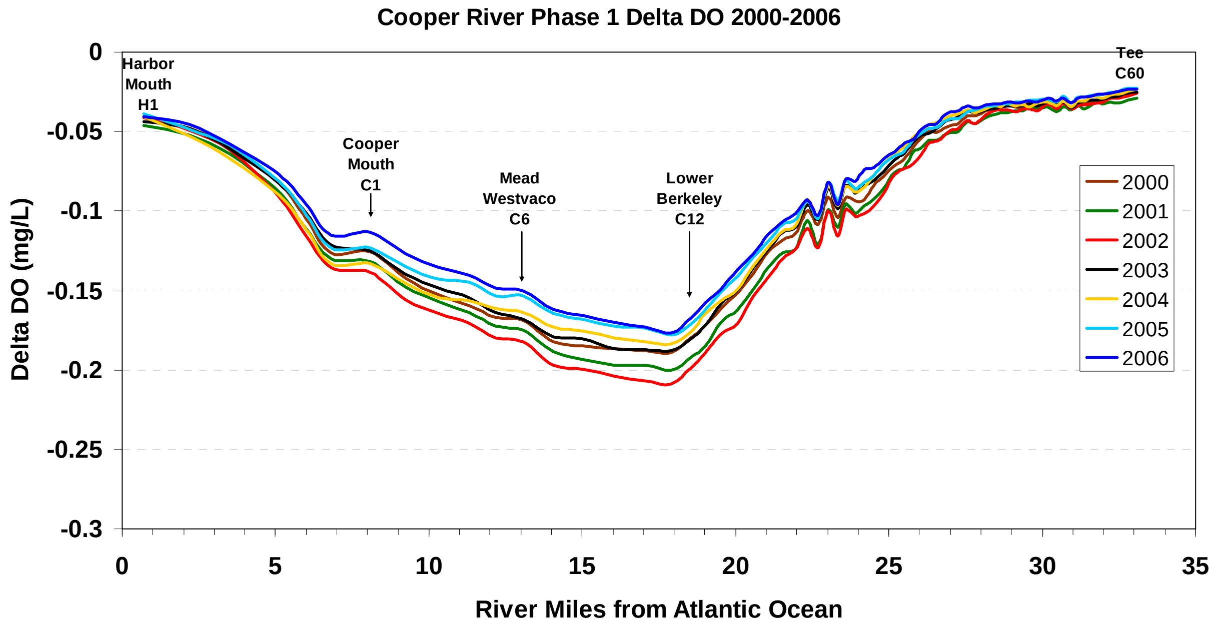


The predicted delta DO in the Cooper River also showed a low degree of variability from year to year. The 90th percentile daily average delta DOs in the critical segment are shown in Table 4; complete results are shown in Figure 12. Maximum and minimum values are +10% and -7% of the 2000-2006 mean value. Based on the low variability in the delta DO on the Cooper and considering 2004 to be an appropriate critical year for the Ashley based on dilution results, the calibration year 2004 was selected for critical conditions to develop the TMDL.

Table 4. Annual 90th Percentile Delta DO in the Cooper River at Phase 1 Loading

Year	Delta DO (mg/L)
2000	-0.189
2001	-0.200
2002	-0.209
2003	-0.188
2004	-0.184
2005	-0.178
2006	-0.177

Figure 12. Cooper River 90th Percentile Delta DO at Phase 1 Loading



Design Condition. The 2002 Cooper and 2003 Ashley TMDLs used quasi-dynamic modeling (a combination of time-varying and selected constant model input conditions) setups where simulations were calibrated and run for relatively short timeframes up to 30 days. After model calibration, model boundary inputs were adjusted from calibration conditions to specified values designed to represent appropriate critical conditions in order to develop the TMDLs. Both the 2002 Cooper and 2003 Ashley models were adjusted to TMDL critical conditions following the guidance provided by EPA, prepared by Tetra Tech's Fairfax office, documented by Butcher (1998).

Butcher reviewed the Department's draft WLA model applications for the Waccamaw and Cooper River systems as well as South Carolina's DO standard and "point one" rule. Butcher's recommendations for application of the point one rule under S.C. R.61-68, Section D.4 were implemented and approved in the 2000 Waccamaw, 2002 Cooper, and

2003 Ashley DO TMDLs. In summary, Butcher recommended setting uncontrolled freshwater inflows to 7Q10, Pinopolis Dam flow into the Cooper at the minimum release specified in the flow agreement, seaward boundary to represent a range of spring/neap tides, and set boundary temperature, CBOD, ammonia at the 75th percentile summer value and boundary DO at the 25th percentile summer value. The purpose, according to Butcher, was not to prevent excursions under all conditions, but to design to restrict excursions of the DO standard to an acceptably low frequency.

The current 3-D Charleston Harbor model is fully dynamic representing actual conditions during the simulation period. In this case model inputs for the TMDL scenario are not selected, they are measured, and they represent actual conditions. Once the representative simulation period is selected, design conditions are then applied to the model output. March through October, 2004 was used for the critical period. The 90th percentile was used for the design condition.

4.3.3. TMDL Calculator

The 2002 Cooper TMDL included a spreadsheet allocation tool, or TMDL calculator, that allowed stakeholders to test allocation scenarios in real time in group settings without waiting hours or days for simulation model results. This efficient tool, conceived by Jim Greenfield while at EPA Region 4, helped the BCDCOG successfully allocate the TMDL among the NPDES permit holders.

A new TMDL calculator was developed by the Department and Tetra Tech based on the 3-D model for the revised TMDL. More than a hundred EFDC water quality model simulations were completed to determine the unit response of delta DO in each TMDL segment per pound of effluent CBOD, ammonia, and DO individually for each outfall location. The responses are linear and additive so once the individual responses are determined, they can be stored in spreadsheet tables and added together to get the total delta DO from all discharges. Users adjust effluent loads on the interface tab and the delta DO results are recalculated instantly. The TMDL calculator was verified against the EFDC water quality model. It was used by the BCDCOG in the TMDL allocation process to determine the individual WLAs for this TMDL.

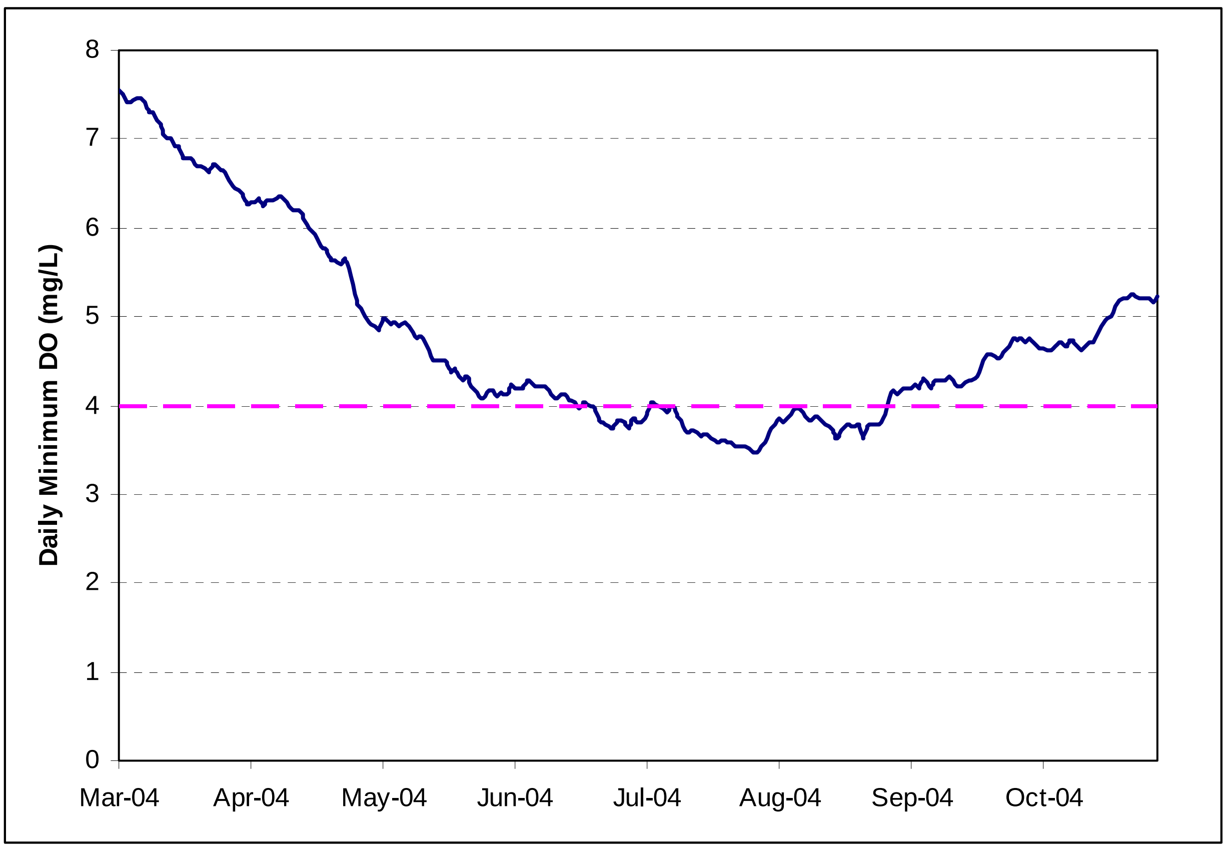
After the TMDL is finalized, the TMDL calculator can be used for future reallocations. As long as the DO standard is maintained as evidenced by the TMDL calculator, future reallocations will be considered to be consistent with this TMDL and reopening or revision of the TMDL is not necessary.

5. TMDL

5.1. TMDL Numeric Target

Modeling, data, and research (Conrads et al., 2002; Lerberg et al., 2000) in areas of the Charleston Harbor system that are largely un-impacted by point source discharges of pollution indicate that, during the critical periods for which wasteload allocations are set and TMDLs are developed, DO concentrations in much of the Charleston Harbor system are low and would not meet applicable standards even without discharger input of oxygen demanding substances. Figure 13 shows EFDC water quality model results for the critical segment Cooper C11 without point source loadings.

Figure 13. EFDC Model Background (no point source loads) Daily Minimum DO in Cooper Segment C11



Under such circumstances where DO concentrations are naturally low, state water quality standards (S.C. R.61-68.D.4.a.) allow an additional lowering of DO of no more than 0.1 mg/l due to point sources and other activities. Therefore, the water quality target for this TMDL is the allowable DO impact of 0.1 mg/L.

The TMDL Target of 0.1 mg/l Delta DO is calculated by taking the 90 percentile of the daily Delta DOs difference calculated by subtracting the background model output from the load run output for each zone for the time period March through October. This time frame is defined by SCDHEC regulations. Figure 14 shows the delta DO in the critical segment Cooper C11. Figure 15 shows 90th percentile Delta DO throughout the system.

Figure 14. Delta DO in Cooper C11

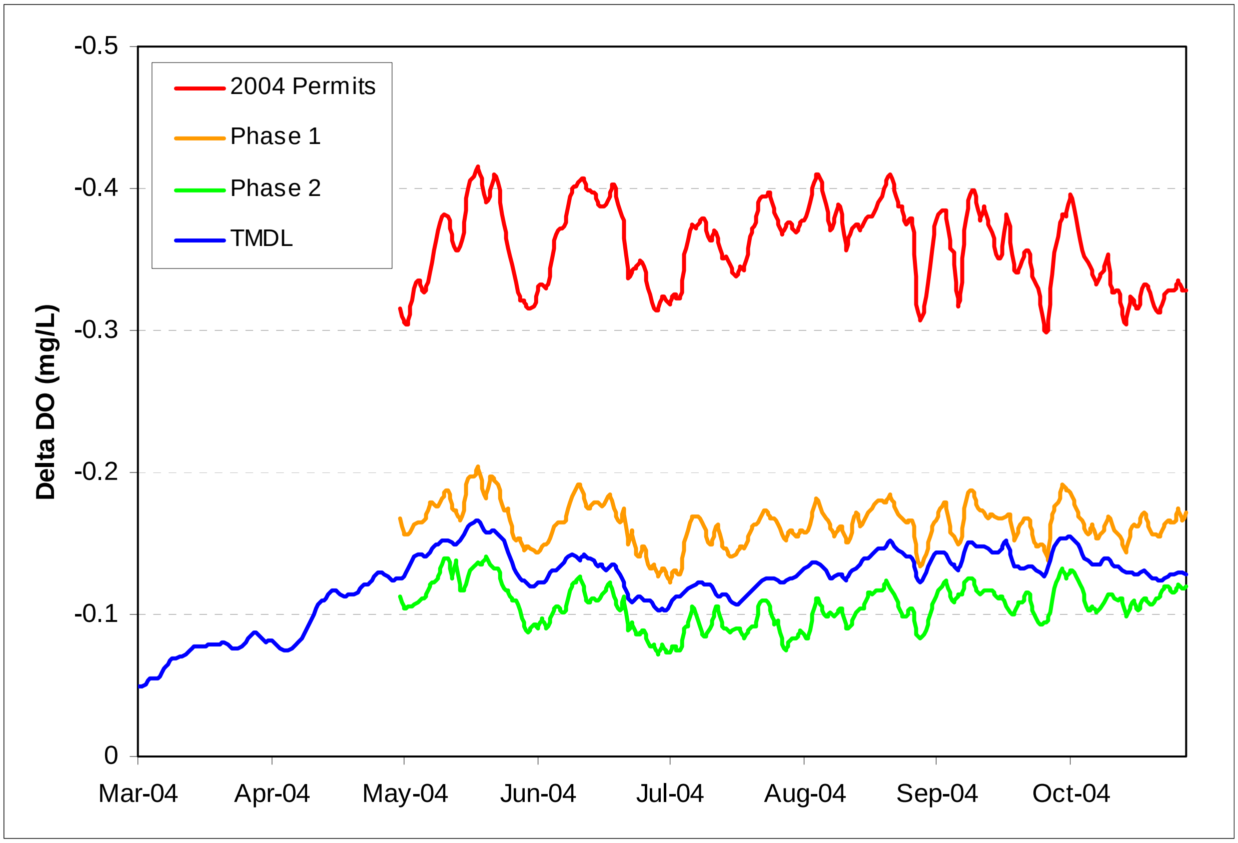
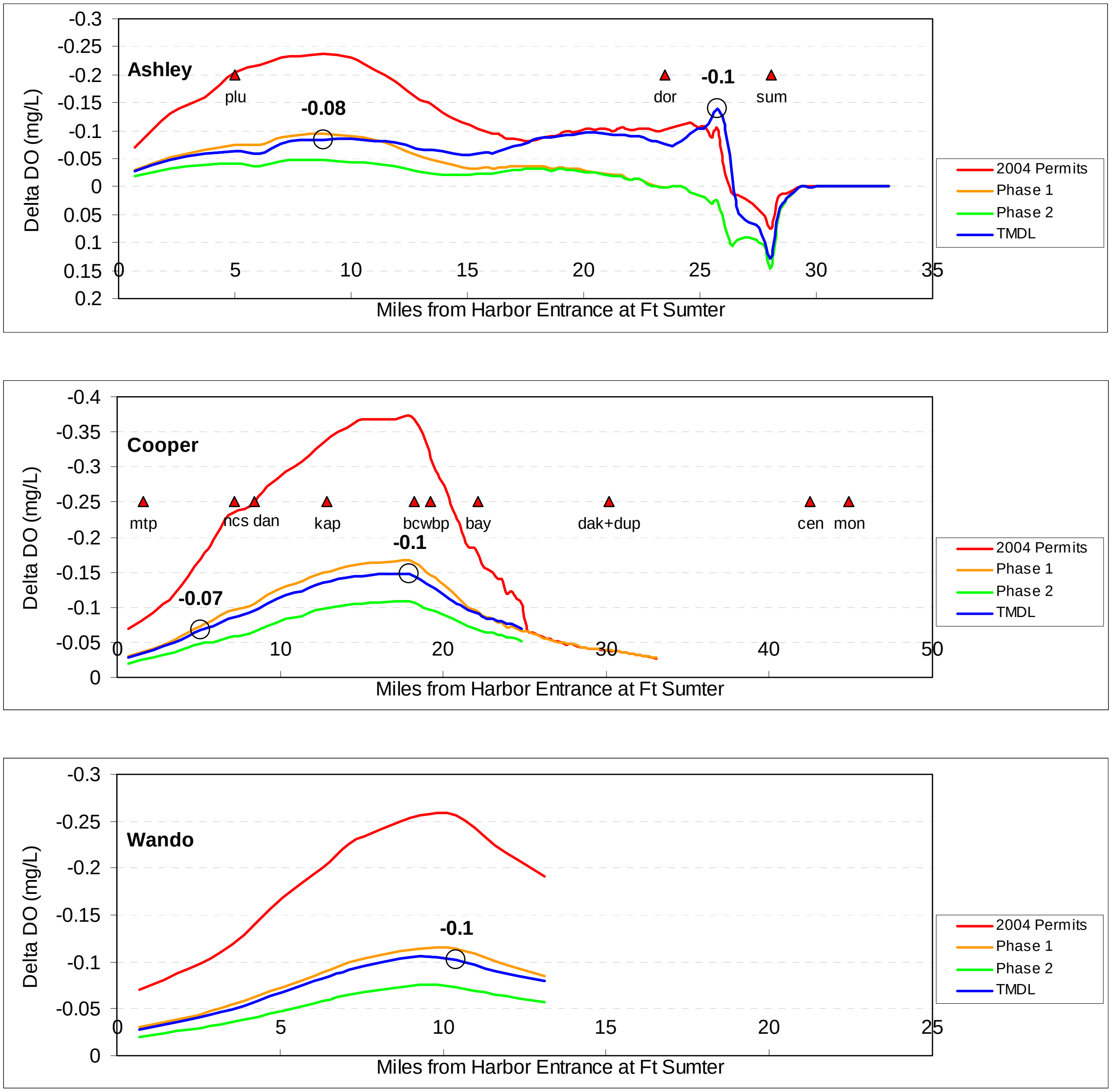


Figure 15. 90th Percentile Delta DO



5.2. Wasteload Allocation (WLA)

The WLA component of the TMDL is the portion of the receiving water's loading capacity that is allocated to NPDES regulated point sources. This TMDL establishes the WLA for continuous non-stormwater dischargers. The WLAs for permitted Municipal Separate Storm Sewer System (MS4) discharges and other regulated stormwater sources are established at background loading conditions and/or oxygen demanding pollutant concentrations such that they will not cause or contribute to further lowering of dissolved oxygen in the mainstem segments. In the future, if additional data or new activity indicates additional loading of oxygen demand from MS4s or other regulated stormwater sources to the TMDL segments, then the TMDL may be revised.

This TMDL includes final limits for continuous NPDES permitted dischargers in the system; however, the revised Charleston Harbor TMDL is not a fixed number. The total WLA may vary depending on the locations of the individual loads in relation to the critical segments. The TMDL Calculator computes the DO depression at the critical locations in the estuary in response to various combinations of individual NPDES wastewater loads. The BCDCOG approved allocation included in this TMDL in Table 5 is one possible combination of individual WLAs shown by modeling to achieve the TMDL target of 0.1 mg/L allowable DO depression. Future reallocations, and changes in the total WLA, are possible without further revision of the TMDL provided the TMDL target is maintained as shown by the EFDC model and/or TMDL Calculator.

5.3. Load Allocation (LA)

The LA component of the TMDL is the portion of the receiving water's loading capacity that is attributed to the non-NPDES regulated sources of oxygen-demanding substances, including non-point source discharges and natural background sources. The majority of the non-NPDES loadings are from natural background sources. Non-point sources are a very minor contributor of oxygen consuming load under critical low flow conditions because of the absence of stormwater runoff.

Wet-weather sampling conducted in the Charleston Harbor watershed and the regression models developed for the LSPC modeling determined developed areas currently contribute no more oxygen demanding pollutants to the TMDL segments than forested areas. Therefore, the non-point source contribution is aggregated with the natural background loads in this TMDL. If, at a later date, a significant upstream non-point source is identified, the TMDL may be revised to account for this source.

The loads normally associated with the LA are not factored into this TMDL computation because the TMDL target is a rise over background load consistent with S.C. R.61-68, Section D.4.a rather than a total load. As defined under S.C. R.61-68, Section D.4.a, only the additional load above and beyond the background load factors into the 0.1 mg/L DO depression target. For comparison purposes the total background UOD load to the Charleston Harbor system is 820,672 lbs per day, excluding the ocean boundary which is a net export from the system. The total is comprised of:

- Atmosphere 10,056 lbs per day;
- Dam 403,065;
- Watersheds 107,663;

- Marshes 253,266;
- Sediments 46,622.

5.4. Margin of Safety

A margin of safety (MOS) is a required component of a TMDL to account for the uncertainty in the relationship between the pollutant loads and the quality of the receiving waterbody. For Charleston Harbor, the amount of uncertainty is considered to be low. This system has been the subject of extensive study, including extensive data collection and model development by various state and federal agencies. The Charleston Harbor MOS is implicitly provided by the abundance of data, the calibrated and verified three dimensional model and conservative critical condition assumptions used to develop the TMDL.

5.5. Seasonal Variation

Seasonal variation is incorporated in the Charleston Harbor TMDL by evaluating multiple years of data and evaluating the months March through October. For the hydrodynamic and water quality model, the years of 2000 through 2006 were evaluated. The TMDL recognizes that permit loads can be larger in the months November through February when the DO standard numeric criteria apply. Thus the model can also be used to develop seasonal WLAs and seasonal NPDES permit limits.

6. TMDL WLA Implementation

The BCDCOG used the TMDL Calculator to facilitate the wasteload allocation process among the Charleston water users. The final individual allocations approved by the BCDCOG plus an aggregate wasteload allocation representing small continuous sources that were excluded during model development due to their small loads is the WLA for this TMDL. The TMDL will be implemented by incorporating the individual allocations into NPDES wastewater permits and maintenance of the aggregate load at existing conditions. The approved TMDL Calculator showing the individual allocations and the resulting delta DO in the controlling segments is shown in Table 5.

The total WLA for this TMDL is 145,532 pounds per day UOD, for all months during March through October. This total includes 144,780 pounds per day as allocated by the BCDCOG and shown in Table 5 plus an aggregate load of 752 pounds per day from the small dischargers. The individual WLAs are computed at the point of discharge, and the total WLA varies depending on the spatial distribution of the individual loads. Thus the total WLA may be higher or lower depending on where the loads are discharged. The aggregate load is determined using the conservative assumption that the small loads are discharged directly to the critical segment. The individual WLAs in Table 5 represent one of many possible allocations that can achieve the TMDL target. Future reallocations, and changes in the total WLA, are deemed consistent with this TMDL as long as the TMDL target is maintained as demonstrated with the EFDC model and/or TMDL Calculator.

This TMDL will be implemented by issuance of NPDES permits for continuous point sources. Any future reallocation of this TMDL would require modifications to the NPDES permit conditions established by this TMDL. In the event that the TMDL is reallocated in the future, the Department will issue a public notice and allow for public participation through the normal NPDES permitting process prior to permit modification.

6.1 Tributary Dischargers

The TMDL model accounts for the existing loads from the tributary wastewater dischargers as part of the background load to the system. Future expansions and introduction of new facilities will have to meet a performance standard of demonstrating that their discharge is equal to the background UOD concentration at the point of entry to the mainstem of Charleston Harbor or the Cooper, Ashley, and Wando Rivers.

Table 5. Final BCDCOG Individual WLAs Scenario (BCDCOG letter included as Appendix B)

Charleston TMDL Calculator

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DRAFT TMDL--Final BCDCOG WLA Scenario (As Approved April 29, 2010) with aggregate load for DAK & Dupont

Discharge	NPDES	Location	Flow	CBOD5		F-ratio	CBODu		Ammonia		UOD	Percent	DO
Name	Permit No.	waterbody	MGD	mg/L	lbs/day		mg/L	lbs/day	mg/L	lbs/day	lbs/day	of total	mg/L
Summerville	SC0037541	Ashley	10	7.7	642	3.8	29	2,440	0.8	67	2,745	1.9%	7
DCPW/Lower Dorchester	SC0038822	Ashley	12	9	901	2.22	20	2,000	0.8	80	2,365	1.6%	5
Moncks Corner	SC0021598	WB Cooper	3.2	30	801	4.11	123	3,291	20	534	5,730	4.0%	5
BCWSA/Central Berkeley	SC0039764	WB Cooper	6	20	1,001	1.5	30	1,501	10	500	3,788	2.6%	5
DAK Americas Dupont	SC0026506 SC0048950	Cooper	1.32	31.3	345	6.99	219	2,409	1.15	13	2,466	1.7%	4
Sun Chemical	SC0003441	Cooper	4.5	30	1,126	4.03	121	4,537	18	676	7,625	5.3%	4
BP Amoco	SC0028584	Cooper	4.19	20.5	716	6.5	133	4,656	0.5	17	4,736	3.3%	4
BCWSA/Lower Berkeley	SC0046060	Cooper	22.5	10	1,877	3.8	38	7,131	2	375	8,846	6.1%	5
KapStone	SC0001759	Cooper	25.6	21	4,484	8.7	183	39,007	2	427	40,959	28.3%	4
CPW/Daniel Island	SC0047074	Cooper	4	5	167	1.5	8	250	1	33	403	0.3%	5
NCSD/Felix Davis	SC0024783	Cooper	34	18	5,104	4.43	80	22,611	5	1,418	29,090	20.1%	5
CPW/Plum Island	SC0021229	Harbor	54	10	4,504	3.18	32	14,321	5	2,252	24,612	17.0%	5
Mount Pleasant/CS	SC0040771	Harbor	3.7	30	926	3.18	95	2,944	10	309	4,354	3.0%	1
Mount Pleasant/RR	SC0040771	Harbor	6	30	1,501	3.18	95	4,774	10	500	7,061	4.9%	1
										Total	144,780	100.0%	

Delta DO Results

Discharge	NPDES	Location	Ashley Seg A5 Delta DO	Ashley Seg A5 Percent	Ashley Seg A43 Delta DO	Ashley Seg A43 Percent	Cooper Seg C11 Delta DO	Cooper Seg C11 Percent	Wando Seg W4 Delta DO	Wando Seg W4 Percent	Harbor Seg H6 Delta	Harbor Seg H6 Percent
Name	Permit No.	mile*	mg/L	of total	mg/L	of total	mg/L	of total	mg/L	of total	mg/L	of total
Summerville	SC0037541	28.1	-0.001	1%	-0.068	49%	0.000	0%	0.000	0%	0.000	0%
DCPW/Lower Dorchester	SC0038822	23.5	-0.003	3%	-0.069	49%	0.000	0%	0.000	0%	0.000	0%
Moncks Corner	SC0021598	44.9	-0.002	2%	0.000	0%	-0.011	8%	-0.004	4%	-0.003	4%
BCWSA/Central Berkeley	SC0039764	42.5	-0.001	2%	0.000	0%	-0.010	7%	-0.003	3%	-0.002	3%
DAK Americas	SC0026506	30.2	-0.001	1%	0.000	0%	-0.004	3%	-0.002	2%	-0.001	2%
Sun Chemical	SC0003441	22.1	-0.004	5%	0.000	0%	-0.017	12%	-0.009	9%	-0.006	9%
BP Amoco	SC0028584	19.2	-0.002	3%	0.000	0%	-0.006	4%	-0.004	4%	-0.003	4%
BCWSA/Lower Berkeley	SC0046060	18.2	-0.005	5%	0.000	0%	-0.013	9%	-0.010	10%	-0.006	9%
MeadWestvaco	SC0001759	12.9	-0.012	15%	0.000	0%	-0.041	28%	-0.026	25%	-0.016	23%
CPW/Daniel Island	SC0047074	8.4	0.000	0%	0.000	0%	0.000	0%	0.000	0%	0.000	0%
NCSD/Felix Davis	SC0024783	7.2	-0.015	18%	0.000	0%	-0.032	22%	-0.030	29%	-0.017	25%
CPW/Plum Island	SC0021229	5.0	-0.033	40%	-0.001	1%	-0.006	4%	-0.007	7%	-0.007	10%
Mount Pleasant/CS&RR	SC0040771	1.6	-0.004	5%	0.000	0%	-0.007	4%	-0.007	7%	-0.007	11%
		Delta DO	**-0.1**	100%	**-0.1**	100%	**-0.1**	100%	**-0.1**	100%	**-0.1**	100%
		calculator	-0.084		-0.140		-0.148		-0.103		-0.068	
*Fort Sumter is mile 0.8		model wla scenario	-0.086		-0.130		-0.146		-0.103		-0.065	

7. References

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Tetra Tech and Jordan, Jones & Goulding, 2008, *3-D Modeling Report for the Charleston Harbor System*, prepared for Berkeley-Charleston-Dorchester Council of Governments, 455 pp. (with appendices).

Appendix A. USGS Continuous DO Monitoring

Figure A1. Daily Minimum DO at 02172050 Cooper River near Goose Creek

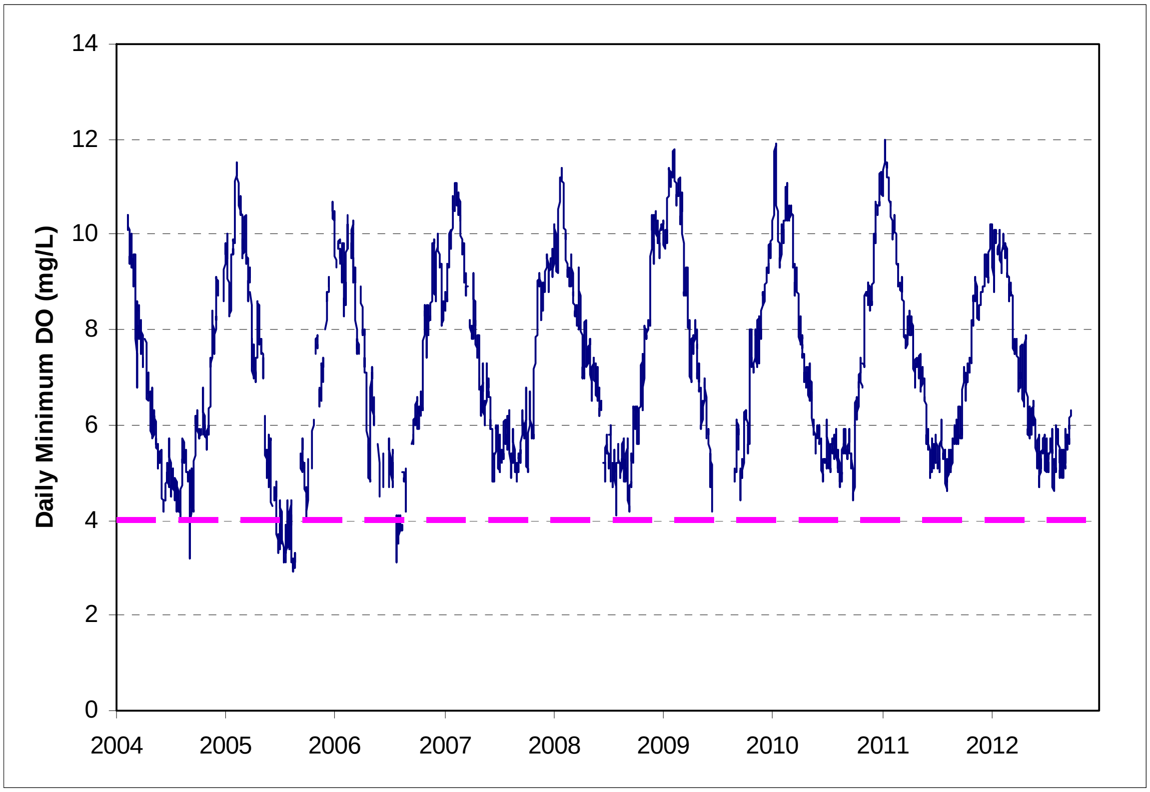


Figure A2. Daily Average DO at 021720698 Wando River at I-526

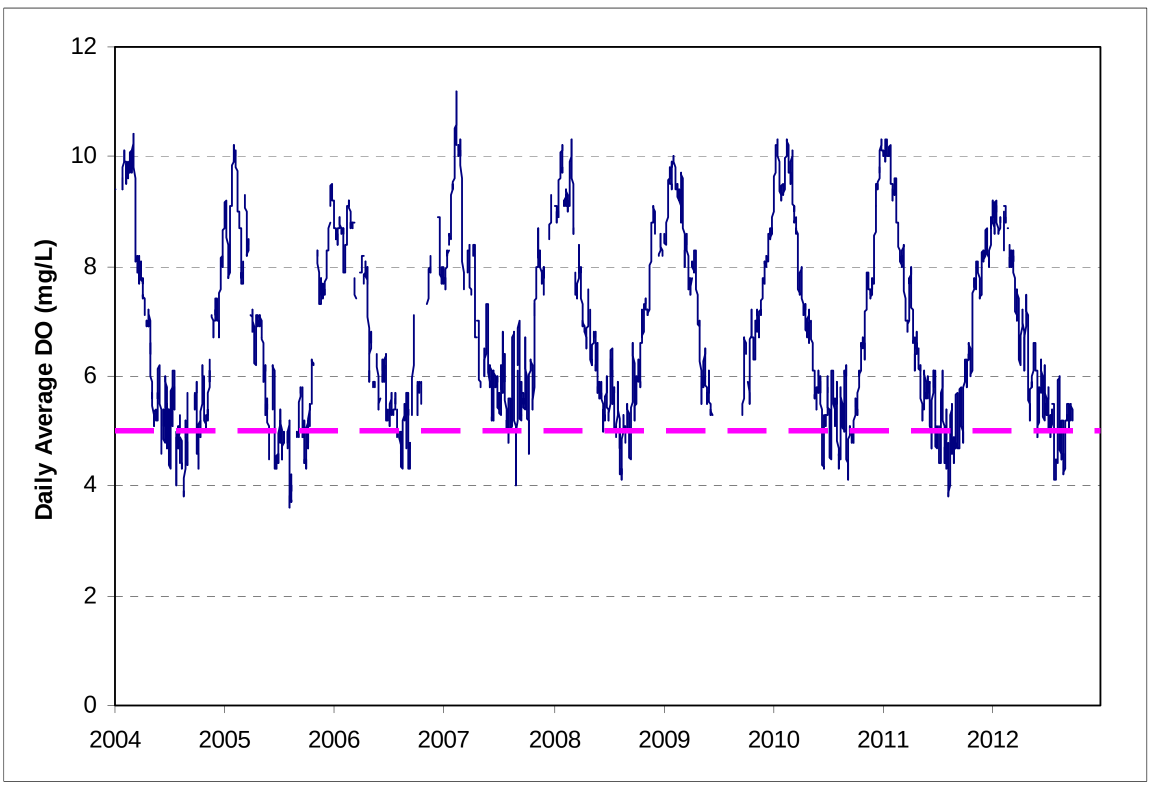


Figure A3. Daily Minimum DO at 021720869 Ashley at I-526

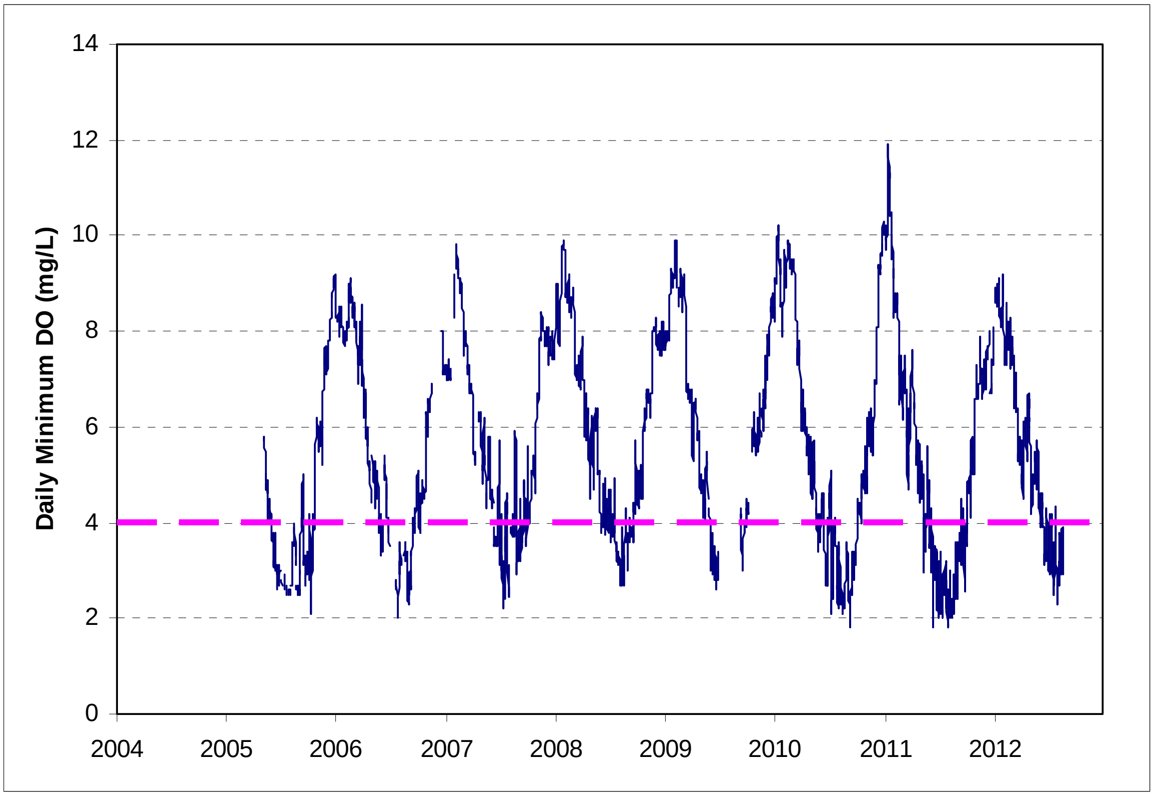
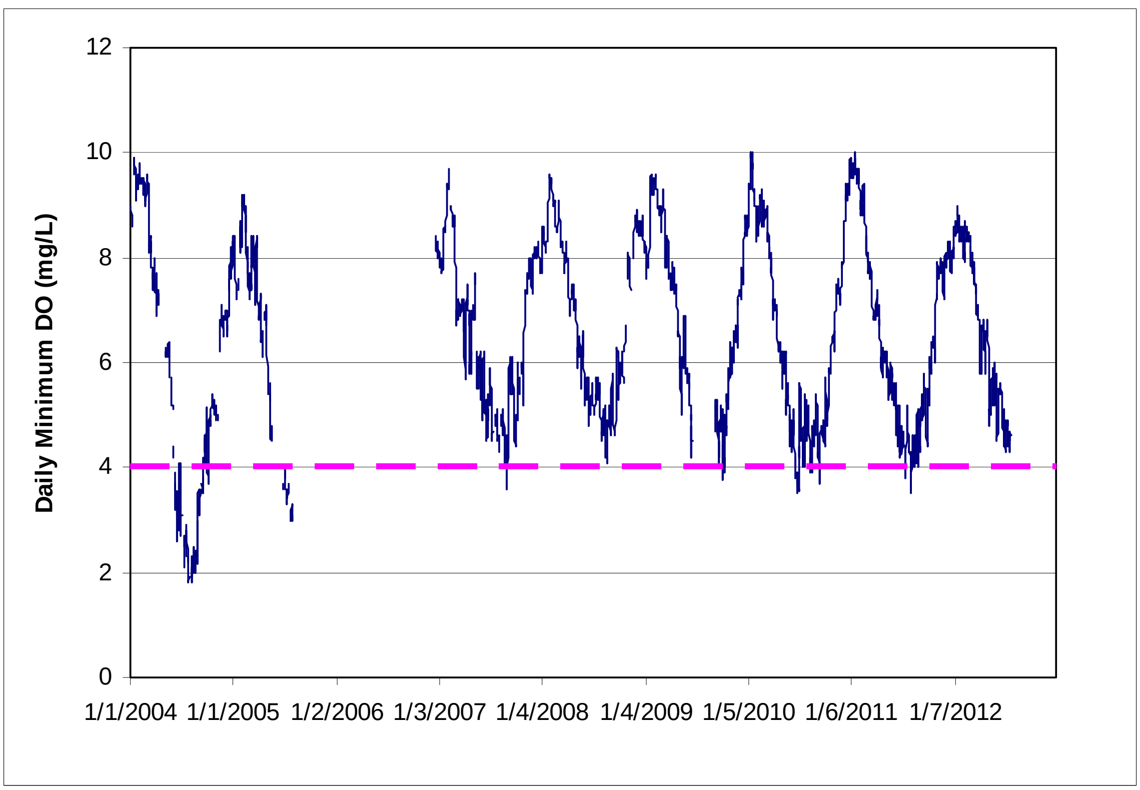


Figure A4. Daily Minimum DO at 021720709



Appendix B. BCDCOG Allocation Letter

Berkeley-Charleston-Dorchester Council of Governments

May 4, 2010

RECEIVED

MAY 05 2010

WATER FACILITIES
PERMITTING DIVISION

Mr. Jeff DeBessonet, Director
Water Facilities Permitting Division
SC DHEC
2600 Bull Street
Columbia, SC 29201

Dear Mr. DeBessonet:

In accordance with the Berkeley-Charleston-Dorchester Water Quality Management Plan, the BCDCOG Board of Directors has approved the enclosed Charleston TMDL calculator. The calculator is in compliance with the 0.1 rule and is presented with a total UOD of 144,780 pounds. I have enclosed a copy of the final approved calculator with the model confirmation numbers for your information.

If you have any questions, or need additional information, please call me.

Sincerely,

Ron

Ronald E. Mitchum
Executive Director

Enclosure

1362 McMillan Avenue, Suite 100 • North Charleston, SC 29405
Tel: (843) 529-0400 • Fax: (843) 529-0305
www.bcdcog.com

Charleston TMDL Calculator

Edit colored cells, copy/paste scenario table in gray frame, or click buttons in bottom right corner

Final BCDCOG WLA Scenario (As Approved April 29, 2010)

Discharge Name	NPDES Permit No.	Location waterbody	Flow MGD	CBOD5 mg/L	CBOD5 lbs/day	F-ratio	CBODu mg/L	CBODu lbs/day	Ammonia mg/L	Ammonia lbs/day	UOD lbs/day	Percent of total	DO mg/L
Summerville	SC0037541	Ashley	10	7.7	642	3.8	29	2,440	0.8	67	2,745	1.9%	7
DCPW/Lower Dorchester	SC0038822	Ashley	12	9	901	2.22	20	2,000	0.8	80	2,365	1.6%	5
Moncks Corner	SC0021598	WB Cooper	3.2	30	801	4.11	123	3,291	20	534	5,730	4.0%	5
BCWSA/Central Berkeley	SC0039764	WB Cooper	6	20	1,001	1.5	30	1,501	10	500	3,788	2.6%	5
DAK Americas	SC0026506	Cooper	1.32	31.3	345	6.99	219	2,409	1.15	13	2,466	1.7%	4
Sun Chemical	SC0003441	Cooper	4.5	30	1,126	4.03	121	4,537	18	676	7,625	5.3%	4
BP Amoco	SC0028584	Cooper	4.19	20.5	716	6.5	133	4,656	0.5	17	4,736	3.3%	4
BCWSA/Lower Berkeley	SC0046060	Cooper	22.5	10	1,877	3.8	38	7,131	2	375	8,846	6.1%	5
KapStone	SC0001759	Cooper	25.6	21	4,484	8.7	183	39,007	2	427	40,959	28.3%	4
CPW/Daniel Island	SC0047074	Cooper	4	5	167	1.5	8	250	1	33	403	0.3%	5
NCSD/Felix Davis	SC0024783	Cooper	34	18	5,104	4.43	80	22,611	5	1,418	29,090	20.1%	5
CPW/Plum Island	SC0021229	Harbor	54	10	4,504	3.18	32	14,321	5	2,252	24,612	17.0%	5
Mount Pleasant/CS	SC0040771	Harbor	3.7	30	926	3.18	95	2,944	10	309	4,354	3.0%	1
Mount Pleasant/RR	SC0040771	Harbor	6	30	1,501	3.18	95	4,774	10	500	7,061	4.9%	1
										Total	144,780	100.0%	

Delta DO Results

Discharge Name	NPDES Permit No.	Location mile*	Ashley Seg A5 Delta DO mg/L	Ashley Seg A5 Percent of total	Ashley Seg A43 Delta DO mg/L	Ashley Seg A43 Percent of total	Cooper Seg C11 Delta DO mg/L	Cooper Seg C11 Percent of total	Wando Seg W4 Delta DO mg/L	Wando Seg W4 Percent of total	Harbor Seg H6 Delta mg/L	Harbor Seg H6 Percent of total
Summerville	SC0037541	28.1	-0.001	1%	-0.068	49%	0.000	0%	0.000	0%	0.000	0%
DCPW/Lower Dorchester	SC0038822	23.5	-0.003	3%	-0.069	49%	0.000	0%	0.000	0%	0.000	0%
Moncks Corner	SC0021598	44.9	-0.002	2%	0.000	0%	-0.011	8%	-0.004	4%	-0.003	4%
BCWSA/Central Berkeley	SC0039764	42.5	-0.001	2%	0.000	0%	-0.010	7%	-0.003	3%	-0.002	3%
DAK Americas	SC0026506	30.2	-0.001	1%	0.000	0%	-0.004	3%	-0.002	2%	-0.001	2%
Sun Chemical	SC0003441	22.1	-0.004	5%	0.000	0%	-0.017	12%	-0.009	9%	-0.006	9%
BP Amoco	SC0028584	19.2	-0.002	3%	0.000	0%	-0.006	4%	-0.004	4%	-0.003	4%
BCWSA/Lower Berkeley	SC0046060	18.2	-0.005	5%	0.000	0%	-0.013	9%	-0.010	10%	-0.006	9%
MeadWestvaco	SC0001759	12.9	-0.012	15%	0.000	0%	-0.041	28%	-0.026	25%	-0.016	23%
CPW/Daniel Island	SC0047074	8.4	0.000	0%	0.000	0%	0.000	0%	0.000	0%	0.000	0%
NCSD/Felix Davis	SC0024783	7.2	-0.015	18%	0.000	0%	-0.032	22%	-0.030	29%	-0.017	25%
CPW/Plum Island	SC0021229	5.0	-0.033	40%	-0.001	1%	-0.006	4%	-0.007	7%	-0.007	10%
Mount Pleasant/CS&RR	SC0040771	1.6	-0.004	5%	0.000	0%	-0.007	4%	-0.007	7%	-0.007	11%
		Delta DO	-0.1	100%	-0.1	100%	-0.1	100%	-0.1	100%	-0.1	100%
		calculator	-0.084		-0.140		-0.148		-0.103		-0.068	
		model wla scenario	-0.086		-0.130		-0.146		-0.103		-0.065	

*Fort Sumter is mile 0.8

Appendix C: Responsiveness Summary

Responsiveness Summary
Revised Charleston Harbor: Including the Ashley, Cooper and Wando Rivers Dissolved Oxygen (DO) TMDL document

Comments were received from the following:

Charleston Riverkeeper

South Carolina Department of Natural Resources (SCDNR)

United States Environmental Protection Agency (USEPA) Region 4

The following comments were submitted by Andrew Wunderley, Esq., Charleston Riverkeeper:

I. NPDES-Regulated Stormwater Discharges Must be Included in the Wasteload Allocation

Comment 1:

"Sections 3.2.2., Non-continuous Sources, 5.2, Wasteload Allocation (WLA), and 5.3 Load Allocation (LA) of the draft revised Charleston Harbor dissolved oxygen TMDL account for NPDES-regulated stormwater discharges as part of an aggregate watershed load. NPDES-regulated stormwater discharges are point sources and must be explicitly included in the wasteload allocation (WLA) portion of theTMDL."

"Based on the foregoing, Charleston Waterkeeper requests that NPDES-regulated stormwater discharges be included in the WLA portion of the revised Charleston Harbor dissolved oxygen TMDL. Additionally, if the available data and modeling allow, MS4s and industrial sites should be assigned separate wasteload allocations. Revising the TMDL in this manner will place it in accord with the applicable law and EPA guidance."

Response 1:

Section 5.2, Wasteload Allocation (WLA), page 27, identifies regulated MS4s as part of the WLA. Additionally, this section has been modified to clarify that all regulated stormwater is considered part of the WLA. Section 3.2.2, Non-continuous Sources, page 14, refers to the modeling approach used to represent all non-continuous sources and watershed inputs.

The NPDES-regulated stormwater discharges are included in the WLA portion of the revised TMDL. Section 5.2, Wasteload Allocation (WLA), page 27, states (underlined text has been added as noted above): "The WLAs for permitted Municipal Separate Storm Sewer System (MS4) discharges <u>and other regulated stormwater sources</u> are established at background loading conditions and/or oxygen demanding pollutant concentrations such that they will not cause or contribute to further lowering of dissolved oxygen in the mainstem segments."

To be clear, this TMDL is different than most TMDLs with respect to the TMDL target and the way the TMDL is computed. Most TMDLs target an absolute number such as a maximum allowable instream pollutant concentration where, by definition, the TMDL is computed as the sum of all sources. Here, the target is a relative change in dissolved oxygen concentration from the background level as defined by S.C.

R. 61-68, Section D.4.a, so the TMDL is computed as the amount of anthropogenic loading above and beyond the background load.

Regarding MS4s and other regulated stormwater, only that portion of the loading above and beyond what would be expected from the same area in its natural state would be considered to contribute to the 0.1 mg/L allowable DO depression. Therefore, only that additional loading would be added into the WLA. Based on wet-weather sampling data and regression analysis used to evaluate the effect of developed landuse, it was determined that developed areas in the Charleston Harbor watershed currently contribute no additional loading to the TMDL segments on the watershed scale. This result may be due to the large amount of naturally occurring organic matter in the system, improved stormwater management in newer developments, assimilation in the tributaries prior to the reaching the sampling points, and/or limitations in the available data.

So while MS4s and other regulated stormwater are considered part of the WLA, they are considered equivalent to natural background under current conditions in the watershed, so there is no additional loading above background to factor into the WLA at this time. For added clarity, the following sentence has been added to Section 5.2, Wasteload Allocation (WLA), page 27: "In the future, if additional data or new activity indicates additional loading of oxygen demand from MS4s or other regulated stormwater sources to the TMDL segments, then the TMDL may be revised."

As currently configured for the Charleston application, the models used for this TMDL (LSPC watershed model and EFDC water quality model) do not allow separation of non-continuous sources by type. So it is true as noted that all sources related to rainfall and runoff including regulated stormwater, non-point, and natural sources are represented in the model as aggregate watershed loads. Based on the aforementioned, it is unnecessary to revise the model to identify specific sources at this time.

II. The TMDL Should Provided for Public Participation During WLA Reimplementation and/or Reallocation

Comment 2:

"As currently structured the public lacks an opportunity to participate in or comment on reimplementation and/or reallocation. Because local waterways are public resources the Clean Water Act is based upon a foundation of public participation. Charleston Waterkeeper requests the TMDL require that DHEC and the BCDCOG notify the public and allow for participation in reimplementation and/or reallocations the TMDL load."

Response 2:

SCDHEC (the Department) agrees that any future reallocations of this TMDL should and will include public notification and participation. In fact, the existing 2002 Cooper River TMDL was successfully reallocated in 2008 to allow new loading and an offsetting reduction in an existing permit. The permits involved in the reallocation were placed on public notice and public participation was allowed for through the normal NPDES permitting process. The following clarifying language has been added to Section 6, TMDL WLA Implementation, page 30:

"This TMDL will be implemented by issuance of NPDES permits for continuous point sources. Any future reallocation of this TMDL would require modifications to the NPDES permit conditions established by this TMDL. In the event that the TMDL is reallocated in the future, the Department will issue a public notice and allow for public participation through the normal NPDES permitting process prior to permit modification."

III. The Aggregate Load for Small Flow NPDES Permit Holders Must be Included in the WLA

Comment 3:

"Section 3.2.1., NPDES Wastewater Discharges, of the draft revised Charleston Harbor dissolved oxygen TMDL states several NPDES permit holders were included in an aggregate UOD load of 752 pounds per day due to their small loadings. However, the WLA in Table 5 does not include this aggregate load. Even though these sources contribute a relatively small UOD load, they are point sources and therefore must be included in the WLA."

Response 3:

The Department has included an aggregate load in the WLA, Section 6, TMDL WLA Implementation. In addition, page 29 has been modified to clarify that the total WLA is 145,532 pounds per day UOD which is the sum of the individual WLAs shown in Table 5 plus the aggregate load. The aggregate load is included in the TMDL model as a conservative load directly to the critical segment. Construction of the TMDL Calculator was resource intensive due to multiple model simulations required for each point source. It was neither feasible nor necessary to include the small sources in the TMDL Calculator individually. The aggregate load is accounted for in the TMDL Calculator by the slight overprediction in the analysis, i.e. as shown in Table 5, the TMDL Calculator gives a slightly higher predicted impact than the EFDC model in segment C11. The DO impact of the aggregate load is within this margin.

The following comments were submitted by Priscilla Wendt, Office of Environmental Programs, SCDNR:

Comment 1:

"The South Carolina Department of Natural Resources (SCDNR) has reviewed the revised Total Maximum Daily Load (TMDL) for dissolved oxygen (DO) in the Charleston Harbor estuary (HUC Code: 03050201), and concurs with the approach taken to achieving a DO deficit no greater than 0.1 mg/l below the state standard."

Response 1:

SCDHEC (the Department) appreciates the support for these TMDLs.

Comment 2:

"Although the revised TMDL will not require as large a reduction in permitted UOD as that required by the two original TMDLs for Charleston Harbor and the Ashley River, it still represents a substantial reduction from the pre-TMDL permitted UOD. Provided future permit limits are consistent with "antibacksliding" provisions of SC Regulation 61-9, successful implementation of the revised TMDL should be protective of water quality in the Charleston Harbor watershed."

Response 2:

See below Response to USEPA Region 4 Comment 2 related to the difference between the original TMDLs and this revised TMDL.

Future permit limits will be consistent with "antibacksliding" provisions in the Regulation.

The following comments were submitted by Alya Singh-White of the USEPA Region 4. Note that some comments were submitted during the advertised public comment period 10/19/12-12/19/12 and some comments after that time-frame.

Comment 1:

" What is the load allocation? I understand that wastewater discharges will only be affected, but quantifying the LA would also be helpful."

Response 1:

The TMDL target is a relative change in DO concentration due to anthropogenic loading, so background loading does not factor into the TMDL calculation in the normal sense because the standard is not a number per se, rather it is a relative change. In addition, non-point sources are considered equivalent to natural background at current conditions, so there is no additional anthropogenic load to factor into the LA.

However, the Department agrees it would be useful to provide the background loading in the TMDL document for comparison purposes. Section 5.3 Load Allocation (LA), page 28 has been modified to show the unregulated loadings to the Charleston Harbor system.

Comment 2:

"When comparing the load reduction of the current TMDL with the original TMDLs (as was done in the draft) it may be interpreted that the current TMDL is less stringent (calls for less of a reduction than the Ashley TMDL). It may be helpful to clarify what the difference in reductions is due to...more data, model, etc."

Response 2:

There are several reasons the loading went up from existing levels in Table 3 to the revised TMDL in Table 5. First, the 2003 Ashley TMDL (on which Table 3 is based) was based on the law at the time of 0.10 mg/L impact. The revised TMDL is based on current law which allows 0.1 mg/L impact, so the new law and water quality standard allow more loading than the previous Ashley TMDL.

Second, the new model more accurately represents estuarine circulation in Charleston Harbor and the Cooper River and freshwater inflow to the upper Ashley River resulting in higher predicted dilution and allowable effluent loading throughout the system.

Third, allowable loading to the upper Ashley River depends on the volume of effluent due to low ambient flushing. The more water that is put into the river, even if it is wastewater, the more loading can be added with it. The 2003 TMDL is based on Lower Dorchester at 8 MGD where the revised TMDL has Dorchester at 12 MGD. There is an increase in effluent concentration, but the load goes up in part because it is delivered in more water.

The Department agrees it would be helpful to further explain in the document the reason loading has been revised upward. Additional explanation has been included in the Abstract and in Section 1.1 Background, page 2.

Comment 3:

EPA requested additional discussion on the delta DO depression and modeled scenarios.

Follow-up discussions between EPA and the Department led to EPA's request for additional explanation on the selected critical condition.

Response 3:

The EFDC model used for developing this TMDL was calibrated to an extensive dataset collected in 2004 including instream hydrodynamic and water quality data, effluent data and characteristics, and measured values for kinetic rate parameters. The model was validated using a 1996 dataset. The model was extended to simulate the period 2000-2006 for the purpose of assessing annual hydrologic variability. Less data were available for the extended model years 2000-2003 and 2005-2006 than were collected for the calibration year 2004, and the extended model was not validated; however, it is considered suitable for the intended purpose of assessing annual variability.

Model results for 2000-2006 showed low annual variability for dilution and assimilative capacity in the Cooper River due to controlled freshwater inflow at Pinopolis Dam which operates with a 4500 cfs weekly average target flow rate. The dam consistently operates close to the target to ensure enough water is released to protect the downstream freshwater supply but not enough to increase the sediment load to the harbor. Additional flow occurring during wet periods and high lake levels is routed to the Santee River at St. Stephen. The primary freshwater source to the Cooper River is consistent on an annual basis, therefore the year-to-year variability in dilution and assimilative capacity is low.

Additional considerations included: (1) the suitability of the 2004 calibration year for critical conditions on the Ashley River where dilution is more variable; (2) the desire to use one critical period for the entire system; and (3) the extensive dataset and demonstrated capability of the model for the 2004 period as compared to 2000-2003 and 2005-2006. On this basis, modeling staff at DHEC, EPA Region 4, and Tetra Tech determined that the EFDC model simulating the 2004 period was appropriate for Charleston TMDL development.

Once the model simulation period was determined, critical conditions were considered. The Charleston Harbor waters covered by this TMDL are considered naturally low DO waterbodies. In addition, continuous NPDES point sources were identified as the only sources contributing to the DO depression at this time. Therefore, the outcome of this TMDL is NPDES permit conditions for wastewater facilities. Permit conditions for facilities discharging to naturally low DO waterbodies are covered in South Carolina Regulation 61-68, Section C. Applicability of Standards, Part 4.a which states:

4. Flow requirements, prohibitions, and exceptions.

> *a. Aquatic life numeric criteria.*
>
> *(1) The applicable critical flow conditions for aquatic life criteria shall be defined as 7Q10 or tidal conditions as determined by the Department. The numeric criteria of this regulation are not applicable to waters of the State when the flow rate is less than 7Q10 except as prescribed below.*
>
> *2) The Department shall consider conditions that are comparable to or more stringent than 7Q10 where appropriate to protect classified and existing uses, such as below dams and in tidal*

situations. Only those situations where the use of 7Q10 flows are determined to be impracticable, inappropriate, or insufficiently protective of aquatic life uses shall be considered as a situation in which the Department may consider other flow conditions.

(3) The Department shall use the applicable critical flow conditions for the protection and maintenance of aquatic life for, but not limited to, the following: permit issuance, wasteload allocations, load allocations, and mixing zones.

(4) NPDES Permit conditions shall be based on a critical condition analysis (e.g., critical flow, temperature or pH, or a combination of factors which would represent a critical conditions). Regarding ambient water temperature as a component of a critical condition analysis, the Department may consider less stringent limits during November through February based on a critical ambient water temperature during November through February.

And in Section D. Antidegradation Rules, Part 4 which states:

4. Certain natural conditions may cause a depression of dissolved oxygen in surface waters while existing and classified uses are still maintained. The Department shall allow a dissolved oxygen depression in these naturally low dissolved oxygen waterbodies as 14 prescribed below pursuant to the Act, Section 48-1-83, et seq., 1976 Code of Laws:

a. For purposes of section D of this regulation, the term "naturally low dissolved oxygen waterbody" is a waterbody that, between and including the months of March and October, has naturally low dissolved oxygen levels at some time and for which limits during those months shall be set based on a critical condition analysis. The term does not include the months of November through February unless low dissolved oxygen levels are known to exist during those months in the waterbody. For a naturally low dissolved oxygen waterbody, the quality of the surface waters shall not be cumulatively lowered more than 0.10 mg/l for dissolved oxygen from point sources and other activities; or

b. Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable water quality standard established for that waterbody, the minimum acceptable concentration is 90 percent of the natural condition. Under these circumstances, an anthropogenic dissolved oxygen depression greater than 0.10 mg/l shall not be allowed unless it is demonstrated that resident aquatic species shall not be adversely affected pursuant to Section 48-1-83. The Department may modify permit conditions to require appropriate instream biological monitoring.

c. The dissolved oxygen concentrations shall not be cumulatively lowered more than the deficit described above utilizing a daily average unless it can be demonstrated that resident aquatic species shall not be adversely affected by an alternate averaging period.

The Regulation establishes the maximum allowable DO impact at 0.1 mg/L as a daily average. It also establishes that NPDES permit limits shall be based on a critical conditions analysis and that these limits apply during March through October. Critical conditions analysis is defined by example in the Regulation as critical flow, temperature or pH, or a combination of factors which would represent a critical condition. Critical flow is defined as 7Q10 or a flow condition comparable to or more stringent than 7Q10 in tidal waters and below dams. The other input conditions such as temperature, DO concentration, and other water quality constituents are not specified in Regulation.

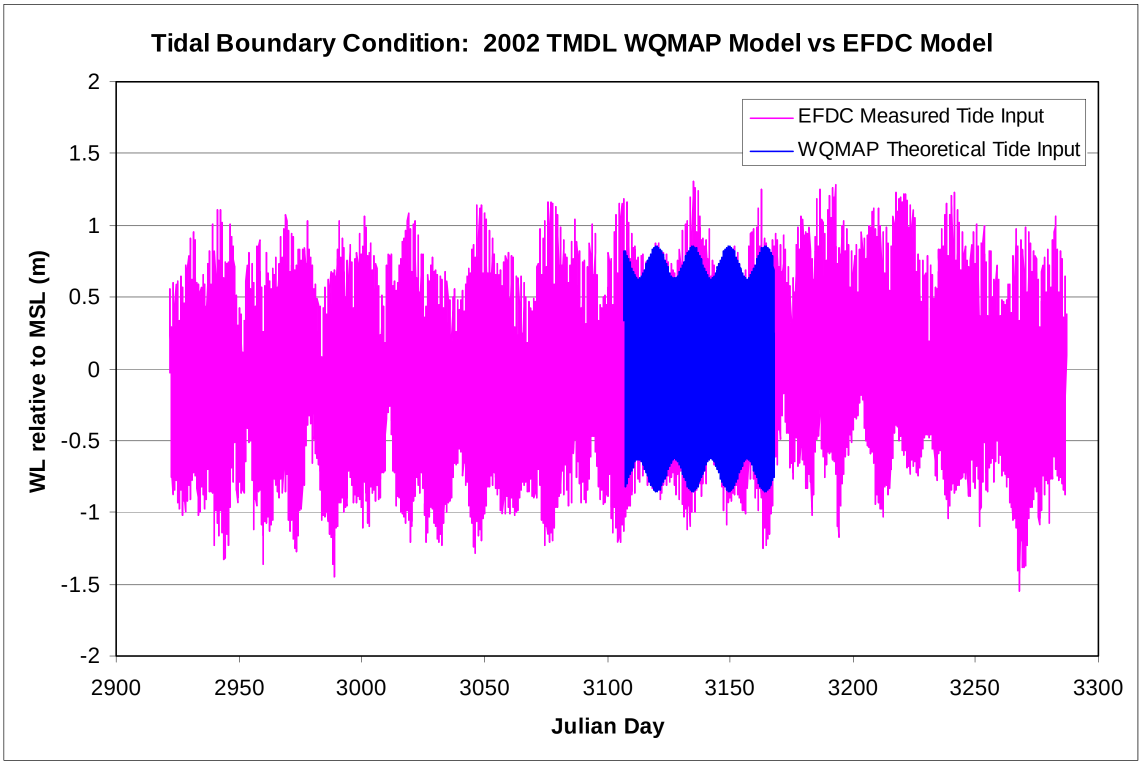
Previously, Butcher (1998) reviewed the Department's coastal DO model applications and interpreted S.C. R. 61-68 to provide recommendations for model inputs at appropriate critical conditions. Butcher's review was conducted on behalf of EPA. The recommended inputs were used in the WQMAP water quality model to develop the 2002 Cooper River TMDL. The specific inputs are described in Butcher (1998) and stated in the 2002 Cooper River TMDL document.

Two key points are important here. First, Butcher notes: “The applicability clause is written for uni-directional flowing streams in which the 7Q10 flow is readily determined. In tidal systems, 7Q10 may not be readily measured, and the interpretation is much less clear. The intent of the standards appears clear, however, that allocations for these types of waterbodies should be designed to restrict excursions of the DO standard to an *acceptably low frequency* (emphasis added), rather than prohibiting excursions under all extreme low dilution conditions.”

Second, as Butcher notes, the previous Charleston model applications were design condition analyses performed with freshwater inflow and other critical condition inputs held constant. This approach sets the model inputs at the appropriate critical condition. As a result, the natural variability and more extreme conditions are filtered out of the analysis on the front end. On the back end, the model output is easy to interpret, and permits are simply set to meet the target for all predicted conditions because the model has been restricted to the critical conditions determined in advance.

Tidal dynamics are particularly variable in response to astronomical and meteorological forces. Due to the effect on dilution, tidal dynamics are important factor in determining assimilative capacity. The 2002 Cooper TMDL WQMAP model simulated a relatively short period using “average” theoretical tidal conditions based on the two main astronomical components. This approach included the regular spring-neap variability, but excluded the more random variation due to weather conditions and other factors. The basis for this design tidal condition is analogous to the choice of 7Q10 for freshwater inflow, to avoid overly conservative wasteload allocations due to inclusion of the most extreme conditions.

The current Charleston EFDC model is different. The Charleston EFDC model outputs a series of rapidly changing predictions for each day in the 245-day simulation period. In addition, unlike the previous Charleston model, the EFDC model uses the actual measured tide levels. The predictions from the previous WQMAP model and the current EFDC model are fundamentally different. The WQMAP model used design conditions to control variability. Extreme conditions, including potential measurement anomalies in the input data, have been filtered out of the model predictions by the input design conditions. With the current Charleston EFDC model, the natural variability is inherently retained in the model and presented in the output. The difference in the variability included in the two models is readily apparent in the tidal boundary input as shown in the figure below.

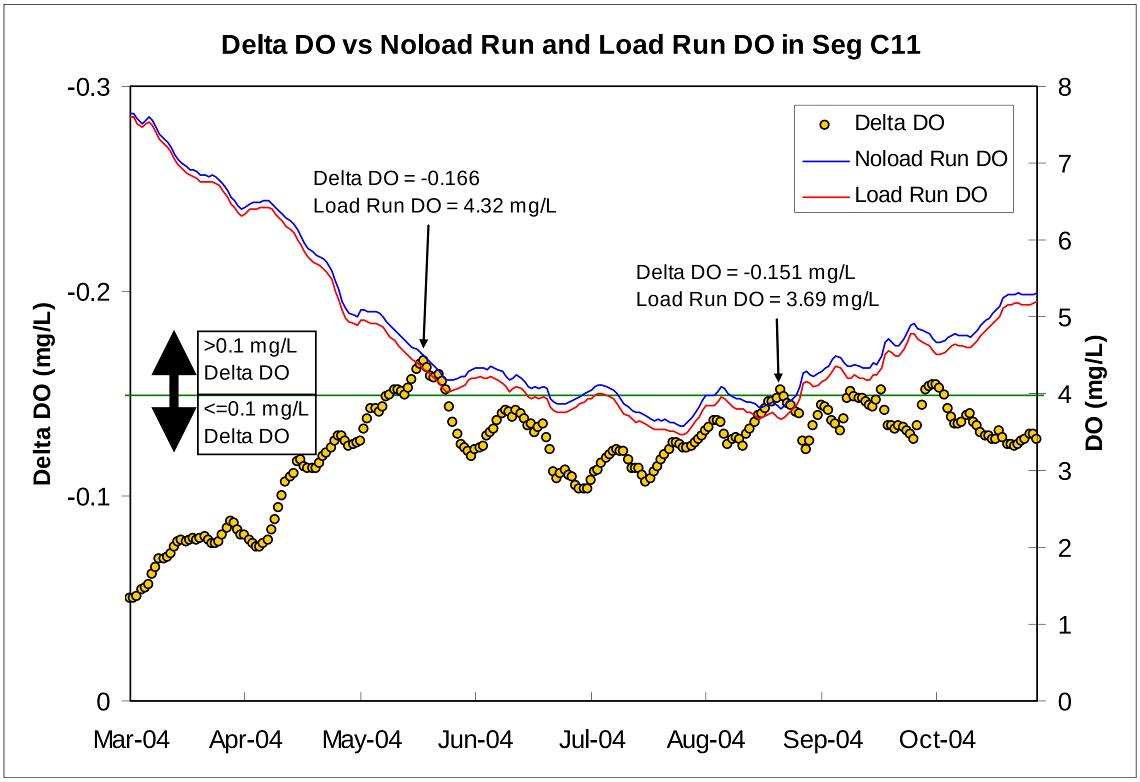


The result is a more realistic representation of conditions in the waterbody, but also a much larger and more variable output dataset compared to simpler models, so determining the appropriate critical condition is more complicated.

Considering the continuous simulation, the dam and tidal effects, that a combination of other factors like temperature also affect the delta DO endpoint, and that the EFDC model retains a large degree of natural variability that is normally excluded from simpler models by design and according to the Regulation, the critical conditions approach selected by modeling staff at DHEC, EPA Region 4, and Tetra Tech was to apply a design percentage to the model output.

This approach was previously applied and approved by EPA for the Beaufort River DO TMDL model where the 95th percentile was used as the target. For the Charleston EFDC model, a 95th percentile target was initially considered. The final target was set at the 90th percentile for consistency with the Savannah Harbor DO TMDL under development by EPA Region 4 at the time.

The Department acknowledges EPA's concern that consistency with other projects does not establish compliance with S.C. R. 61-68. We would argue that consistency is a relevant and important consideration, but would agree that site-specific factors, including the specific model application, should also be considered. The Charleston EFDC model predicts a continuous series of DO impacts for the full period March through October. The distribution of the model predictions can be used to quantify the level of protection provided by the wasteload allocations in this TMDL. The figure below shows the model predicted delta DO as well as predicted "noload" run DO (background DO level with point sources at zero load) and "load" run DO (TMDL DO level with point sources set to the TMDL WLAs).



For Charleston, the 90th percentile target for the delta DO results in 22 of 245 days predicted to exceed 0.1 mg/L impact. This equals 9 percent of the time (the reason it is not 10 percent is the final allocated 90th percentile cumulative delta DO ended up slightly less than the maximum allowed).

It is notable, however, that most of the days with predicted delta DO values greater than 0.1 mg/L also have predicted DO level greater than the allowable minimum numeric criterion of 4.0 mg/L (recall the daily average 5.0 mg/L requirement does not apply in the Cooper River and Charleston Harbor). Only 2 days out of 245 are predicted to both exceed 0.1 mg/L delta DO and have the predicted DO level less than 4.0 mg/L. The actual predicted excursion frequency is then 2/245 or less than 1 percent.

It should also be noted that the magnitude of the difference between 90th percentile delta DO and the maximum predicted delta DO is 0.017 mg/L, and this occurs when the predicted river DO is meeting the 4.0 mg/L standard. If only those days when predicted river DO is less than 4.0 mg/L are considered, the magnitude of the difference is only 0.003 mg/L. That is, the model predicts that either the 4.0 mg/L DO standard for the Cooper River is attained OR the difference between the 90th percentile TMDL target and a 100th percentile critical condition is 0.003 mg/L. While these levels are important in terms of tracking individual allocations and cumulative impacts from all dischargers, the Department considers the difference to be inconsequential in terms of the relative impact to the aquatic biota in these waters.

Lastly, the one model input changed from calibration to TMDL application is the effluent loading. The calibration run used actual effluent loads. The TMDL run uses constant load inputs for all NPDES continuous sources set at full permit levels for the entire period March through October. This is standard wasteload allocation practice, but is also conservative. When assessing the expected frequency and magnitude of predicted excursions, it should be recognized that the probability is very low that all of the individual facilities will be discharging exactly at their full permit loadings at the same time and continuously over the 245-day model simulation.

Based on the frequency and magnitude of the predicted excursions, as well as the additional margin provided by the constant load assumption, the Department concludes that the critical condition identified in this TMDL is fully consistent with the "comparable to or more stringent than 7Q10" threshold under S.C. R. 61-68, Section C.4.a.2 and the definition of critical conditions including additional factors as given in Section C.4.a.4. Further, the Department concludes the identified critical condition is fully protective of the aquatic life use related to biological DO requirements. Therefore, we consider the TMDL target and critical condition used in this revised Charleston DO TMDL to be appropriate as applied.

Errata Sheet

For the TMDL Report: "Total Maximum Daily Load Revision Charleston Harbor, Cooper, Ashley, and Wando Rivers" dated March 2013

Technical Document Number: 0506-13

This TMDL was approved by EPA on April 26, 2013. The TMDL document was distributed in electronic form via email and Department website. Subsequently, the following minor errors listed in the table below were discovered and corrected. The corrected document is available for download at the Department website: **http://www.scdhec.gov/HomeAndEnvironment/Water/ImpairedWaters/ApprovedTMDLs/.**

Date	Location in the TMDL	Original Text	Corrected Text (underlined)	Comment
May 21, 2013	Page 29, last paragraph	The total WLA for this TMDL is 149,532 pounds per day UOD, for all months during March through October. This total includes 148,780 pounds per day as allocated by the BCDCOG and shown in Table 5 plus an aggregate load of 752 pounds per day from the small dischargers.	The total WLA for this TMDL is <u>145,532</u> pounds per day UOD, for all months during March through October. This total includes <u>144,780</u> pounds per day as allocated by the BCDCOG and shown in Table 5 plus an aggregate load of 752 pounds per day from the small dischargers.	Original text incorrectly stated the total of individual allocations shown in Table 5 and incorrectly stated the total WLA which is equal to the individual allocations in Table 5 plus the aggregate load.

May 21, 2013	Page 42, Response 3	In addition, page 29 has been modified to clarify that the total WLA is 149,532 pounds per day UOD which is the sum of the individual WLAs shown in Table 5 plus the aggregate load.	In addition, page 29 has been modified to clarify that the total WLA is 145,532 pounds per day UOD which is the sum of the individual WLAs shown in Table 5 plus the aggregate load.	Original response incorrectly stated the total WLA which is equal to the individual allocations in Table 5 plus the aggregate load.
February 6, 2015	Page 11	CBODu = TOC/2.7	CBODu = TOC*2.7	Equation error corrected