Draft Revised

TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Dissolved Oxygen

In Savannah Harbor

Savannah River Basin

Chatham and Effingham Counties, Georgia

Jasper County, South Carolina

Savannah Harbor Dissolved Oxygen TMDL

Executive Summary

This report establishes a revised Total Maximum Daily Load (TMDL) for dissolved oxygen (DO) for the Savannah Harbor from Fort Pulaski (River Mile 0) to the Seaboard Coastline Railway Bridge (River Mile 27.4). The Savannah Harbor is located at the mouth of the Savannah River where it discharges to the Atlantic Ocean. The Savannah River, including the Harbor, serves as the boundary between Georgia and South Carolina.

This TMDL is established at a level necessary to implement the applicable water quality standards, which include the newly adopted Georgia DO criteria and the existing South Carolina DO water quality criteria established for the Savannah Harbor. This TMDL identifies the range of loadings of oxygen-demanding substances that may occur in the watershed, from the Thurmond Dam near Augusta, Georgia through the Savannah Harbor, without exceeding the applicable water quality standards. Consistent with 40 CFR §122.44(d)(1)(vii)(B), EPA expects that the wasteload allocations for the oxygen-demanding substances contained in the TMDL, along with any relevant assumptions and requirements, will be implemented through NPDES permits. This TMDL provides the framework for the State permitting authorities to determine a range of appropriate oxygen-demanding substances (e.g., Ultimate Oxygen Demand [UOD], 5-day Carbonaceous Biochemical Oxygen Demand [CBOD5] and/or ammonia) permit limits using a TMDL Calculator.

The TMDL Calculator will allow the States to evaluate various scenarios and develop a practicable and equitable TMDL reduction implementation strategy. As long as the TMDL reduction implementation strategy and the resultant Ultimate Oxygen Demand (UOD) and National Pollutant Discharge Elimination System (NPDES) UOD, CBOD5 and/or ammonia permit limits selected meet the applicable TMDL as calculated via the TMDL Calculator, the TMDL scenario meets the goals of this TMDL. The allowable UOD will vary depending on the size and location of the individual CBOD5 and ammonia loads and which specific conditions of the Georgia and South Carolina Water Quality Standards are applicable. The initial TMDL target is a daily average delta DO of 0.1 mg/L for Georgia only waters and 0.10 mg/L for waters that are shared with South Carolina. For this initial TMDL target, established during the critical period, the allowable TMDL range is 80,000 to 115,000 lbs/day.

This TMDL replaces the November 2006 United States Environmental Protection Agency (EPA) Savannah Harbor TMDL that was based on the previous Georgia DO Standard, which is no longer applicable for Clean Water Act purposes. EPA has worked with the Georgia Environmental Protection Division (EPD) and the South Carolina Department of Health and Environmental Control (DHEC) along with a Technical Modeling Advisory Group to develop this revised Savannah Harbor DO TMDL.

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1. Savannah Harbor Description

The Savannah River Basin is located on the border of eastern Georgia and western South Carolina and has a drainage area of 10,577 square miles. The Savannah River serves as the boundary between Georgia and South Carolina, and the Harbor is shared by both states. The portions of the Savannah River Basin included in this TMDL are the middle and lower watersheds encompassing the area from Thurmond Dam to the Atlantic Ocean. Land uses within these watersheds are mostly forestlands, wetlands, and agriculture.

The area of concern is the Savannah Harbor located at the mouth of the Savannah River where the Savannah River discharges to the Atlantic Ocean. The Savannah Harbor from Fort Pulaski (Mile 0) to Seaboard Coastline R/R Bridge (River Mile 27.4) is the segment identified on the State of Georgia's Section 303(d) list as impaired for dissolved oxygen. The basis for the 2006 TMDL was that the Savannah Harbor was on Georgia's 2002 Section 303(d) list for failing to meet the dissolved oxygen (DO) criterion associated with the Georgia's Coastal Fishing water quality use designation based on data collected in the summers of 1997 and 1999.

The hydrodynamic and water quality harbor model used to develop the TMDL extends upstream on the Savannah River to River Mile 61.0 near Clyo, Georgia, at United States Geologic Survey (USGS) station 02198500. The downstream end of the model extends approximately 25 miles offshore from Oyster Island to cover the navigational channel of Savannah Harbor. The model covers the Savannah River, the Front River, the Middle River, the Little Back River, the Back River, the South Channel, and the offshore portions in the Atlantic Ocean. Figure 1 is a map that shows the overall location of the study area.

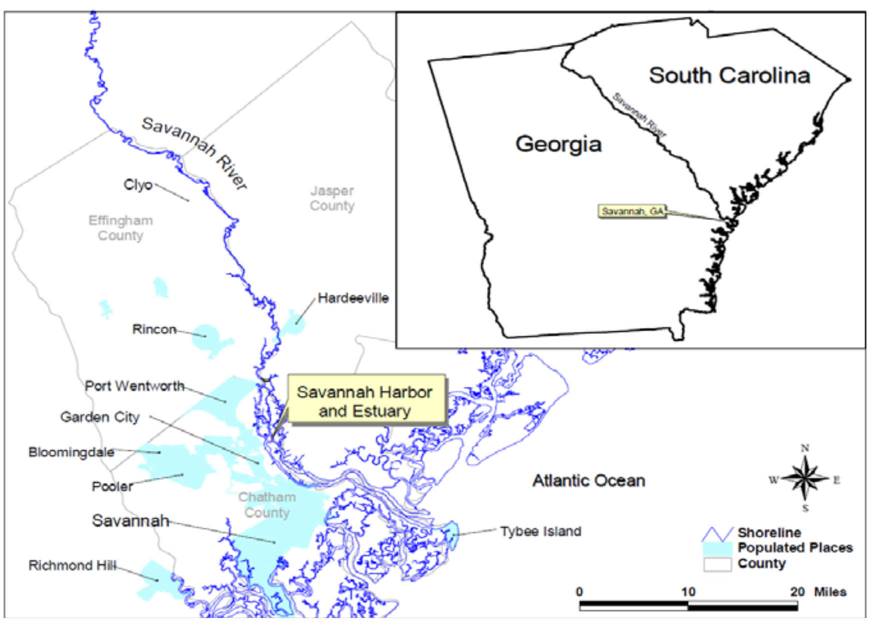

Figure 1 Savannah Harbor Location Map

Water quality studies, conducted over the past twenty years, were used to develop the TMDL. The purpose of the field studies was to characterize the DO regime of the harbor, to determine the principle causes of impairment, and to provide sufficient data and information to develop a complex hydrodynamic and water quality model. The data used in the calibration and confirmation of the hydrodynamic and water quality models were collected by the Georgia Ports Authority (GPA), the USGS, the Georgia Environmental Protection Division (EPD), the U.S. Army Corps of Engineers (USACE), and the United State Environmental Protection Agency (EPA). Additional details on the water quality and hydrodynamic modeling can be found in *Development of the Hydrodynamic and Water Quality Model for the Savannah Harbor Expansion Project, January 2006 (Tetra Tech 2006)* and in the draft EPA and Tetra Tech Z-Grid Modeling Report (EPA 2010).

2. TMDL Targets

2.1. Georgia DO Standard for Savannah Harbor

In Georgia, the water use classification for the Savannah Harbor is Coastal Fishing. The applicable water quality standards for DO for this use classification as stated in Georgia *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03, Water Use Classifications and Water Quality Standards are:

"Dissolved Oxygen (D.O.): A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times. If it is determined that the "natural condition" in the waterbody is less than the values stated above, then the criteria will revert to the "natural condition" and the water quality standard will allow for a 0.1 mg/L deficit from the "natural" dissolved oxygen value. Up to a 10% deficit will be allowed if it is demonstrated that resident aquatic species shall not be adversely affected."

2.2. South Carolina DO Standard for Savannah Harbor

In South Carolina, the applicable water quality standards for DO state that "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 0.10 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."

2.3. Potential TMDL Targets

Based on Georgia's and South Carolina's Water Quality Standards, the TMDL governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor reflects a range from the 0.1 mg/L or 0.10 mg/L deficit from the "natural" dissolved oxygen value, up to a 10% deficit allowed if it is demonstrated that resident aquatic species shall not be adversely affected. Within this range, there are three potential TMDL targets:

1. The initial TMDL target established during the critical period based on a daily average delta DO of 0.1 mg/L for Georgia only waters and 0.10 mg/L for waters that are in South Carolina when Harbor waters naturally fall below 5 mg/L.
2. A 0.1 mg/L Delta DO target for all Harbor waters naturally below 5 mg/L. This target would be available if and when South Carolina changes the applicable Delta DO standard from 0.10 mg/L to 0.1 mg/L.
3. An "up to 10%" deficit DO TMDL target established based on a demonstration, acceptable to the States, that resident aquatic species will not be adversely affected. Such a target would allow for a delta DO range of greater than 0.1 mg/L up to 0.35 mg/L. Under such a scenario, the TMDL calculator can be used to determine the appropriate NPDES limits.

After this TMDL is established, EPA expects the States to select from these potential targets to implement the TMDL based on the then-applicable water quality standards (i.e., either 0.1/0.10 mg/L DO deficit based on the current expression of the standards; 0.1 mg/L DO deficit based on a change to the South Carolina standard; or up to 10% DO deficit based on an acceptable demonstration showing the protection of resident aquatic species).

3. Modeling Approach

EPA Region 4 used the Savannah Harbor Z-Grid Model to develop this TMDL (Tetra Tech 2008; EPA 2010). The Z-Grid model builds on the original harbor model developed for EPA Region 4 during the development of the Total Maximum Daily Load in 2004-2005 and the enhanced model for the United States Army Corps of Engineers (USACE) finalized on January 30, 2006 (2004, 2006 Tetra Tech).

The hydrodynamic model used is the Environmental Fluid Dynamics Code (EFDC) developed and maintained by Tetra Tech (Hamrick 1992). The water quality model used is the Water Quality Analysis Simulation Program (WASP) maintained by EPA.

The setup, calibration, and confirmation of the EFDC and WASP original Savannah Harbor models are well documented in the January 30, 2006 Tetra Tech modeling report. (2006 Tetra Tech) After two years of intense efforts by several modelers and many agency meetings, final acceptance letters approving the use of the model were received from the EPA Region 4, Georgia EPD, South Carolina DHEC, National Marine Fisheries, and the United States Fish and Wildlife Service (USF&W) in March 2006. Other reviewers of the enhanced models included the Harbor Committee (MACTEC as their consultant), the USACE Engineer Research and Development Center (ERDC), and the United States Geological Survey (USGS).

3.1. Z-Grid Model

During 2007, EPA Region 4 determined a need to convert the sigma grid of the enhanced model to a Z-Grid. The Z-Grid allows for varying number of vertical layers throughout the model domain. Where the sigma grid was six vertical layers with widely varying layer depths, converting to a Z-Grid with five vertical layers in the navigation channel and one vertical layer in the Middle, Back, Little Back, and Upper Savannah Rivers allowed all the layers to be similar depths. The Z-Grid allowed for the invert of the river bottom elevation to be modified with one vertical layer going upstream from the I-95 Bridge to the Clyo USGS gage on the Savannah River. The longitudinal slope was evenly distributed from the headwater cell to above the I-95 Bridge by adjusting bottom elevations. The water surface elevation at the headwater boundary cell was raised to better match the gage height reported at the Clyo USGS gage. In addition to the Z-Grid conversion, the watershed tributary flows and marsh areas were revised.

The Z-Grid model contains 608 horizontal cells and 1,778 total cells when including the vertical cells. Figure 2 shows the Harbor portion of the Z-Grid Savannah Harbor model.

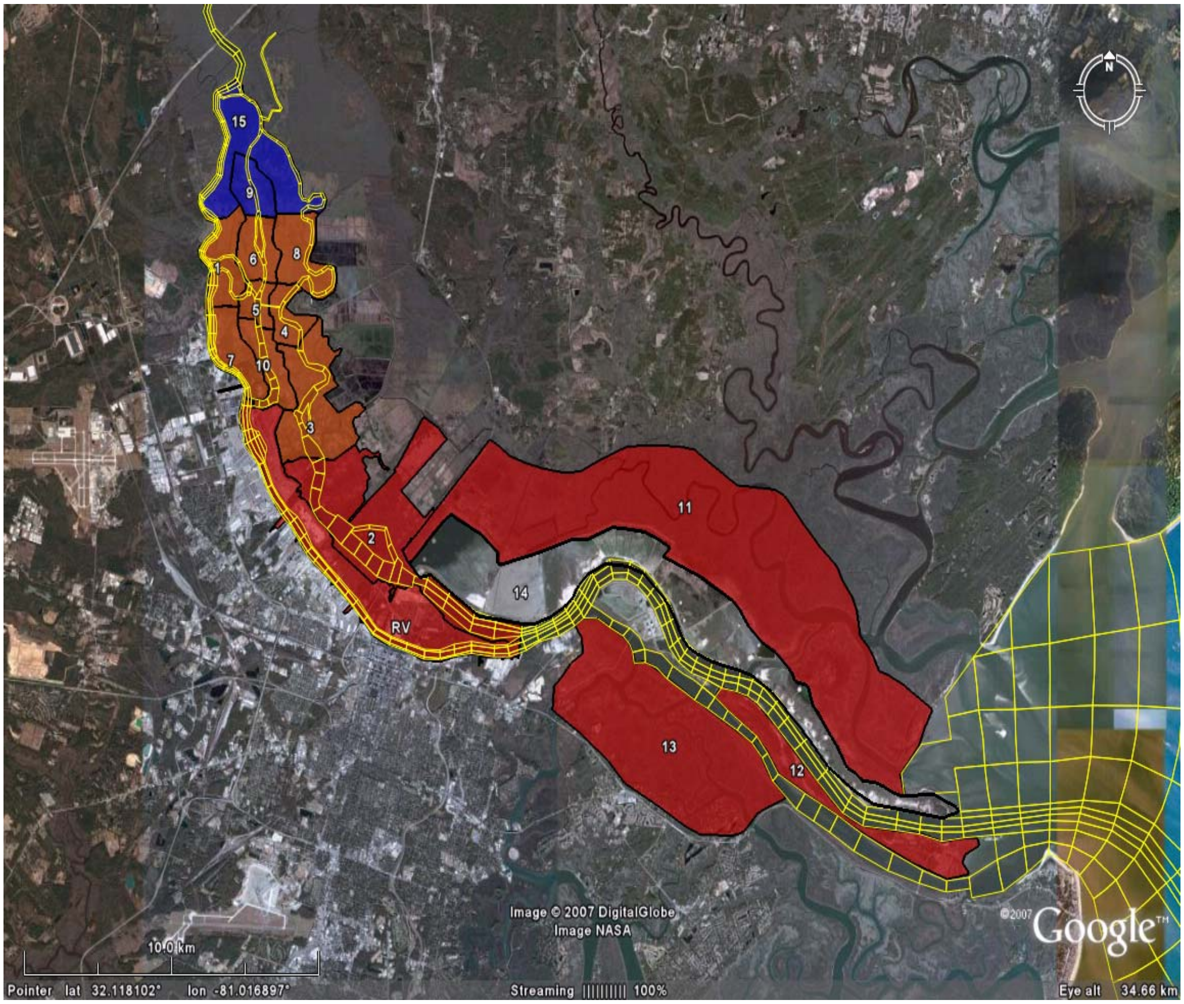

Figure 2 Z-Grid Harbor Cells and Existing Marsh Areas

3.2. Updated Marsh Approach

The marsh areas were revised from the sigma grid model (Tetra Tech 2006) to include the areas downstream of Fort Jackson. One area upstream near the I-95 Bridge was added as well. Table 1 reflects the new marsh loadings. The color of each marsh indicates whether it was included in the model as a freshwater (blue), brackish (orange) or saltwater (red) marsh.

Table 1 Existing Marsh Loads

Marsh	Actual Area (ac)	Actual Depth (m)	BODU Export Rate (kg/day/acre)	BODU (kg/day)	BODU (lb/day)
	742	0.12	6	4,454	9,820
	3,467	0.25	12	41,606	91,726

	1,682	0.18	6	10,089	22,243
	421	0.21	6	2,527	5,570
	310	0.20	6	1,862	4,104
	570	0.16	6	3,423	7,546
	731	0.29	6	4,384	9,665
	845	0.14	6	5,070	11,177
	485	0.21	3	1,456	3,210
	602	0.22	6	3,613	7,966
	12,676	0.15	12	152,114	335,353
	1,548	0.15	12	18,580	40,963
	5,819	0.15	12	69,822	153,931
Q14	6,049	0.15		5,155	11,364 *
	1,633	0.15	3	4,898	10,798
			TOTALS =	**329,053**	**725,436**

* Q14 is Dredge Disposal Area Managed by the Corps, the load was calculated based on CBOD5 and weir flows as a peak load.

To address seasonality of the marsh loads, a reference paper was used that measured dissolved inorganic carbon (DIC) in tidal freshwater marshes in Virginia and the adjacent estuary. The paper is titled "Transport of dissolved inorganic carbon from a tidal freshwater marsh to the York River Estuary" by Scott C. Neubauer and Iris C. Anderson from the Virginia Institute of Marine Science, School of Marine Science, College of William and Mary. The percentages in Table 2 below were derived from the referenced study and were applied to the loads listed in Table 1 (for existing) to develop the monthly WASP loads for Ultimate Carbonaceous Biochemical Oxygen Demand (CBODu) from the marsh areas.

Table 2 Seasonal Distribution of Marsh Loads

Month	Percent of Total Load
January	20
February	20
March	40
April	40
May	60
June	80
July	100
August	100
September	80
October	60
November	40
December	40

3.3. Updated Hydrodynamics

The original flow, velocity, elevation and temperature predictions were calculated using the EFDC hydrodynamic model and calibrated to the extensive 1997 and 1999 data set (2006 Tetra Tech). The EFDC model inputs were updated to reflect more recent information. This information includes new flow gages by USGS in the harbor, long-term DO data at the USACE Dock, updates to the boundary conditions, connection to EPD's river model, and updates to water quality kinetics. Figure 3 shows the original sampling locations for the 1999 study, some of which were also used for the 2008 data collection.

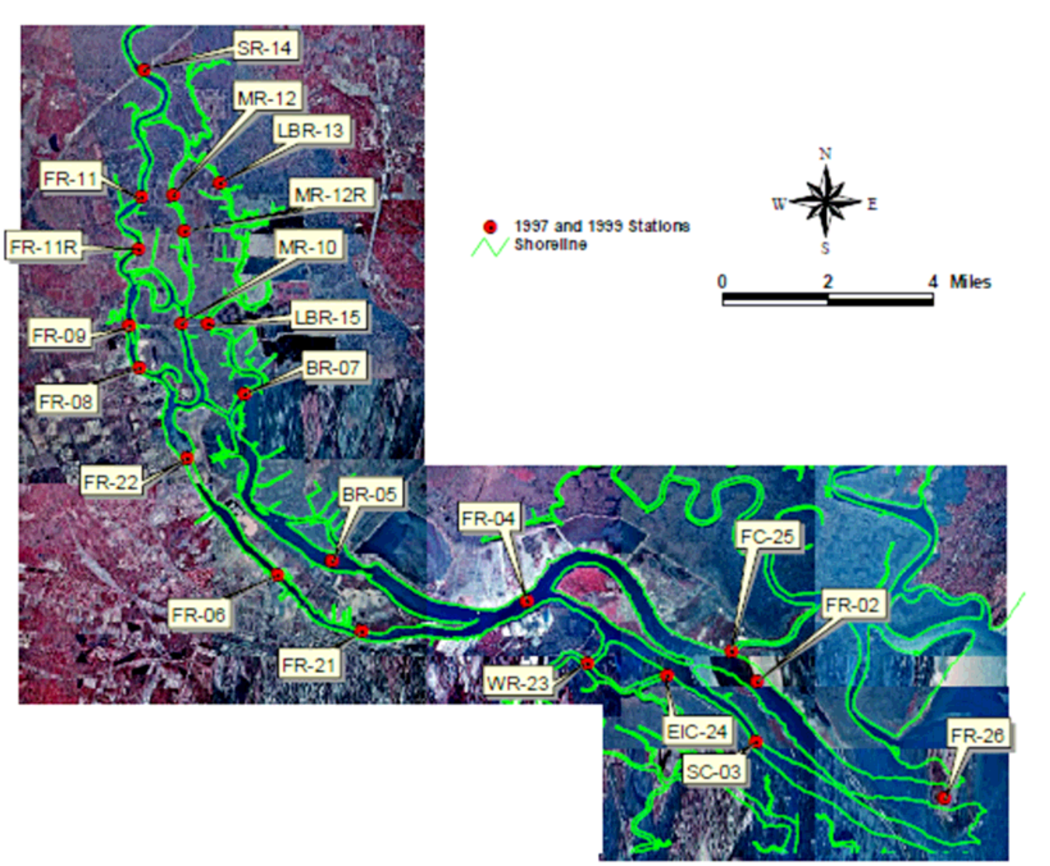

Figure 3 1999 Sampling Locations

3.3.1. Middle and Back Rivers Updated Hydrodynamics

The USGS collected detailed (15 minute) water surface elevation, velocity and flow data during the fall and winter of 2008 – 2009 at the Middle and Back Rivers near the Houlihan Bridge crossings at Stations MR-10 and LBR-15, respectively. These data were used to improve the hydrodynamic predictive ability of the model in the Middle and Back Rivers. The updates focused on improving the width and depths of the river channels in the model and changing the marsh storage areas to better reflect the movement of water through the channels so the model would better reflect the measured flows, velocities and elevations. (2010 EPA Region 4) Figure 4 and Figure 5 illustrate an example of the models predictive capabilities for gage height and flows for Little Back River at Houlihan Bridge. The performance of the model is considered very good.

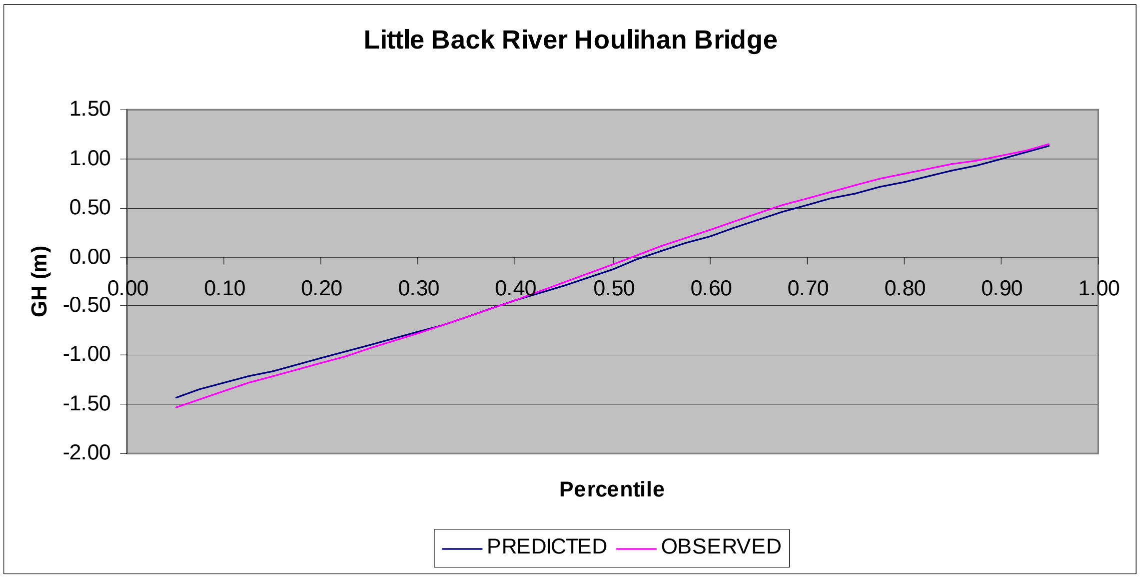

Figure 4 Percentile Comparison of Predicted and Measured Gage Heights

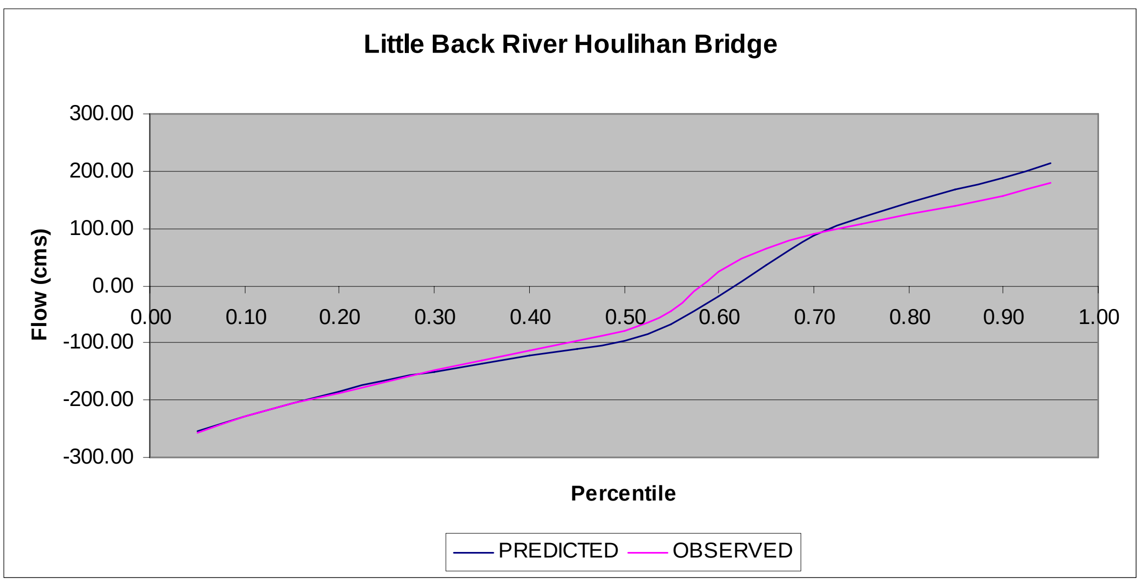

Figure 5 Percentile Comparison of Predicted and Measured Flows

3.3.2. Upstream Boundary Conditions at Clyo

Georgia EPD has developed a hydrodynamic and water quality model (EPDRiv1 Model) for the Savannah River from the Augusta Canal diversion dam to the USGS stage recorder (02198760) near Hardeeville, South Carolina. This model was used to transport the oxygen demanding substances from the upper watershed to the Harbor Model. The River Model (2010, GaEPD) provided the flow, DO, Temperature, CBOD (fast and slow) and ammonia boundary conditions for the calibrated TMDL Harbor Model. (2010 EPA Region 4)

The 2006 EFDC model used USGS gage flow data and monthly measured temperatures at Clyo for the upstream boundary. Since 2006, EPD has updated and recalibrated the Savannah River EPDRiv1 Model. The flow and temperature hourly outputs at Clyo, from the River Model were used as the headwater conditions for the Harbor model. This provides a seamless connection between the Savannah River Model and the Savannah Harbor Model. Figure 6 and Figure 7 illustrate the comparison of RIV1 flows and temperatures to observed data.

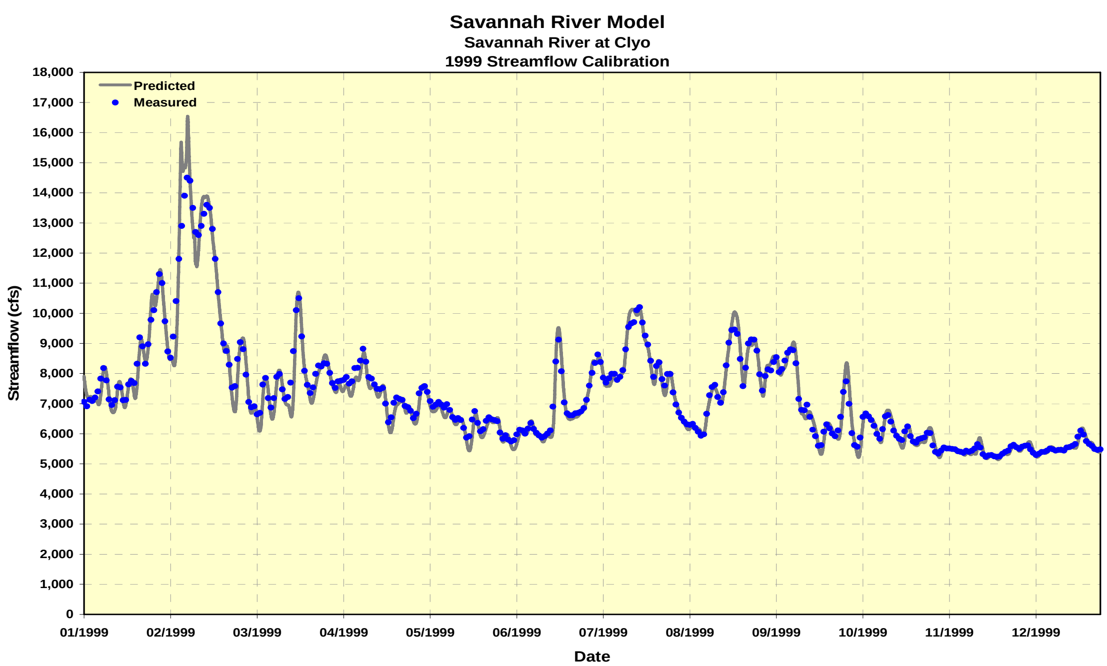

Figure 6 1999 Stream Flow Calibration at Clyo

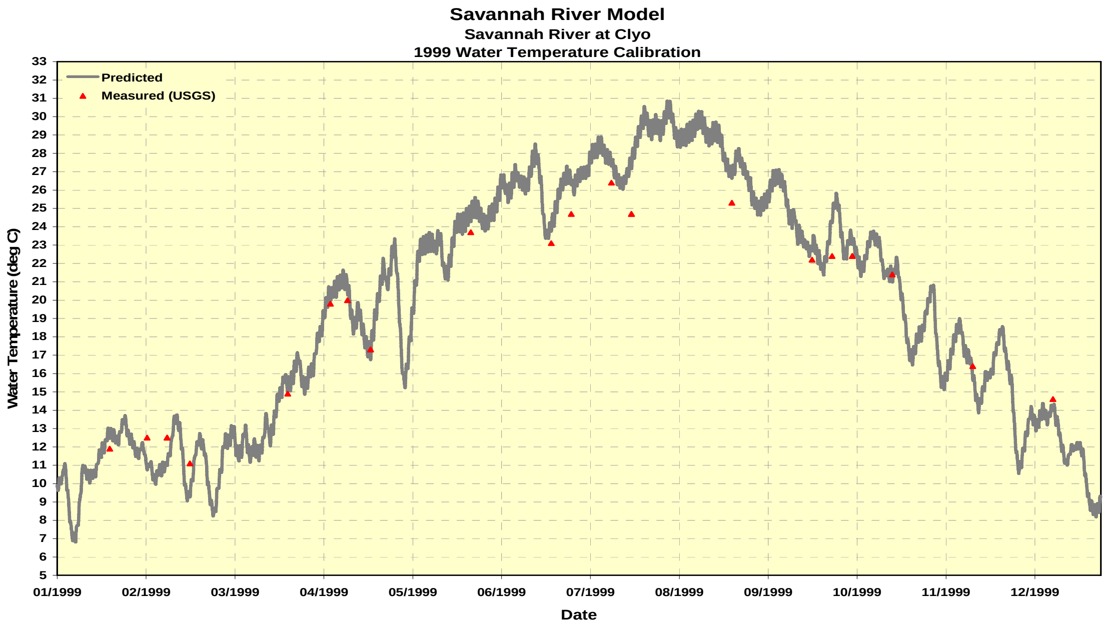

Figure 7 1999 Stream Temperature Calibration at Clyo

3.4. Updated Water Quality Rates and Kinetics

The main changes to the water quality portion of the 2006 Savannah Harbor model (2006 Tetra Tech) were an update of the reaeration approach and a fine tuning of the CBOD decay rates. The main modeling parameters impacting the DO balance of the Harbor are the reaeration rate, the sediment oxygen demand (SOD) rate and the oxygen demanding substances (CBOD and ammonia) decay rates. Table 3 provides a summary of the rates used in the Harbor Model.

Table 3 WASP Kinetic Rates

WASP Kinetic Parameters	Value
Reaeration Rate @ 20 °C (per day)	O'Connor-Dobbins Formulation
Sediment Oxygen Demand (g/m2/day) @20 °C	0.7 to 2.4
BOD (1) Decay Rate Constant @20 °C (per day)	0.06
BOD (2) Decay Rate Constant @20 °C (per day)	0.04
BOD (3) Decay Rate Constant @20 °C (per day)	0.02
Ammonia, nitrate, phosphorus rates @20 °C (per day)	0.015

3.4.1. Reaeration Rate and Sediment Oxygen Demand

The O'Connor-Dobbins Reaeration formulation that uses velocity and total depth (a WASP7 update) of the river was used to determine the reaeration rates for the Savannah Harbor System.

Sediment oxygen demand rates were revised and ranged from 0.7 to 2.4 g/m^2/day at @20 °C:

- 0.7 g/m^2/day for Ocean, Middle and Back Rivers
- 1.6 g/m^2/day for Upper Savannah River Clyo to Hwy 17 bridge
- 2.0 g/m^2/day for main Harbor area
- 2.4 g/m^2/day for Sediment basin and Turning Basins.

3.4.2. Pollutant Decay Rates

The WASP 7 model has the option of using up to three separate CBODu inputs and decay rates i.e., the CBOD loads to the model can be divided into three CBODu state variables. Based on analyses of the Harbor's long term BODs and the wastewater dischargers effluent long term BODs, it was determined that the three CBODu decay rates of 0.02, 0.04 and 0.06 per day best reflected the BOD decay activity going on in the Harbor system. Each BOD load to the system was assigned to one of these compartments based on their specific long term BOD characteristics.

- Marsh BOD loads were put in the 0.04/day compartment
- River fast decaying BOD loads in the 0.06/ day compartment
- River slow decaying BOD loads in the 0.02/ day compartment
- Ocean BOD concentrations/loads half in 0.06 and the rest in 0.02/ day compartments
- Dischargers BOD loads in to their appropriate compartment(s) based on their specific long term data. More details in Section 4.

Note the original 2006 modeling had a CBODu decay rate compartment of 0.12/day to reflect the decay of secondary treated wastewater in the Harbor. Now most of the wastewater is more highly treated and the 0.12/day decay rate is no longer appropriate.

3.5. Modeling Technical Review Group

Interactive discussions between state and federal agency staff and dischargers regarding the Savannah Harbor DO issue have been ongoing for more than a decade. Formation of a group of technical experts, from the Savannah Harbor Committee (SHC), Central Savannah River Area TMDL (CSRA) Group and agencies, was established to provide ongoing input on model development for the river and harbor portions of the system. The participants in the modeling subgroup were nominated by USEPA, Georgia EPD, South Carolina DHEC, SHC, and CSRA for their expertise in modeling and for their specific knowledge of the Savannah River and Harbor ecosystem (2009 SHMTRG). These refined modeling tools reviewed by the modeling subgroup were used to develop this revised TMDL to achieve the recently adopted Georgia DO standard for Savannah Harbor.

Recommendations from the Modeling Technical Review Group:

1. River and Harbor Models as refined during 2009 subgroup work effort provide sufficient tools to develop a revised TMDL based on a relative change in DO concentrations (e.g. DO deficit). Use of the models for precise comparisons of predicted DO concentrations with individual species needs may require additional refinement.
2. Time-variable loading approach was utilized for TMDL development for the Savannah Harbor based on overall flow and DO target conditions developed by the modeling subgroup agency participants. (See section 4.2)
3. Development of the TMDL Calculator for the Savannah Harbor that allows multiple alternative scenarios to be evaluated without hours of model runs for each scenario. The Calculator is based on a unit response for BOD and DO discharged for each permit holder throughout the 2 mile segments of the Harbor model. (See Section 4.3)
4. Verification process for dischargers simulated with a variable-loading approach included an annual comparison of achieved effluent quality with the distribution used in the final TMDL simulation..
5. The modeling subgroup to remain as a resource to agency staff, throughout the TMDL development process, as technical questions arise that would benefit from the group discussions that have occurred over the past eleven months.

4. Source Assessment for Oxygen Demanding Pollutants

A TMDL evaluation examines the known potential sources of the pollutant of concern in the watershed, including facilities regulated by the NPDES program, non-point sources, other sources of pollution, and background levels of the pollutant in the affected waterbody.

4.1. NPDES Permits

The NPDES permitted discharges to the Savannah watershed can be separated into three groups:

- Direct Discharges to the Harbor
- Direct Discharges to Savannah River below Thurmond Dam to Clyo
- Watershed Discharges to tributaries feeding the Savannah River

4.1.1. Harbor NPDES Dischargers

Table 4 NPDES Permitted Dischargers BOD5 and Ammonia Loads to Harbor lists the relevant NPDES dischargers to the Harbor along with their permit number and permitted CBOD5 and ammonia loadings. Figure 8 shows the Harbor discharger locations in the Harbor.

Table 4 NPDES Permitted Dischargers BOD5 and Ammonia Loads to Harbor

Facility Name	Receiving Water	Permit Number	Effluent Flow Rate (MGD)	BOD5 (mg/L)	Ammonia (mg/L)	BOD5 (lbs/day)	Ammonia (lbs/day)
BASF	Harbor	GA0048330	--	--	--	--	880
Garden City WPCP	Harbor	GA0031038	2	30	17	500	290
Georgia Pacific - Savannah River Mill	Harbor	GA0046973	*18*	--	--	10,850	105
BJW&SA	Harbor	SC0034584	4	30	20	1001	667
International Paper Company - Savannah Mill	Harbor	GA0001988	*44*	--	--	25,000	257
PCS Nitrogen Fertilizer	Harbor	GA0002356	--	--	--	--	1,000
Savannah - President Street WPCP	Harbor	GA0025348	27	18.5 (CBOD5)	12.6	4,165	2,837
Savannah - Travis Field WPCP	Harbor	GA0020427	2	20	12	250	145
Savannah - Wilshire WPCP	Harbor	GA0020443	5	30	17.4	1126	653
US Army - Hunter Airfield	Harbor	GA0027588	1	20	17	209	181
Weyerhaeuser Company - Port Wentworth	Harbor	GA0002798	*13*	--	--	6,700	76

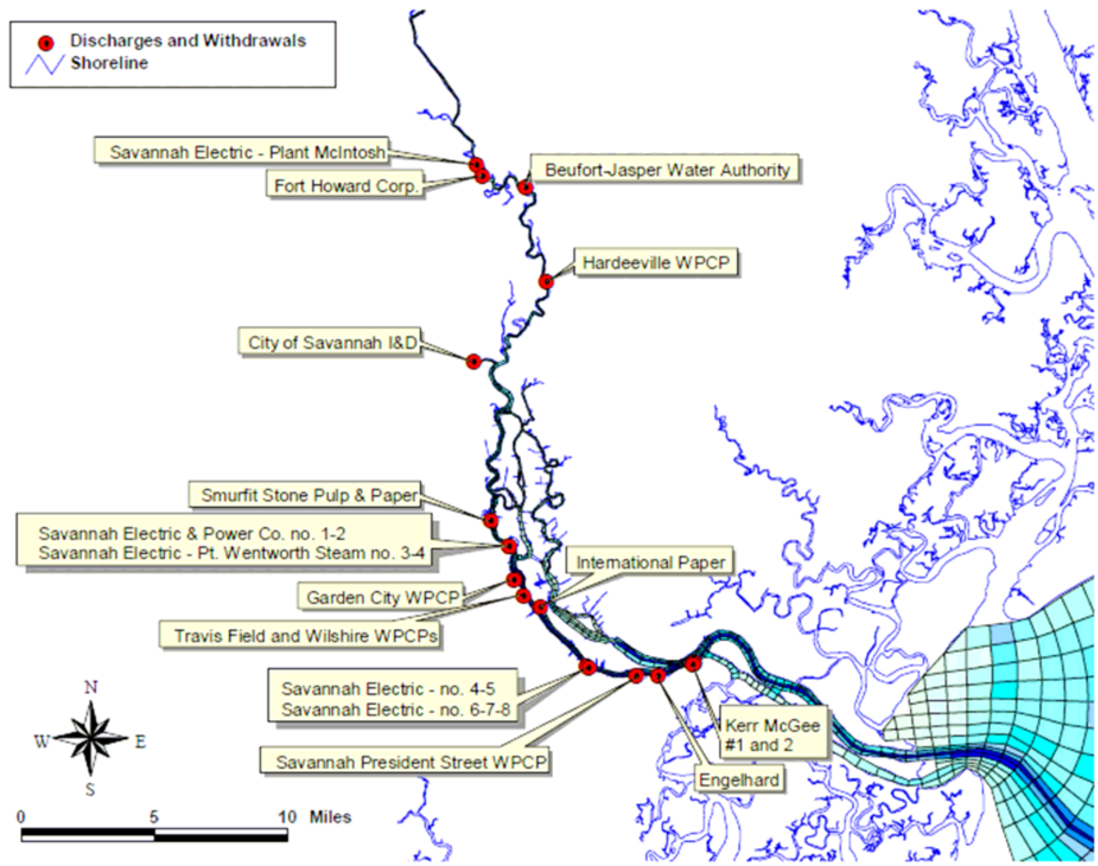

Figure 8 NPDES Permit Discharge Location

Long-term BOD analyses were completed (2000 and 2004 MACTEC; 2006 Tetra Tech; 2010 EPA Region 4) on the dischargers' wastewater to develop the appropriate f-ratios and CBODu category to input the CBOD5 loads into the model. Table 5 provides the permitted ultimate CBOD and ultimate Nitrogenous BOD (NBOD) loads to the Harbor Model. The specific WTFs' CBODu division between fast and slow CBODu decay rates is detailed in the updated Harbor Modeling Report (2010, EPA).

Table 5 Harbor Dischargers Permitted CBODu and NBODu Loads

Facility Name	Receiving Water	Permit Number	CBODu (lbs/day)	NBODu (lbs/day)
BASF	Harbor	GA0048330	--	4,022
Garden City WPCP	Harbor	GA0031038	2,760	1,325
Georgia Pacific - Savannah River Mill	Harbor	GA0046973	59,892	480
BJW&SW	Harbor	SC0034584	5,524	3,049

International Paper Company - Savannah Mill	Harbor	GA0001988	146,300	1,174
PCS Nitrogen Fertilizer	Harbor	GA0002356	--	4,570
Savannah - President Street WPCP	Harbor	GA0025348	22,991	12,965
Savannah - Travis Field WPCP	Harbor	GA0020427	1,380	663
Savannah - Wilshire WPCP	Harbor	GA0020443	6,216	2,984
US Army - Hunter Airfield	Harbor	GA0027588	1,154	827
Weyerhaeuser Company - Port Wentworth	Harbor	GA0002798	54,334	347
TOTAL	Harbor		300,551	32,407

4.1.2. River NPDES Dischargers

Table 6 lists the relevant NPDES dischargers along with their permit number and permitted CBOD5 and ammonia loadings to the Savannah River below Thurmond Dam to Clyo. Table 7 provides the permitted ultimate CBOD and ultimate Nitrogenous BOD (NBOD) loads to the River Model. The specific WTFs' CBODu division between fast and slow CBODu decay rates is detailed in the River Modeling Report (2010, GaEPD).

Table 6 NPDES Permitted Dischargers BOD5 and Ammonia Loads to River

Facility Name	Receiving Water	Permit Number	Effluent Flow Rate (MGD)	BOD5 (mg/L)	Ammonia (mg/L)	BOD5 (lbs/day)	Ammonia (lbs/day)
Aiken PSA/Horse Creek WWTF	River	SC0024457	26	30	11	6,505	2,385
Allendale	River	SC0039918	4	25	20	834	667
Augusta - James B. Messerly WPCP	River	GA0037621	46	30	17	11,534	6,690
Clariant Corp/Martin Plant	River	SC0042803	--	--	--	564	2,000
Columbia County - Crawford Creek WPCP	River	GA0031984	2	12	1	150	15

Columbia County - Little River WPCP	River	GA0047775	6	8	4	375	215
Columbia County - Reed Creek WPCP	River	GA0031992	5	30	17	1,151	668
Columbia County – Kiokee Creek WPCP	River	GA0038342	*0.3*	20	7	50	18
DSM Chemicals Augusta Inc	River	GA0002160	*4*	--	--	727	--
International Paper Company - Augusta Mill	River	GA0002801	*24*	--	0.7	30,000	140
Kimberly-Clark/Beech Island	River	SC0000582	11	--	--	4,031	--
PCS Nitrogen Fertilizer	River	GA0002071	*1*	30	--	350	1,162
Savannah River Site (SRS) Discharges (50% Reduction)	River	SC0000175				218	22

Table 7 River Dischargers Permitted CBODu and NBODu Loads

Facility Name	Receiving Water	Permit Number	CBODu (lbs/day)	NBODu (lbs/day)
Aiken PSA/Horse Creek WWTF	River	SC0024457	19,924	8,386
Allendale	River	SC0039918	3,019	3,048
Augusta - James B. Messerly WPCP	River	GA0037621	41,753	30,573
Clariant Corp/Martin Plant	River	SC0042803	2,042	9,140
Columbia County Combined	River	GA0031984	5,705	4,118
DSM Chemicals Augusta Inc	River	GA0002160	2632	--
International Paper Company - Augusta Mill	River	GA0002801	108,600	640
Kimberly-Clark/Beech Island	River	SC0000582	14,592	--

PCS Nitrogen Fertilizer	River	GA0002071	1,267	5,310
Savannah River Site (SRS) Discharges (50% Reduction)	River	SC0000175	789	101
TOTAL	River		204,491	63,899

4.1.3. Watershed NPDES Dischargers to Tributaries

The watershed discharges to the Savannah River tributaries at their existing loadings have an insignificant impact on the DO levels in the Harbor and are not included as contributing sources in this TMDL. Current or future tributary discharger loadings, including municipal and industrial stormwater, are allowable if it is demonstrated, via modeling that their loads are at background conditions by the time they reach the river.

The SRS dischargers, although multiple watershed discharges, was handled as a direct discharge because of its proximity to the River. A fifty percent decay of the effluent load was assumed to account for the travel time to the River. The Columbia County dischargers were assumed to enter the Savannah River at 100 percent of their load.

The CBOD5 and ammonia loadings from future discharges or expansions of existing dischargers over their 2009 loadings to the Savannah River should be examined and if significant included in the River Model and TMDL Calculator.

4.1.4. Total Ultimate Oxygen Demand for NPDES Dischargers

The summary of the Ultimate Oxygen Demand (UOD) loads from NPDES Dischargers to the Savannah Harbor and River System is listed in Table 8.

Table 8 Summary of the Permitted UOD Loads for the Harbor and the River

Receiving Water	CBODu (lbs/day)	NBODu (lbs/day)	UOD (lbs/day)
Harbor	300,551	32,407	332,958
River	204,491	63,899	268,390
TOTAL	505,042	96,306	601,347

4.2. Time-variable loading approach for NPDES Discharger Inputs

The traditional TMDL and wasteload allocation (WLA) approach uses steady state models with 7Q10 stream flows, average tides, and constant WTF discharger loads incorporated into monthly permit limits. The Savannah Harbor Variable Discharge Approach uses a dynamic three dimensional model with actual flows, tides, and meteorological data and variable (daily) WTF discharger loads. These variable loads, through a TMDL Calculator, are incorporated into the analysis and are developed into appropriate NPDES monthly permit limits. The Variable Loading Approach considers assimilative capacity of the flows above the 7Q10 and provides protection for flows below the 7Q10.

The variable discharger load time-series are based on historical wastewater effluent CBOD5 and ammonia data for each facility and then simulated using monthly permit load and Coefficient of Variance CV. For the smaller dischargers, a constant load based on the monthly permitted load and CV was used with the result that the Permit monthly load equals 1.5 times the TMDL daily load. For the five largest discharges, three years of daily time-series loading were used with each year time-series representing a high, medium, and low loading year. These three loading years were based on and are representative of fifty years of simulated discharge loadings. HydroQual's 2010 report provides the details for each of the wastewater dischargers (2010 HQI). Figure 9 illustrates the relationship between the monthly permitted load and the actual discharge daily time-series for CBOD5.

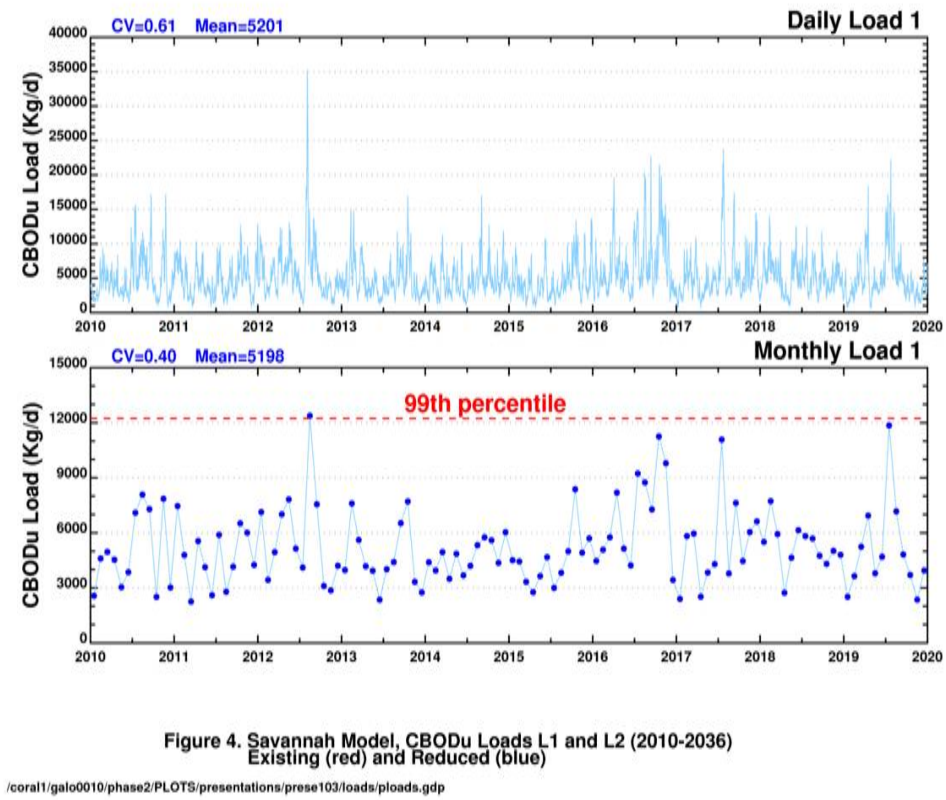

Figure 9 Monthly Permit CBODu Load and the 99 Percentile

The use of variable discharge loads in permits is not a "new" idea. The MeadWestvaco Pulp and Paper Mill in Covington, Virginia has a variable discharge NPDES permit. Also EPA's Technical Support Document (TSD) for Toxics provides methodology and examples of incorporating variable load calculations in permits using 99 percentile and an appropriate CV, while the Anacostia TMDLs set a clear precedent that daily maximum loads can allow for daily variability in continuous point sources.

Additional details of this approach are laid out in the HydroQual's 2010 report. (2010 HQI).

4.3. TMDL and NPDES Permit Limit Calculator for the Savannah Harbor

The Savannah DO TMDL Calculator was developed as an efficient method to calculate the effect of various combinations of the 22 wastewater effluent dischargers on the DO levels in the Savannah Harbor and all the conditions allowable in the Georgia and South Carolina Water Quality Standards for the Harbor. The potential TMDL targets governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor are described in Section 2.3 of this TMDL.

With 22 wastewater dischargers, there are many combinations of wastewater effluent CBOD5 and ammonia that could meet this TMDL target. Given the run time of an annual water quality model simulation, it is impractical to evaluate a sufficient number of wastewater CBOD5 and ammonia loading combinations to adequately satisfy all the potential alternatives. The TMDL Calculator, based on hundreds of Savannah River and Harbor model runs, provides an accurate estimation of the DO impact of each discharger and can be used to evaluate various discharge scenarios and to develop the appropriate TMDL that meets the applicable standard.

4.4. Background Sources

The vast majority of the nonpoint source loadings of oxygen-demanding substances are from natural background sources including detritus transported in the stream, detritus from marsh areas flowing directly into the Harbor, and tidally-transported detritus from the ocean. These natural background loads are not controllable and therefore additional nonpoint source reduction to improve water quality is not an option.

In developing the TMDL, EPA evaluated oxygen-demanding loads from industrial and municipal stormwater sources discharging pursuant to an NPDES permit into, or upstream of, the Harbor. These loads were shown to have no measurable impact on the dissolved oxygen levels in the critical areas of concern in the Harbor. During critical periods, permitted stormwater loads were considered to be equivalent to, and part of, the natural background. EPA expects that stormwater pollution prevention plans will continue to provide for use of best management practices to ensure that such stormwater loadings do not increase above natural background levels. As long as stormwater loads continue to be less than, or equivalent to, natural background loads, the TMDL does not necessitate reductions to existing industrial and municipal stormwater sources discharging pursuant to an individual or general NPDES stormwater permit (e.g., MS4, industrial and construction general permits). [Note: This text was taken directly from EPA's August 27, 2007 letter to the States in resolution of the first round TMDL dispute.]Tributaries discussed in 4.1.3 are also included in the background condition.

As a matter of practice, EPA has established, acknowledged and approved TMDL *de minimis* thresholds below which dischargers are not subject to specific wasteload allocations or reduction expectations. Any new or existing discharger that can demonstrate that its loading is within natural background shall be considered a background source. For purposes of this TMDL, background includes those dischargers whose impact on the delta DO deficit is of such an inconsequential nature that such discharges may be deemed part of the background load.

5. TMDL Development

A TMDL establishes the total pollutant load that a waterbody can assimilate and still achieve the applicable water quality standard. The components of a TMDL include a wasteload allocation (WLA) for facilities and sources regulated by the NPDES program, a load allocation (LA) for all other sources including natural background, and a margin of safety (MOS), either implicitly or explicitly, to account for uncertainty in the analysis. Conceptually, a TMDL is defined by the equation:

$$TMDL = \Sigma\ WLA + \Sigma\ LA + MOS$$

Since the TMDL is established based on the allowable *point source* deficit below natural background conditions, the LA is not relevant to the TMDL calculation itself.

The TMDL for the Savannah Harbor in the Savannah River Basin is in terms of oxygen-demanding substances expressed as UOD, where:

UOD = CBODu + NBODu

CBODu = CBOD5 multiplied times a f-ratio associated with the appropriate CBODu decay rate(s).

NBODu = ammonia multiplied times 4.57 conversion factor

The TMDL provides for the calculation of the appropriate WLA and NPDES UOD, CBOD5 and/or ammonia effluent limits through the use of the TMDL Calculator.

Because of the distribution of the NPDES dischargers and associated loads throughout the Savannah Harbor and River system, the different conditions allowable in Georgia and South Carolina Water Quality Standards and the potential for numerous allocation strategies, along with trading scenarios to be evaluated by the States, a single TMDL UOD cannot be developed but a range of values will be proposed. The final implementation of the TMDL must provide for a UOD and associated NPDES parameters such as UOD, CBOD5, ammonia, and/or DO limits that comply with the applicable TMDL target (see Section 2.3 above).

5.1. Critical Conditions

For an estuarine TMDL, critical conditions are more complex than the critical conditions typically considered for a river system (e.g., summer temperatures and 7Q10 flow). Tidal dynamics play an important role in the DO levels of the Savannah Harbor. Calendar year 1999 was determined as the set of model flow, tide, and metrological inputs that represents the critical period and was used to develop the TMDL model and to construct the TMDL Calculator. Critical conditions were established to include an event that would occur once in ten years on the average or less often. In May 2000 and May 2003 letters, Georgia and South Carolina set the critical conditions for Savannah Harbor as:

- Upstream boundary determined by the States' Savannah River Model;
- Harbor model kinetic rates and parameters as determined by the Savannah Harbor Model calibration;
- 1999 harbor channel bathymetric physical conditions;
- A critical flow including a seven-day ten-year low-flow (7Q10), taking into account the low-flow release from Thurmond Dam;
- Meteorological and tidal conditions based on 1999 data.

Therefore, critical conditions applied to the Savannah Harbor DO TMDL are based on model runs for March through October 1999 incorporating the existing harbor physical conditions and the upstream low flow, as well as actual 1999 tidal regimes, temperature, and other meteorological conditions measured during these periods.

Additional analysis of the critical condition was completed through the Technical Model Group Review. SCDHEC conducted a flow analysis of the Savannah River and concluded that period of record 1955 through 2008 was an appropriate time frame to evaluate for appropriate critical conditions. See Appendix A. HydroQual (HQI) conducted a fifty year DO analysis and showed that 1999 was a year that adequately represented the past 50 years (2010 HQI).

Based on the critical conditions defined here, the TMDL and its associated wasteload allocation only applies during the critical months. NPDES permits may provide for different limits, not based on the TMDL, during the non-critical season.

5.2. TMDL Numeric Target

Pursuant to the Clean Water Act (CWA), TMDLs are established at a level necessary to implement the applicable water quality standard for the waterbody. For several months during the critical period, the natural background DO for the Harbor is below the daily average standard of 5 mg/L. Therefore the initial TMDL target DO is a daily average delta DO of 0.1 mg/L for Georgia only waters and 0.10 mg/L for waters that are shared with South Carolina.

The Savannah Harbor system was divided in to 27 zones as listed in Table 8. The models predicted DO values were volumetrically and daily average to produce a daily average DO time series per zone.

Table 8 Savannah Harbor Zone Descriptions and Extent

Zone	Zone Name	Ga and/or SC Waters
FR-01	Main Channel RM 0 to RM 2	Ga/SC
FR-03	Main Channel RM 2 to RM 4	Ga/SC
FR-05	Main Channel RM 4 to RM 6	Ga/SC
FR-07	Main Channel RM 6 to RM 8	Ga/SC
FR-09	Main Channel RM 8 to RM 10	Ga/SC

FR-11	Main Channel RM 10 to RM12	Ga/SC
FR-13	Main Channel RM 12 to RM 14	Ga
FR-15	Main Channel RM 14 to RM 16	Ga
FR-17	Main Channel RM 16 to RM 18	Ga
FR-19	Main Channel RM 18 to RM 20	Ga
FR-21	Main Channel RM 20 to RM 22	Ga
FR-23	Main Channel RM 22 to RM 24	Ga
FR-25	Main Channel RM 24 to RM 26	Ga
FR-27	Main Channel RM 26 to RM 28	Ga/SC
FR-29	Main Channel RM 28 to RM 30	Ga/SC
FR-35	Main Channel RM 30 to RM 40	Ga/SC
FR-45	Main Channel RM 40 to RM 50	Ga/SC
FR-55	Main Channel RM 50 to RM 60	Ga/SC
MR-01	Lower Middle River	Ga
MR-02	Upper Middle River	Ga
BR-01	Back River	Ga/SC
LBR-02	Lower Little Back River	Ga/SC
LBR-03	Upper Little Back River	Ga/SC
SC	South Channel	Ga
Ocean1	Ocean Channel Mouth to 10 miles	Ga/SC
Ocean2	Ocean Channel 10 to 20 miles	Ga/SC
SedBas	Sediment Basin - connecting Back River to Main Channel	Ga/SC

The 1999 Baseline Model - a Harbor and River model with no point source dischargers BOD and ammonia loadings - was run and a daily average DO per zone computed. Figure 10 illustrates the daily average DO time series for Zone FR-13, one of the lower DO areas of the Harbor. Figure 11 illustrates the natural daily average Zone DO for August 30, 1999. Various Scenario Model runs were then completed. These runs include the point source dischargers' BOD and ammonia loads.

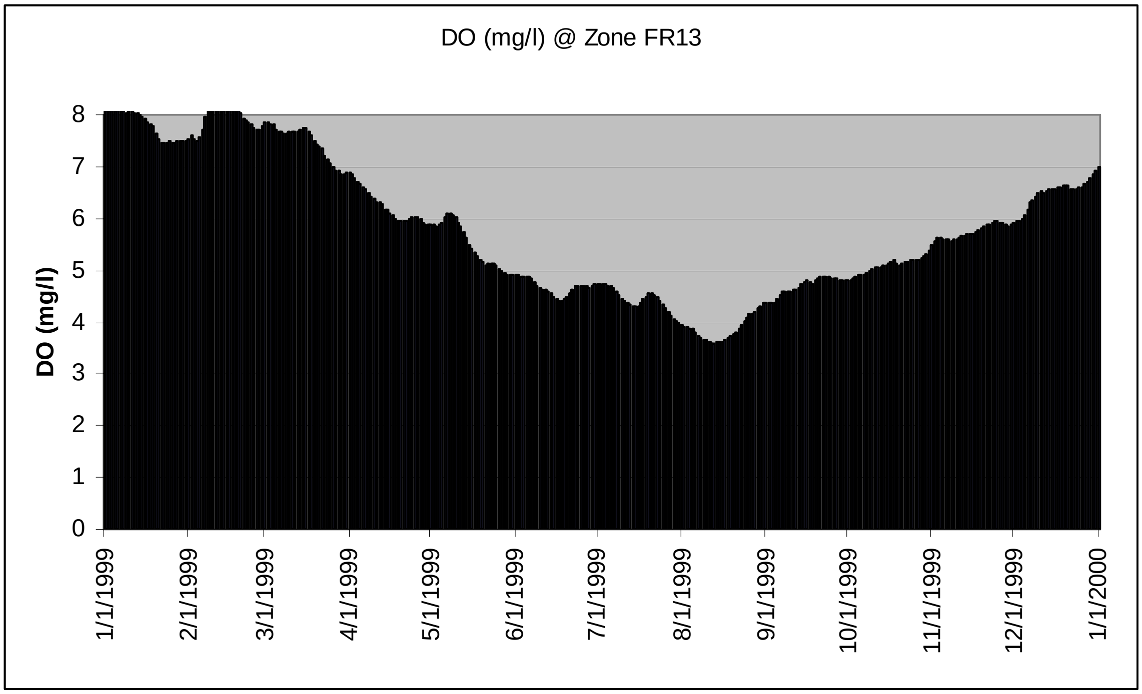

Figure 10 1999 Time Series Daily Average DO for Zone FR-13

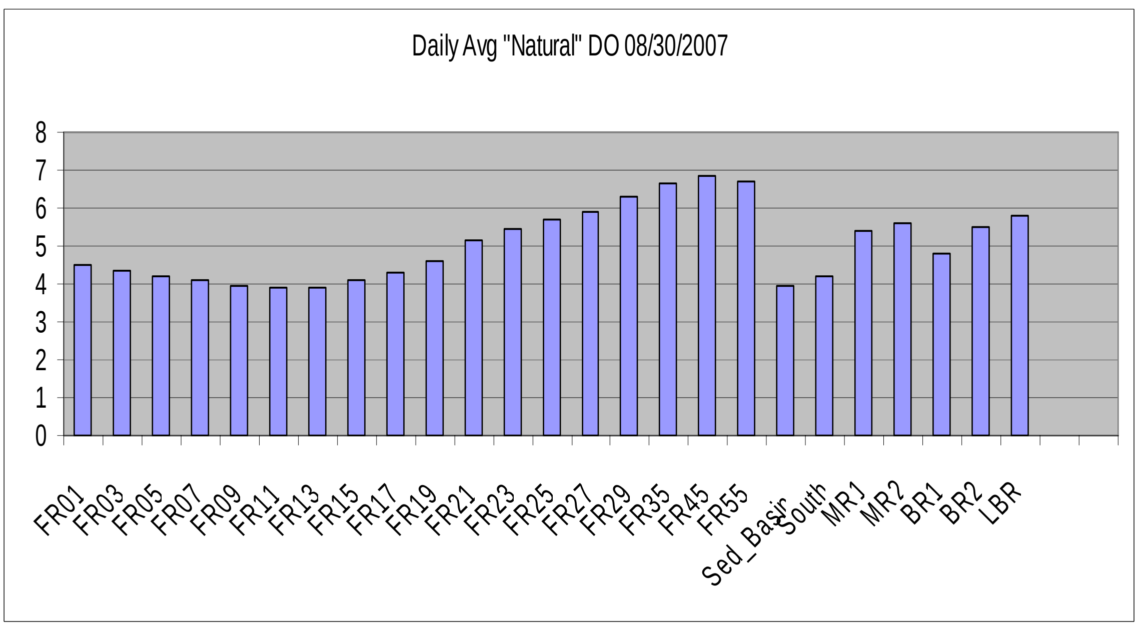

Figure 11 Daily Average DO by Zones

The initial delta DO TMDL target is calculated by taking the 90 percentile of the daily delta DOs difference calculated by subtracting the Baseline Model outputs by the Scenario Model outputs for each zone for the time period March through October. The 90 percentile was identified by the MTRG to allow for the natural variability as defined by GaEPD regulations. The March through October time frame is defined by SCDHEC regulations. Figure 12 illustrates the Calculated Delta DOs between the Baseline and Permit Limits scenarios for all the Zones.

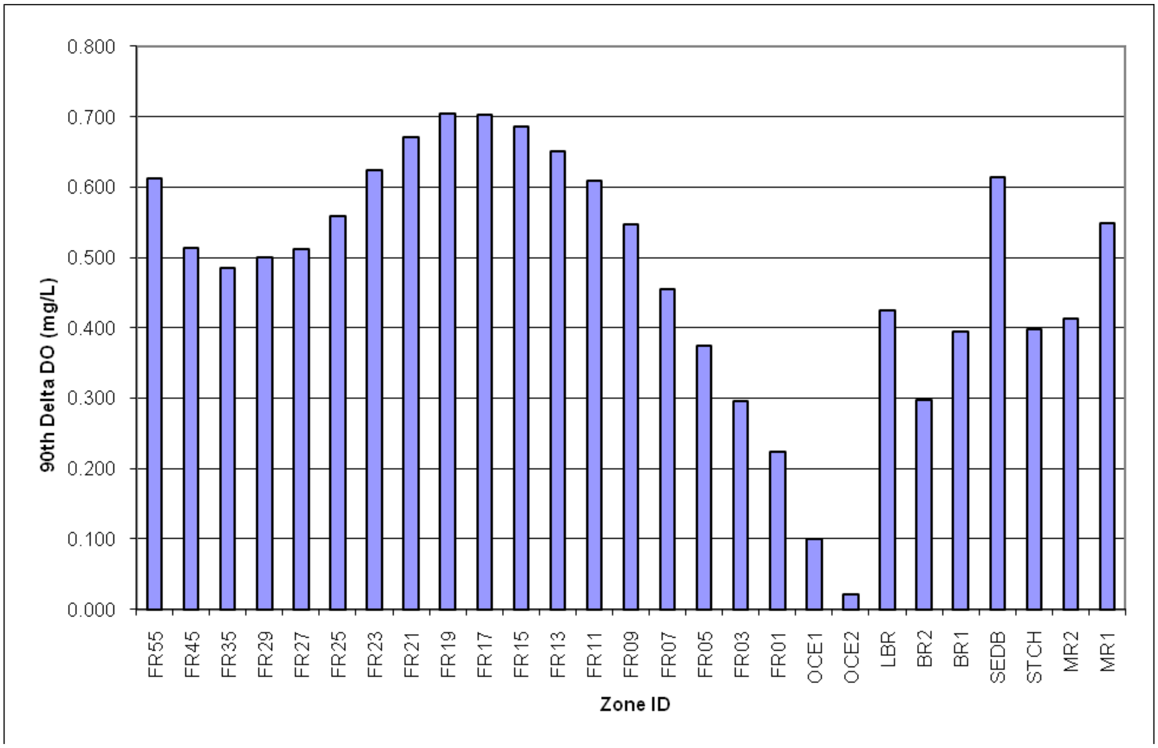

Figure 12 Delta DOs by Zone due to Point Sources at Permitted Loads

5.3. 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 total WLA for continuous non-storm water dischargers. The individual WLA for each discharger will be determined using the TMDL Calculator.

The background sources described in Section 4.4 are not considered to be subject to the WLA.

5.4. 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 wastes under critical low flow conditions because of the absence of storm water runoff. Therefore, the non-point source contribution is aggregated with the natural background loads in this TMDL. LA is used in overall modeling of the Harbor, but is not included in the Delta DO TMDL range. If, at a later date, a significant upstream non-point source is identified, the TMDL will be revised to account for this source.

The natural background loadings to the harbor are as follows:

- Upstream loads from natural riverine UOD = 85,000 lbs/day
- Marsh loadings UOD= 145,000 lbs/day
- Ocean boundary conditions for CBODu = 5 mg/L and ammonia = 0.07 mg/L

5.5. 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 Savannah Harbor, the amount of uncertainty is considered low. This system has been the subject of extensive study, including extensive data collection, and model development by various state and federal agencies. The Savannah 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.

5.6. Seasonal Variation

Seasonal variation is incorporated in the Savannah Harbor TMDL by evaluating multiple years of data. For the hydrodynamic and water quality model, the years of 1997 through 2008 were evaluated. The TMDL recognizes that permit loads can be larger in the winter months when the DO standard of a daily average of 5.0 mg/L not less than 4.0 mg/L applies. Thus the River and Harbor Models can also be used to develop seasonal WLAs and seasonal NPDES permit limits, which can be done outside the TMDL as a Water Quality Based Effluent Limitation.

6. TMDL and WLA Range

There are hundreds of possible discharge reduction scenarios that could achieve the Delta DO TMDL Target. The TMDL Calculator will allow the States to evaluate various scenarios and develop a WLA or Point Source Load distribution and reduction strategies that will most practicably allow the TMDL target to be met. As long as the TMDL reduction strategy and the resultant WLA Ultimate Oxygen Demand (UOD) and National Pollutant Discharge Elimination System (NPDES) CBOD5 and ammonia permit limits selected meet the TMDL target as calculated via the TMDL Calculator, the WLA or Point Source Load distribution scenario meets the goals of this TMDL.

The allowable WLA will vary depending on the size and location of the individual CBOD5 and ammonia loads and which conditions of the Georgia and South Carolina Water Quality Standards are applicable.

The TMDL targets, based on Georgia and South Carolinas' Water Quality Standards, governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor are 1) the 0.1 mg/L or 0.10 mg/L deficit from the "natural" dissolved oxygen value, 2) the 0.1 mg/L deficit from "natural" dissolved oxygen value (provided the S.C. standard is changed), and 3) up to a 10% deficit allowed if it is demonstrated that resident aquatic species shall not be adversely affected.

The Savannah Harbor TMDL is equal to the selected WLA UOD alternative plus the background LA as listed in Section 5.4.

The TMDL targets, based on Georgia and South Carolinas' Water Quality Standards, governing the discharge of wastewater CBOD5 and ammonia to the Savannah River and Harbor are 1) the 0.1 mg/L or 0.10 mg/L deficit from the "natural" dissolved oxygen value, 2) the 0.1 mg/L deficit from "natural" dissolved oxygen value (provided the S.C. standard is changed), and 3) up to a 10% deficit allowed if it is demonstrated that resident aquatic species shall not be adversely affected.

6.1. Alternative TMDL Scenarios

To demonstrate the capability and usefulness of the TMDL Calculator in determining the WLA reduction and load distribution strategy to meet the applicable TMDL target, the following scenarios are presented.

6.1.1. Initial TMDL Target

To establish the likely range for the WLA UOD values to meet the initial TMDL target of 0.1 mg/L for Georgia waters and 0.10 mg/L for joint Georgia/South Carolina waters, the distribution of loading within the system was varied resulting in a range of from 80,000 to 115,000 lbs/day UOD, depending on how the load was distributed. The WLA strategy that is ultimately implemented will depend on the distribution and location of the UOD sources and the output of the TMDL Calculator.

6.1.2. Alternative TMDL Target #1

An alternative TMDL target could be a 0.1 mg/L Delta DO for all Harbor waters naturally below 5 mg/L. This would occur if South Carolina changes their Delta DO standard from 0.10 mg/L to 0.1 mg/L. To meet the initial TMDL target of 0.1 mg/L for Georgia waters and South Carolina waters, the WLA could range from 100,000 lbs/day UOD to 130,000 lbs/day UOD. Again, the actual WLA that is ultimately implemented will depend on the distribution and location of the UOD sources and the output of the TMDL Calculator.

6.1.3. Alternative TMDL Target #2

Alternative target #2 could be if a demonstration is completed showing an increased DO delta, not to be greater than 10% of natural, does not impact the resident species. This demonstration would have to meet the requirements of both Georgia and South Carolina Water Quality Standards. This new delta DO may range from greater than 0.1 mg/L to 0.35 mg/L. If the new Delta DO were 0.25 mg/L, then the WLA could range from 200,000 lbs/day UOD to 250,000 lbs/day UOD. Again, the actual WLA that is ultimately implemented will depend on the distribution and location of the UOD sources and the output of the TMDL Calculator.

6.2. Oxygen Injection Scenario

One treatment alternative the dischargers are considering, along with other treatment upgrades, is injecting super-saturated levels of oxygen in their effluent. This could be done regardless of which of the 3 TMDL targets described above becomes the final target. Note the testing will be required to assure these oxygen levels are non-toxic and additional analysis will be required to assure oxygen entrainment under ambient conditions at injection locations.

For the initial TMDL Target scenario (Section 6.1.1) with 15,000 lbs/day of Oxygen injected equally divided between the three (3) Harbor Pulp and Paper Mill Dischargers, the WLA to meet the initial TMDL target of 0.1 mg/L for Georgia waters and 0.10 mg/L for joint Georgia/South Carolina waters, would range from 175,000 lbs/day UOD to 245,000 lbs/day UOD, depending on where the actual loads are introduced into the system

7. Trading and Implementation Considerations

EPA embraces the concept of water quality trading in watersheds with multiple sources of pollutants, and specifically endorses the use of trading to implement this TMDL. Appropriate trading of pollutant allocations and/or DO deficits between or among sources, or through oxygen injection into the Harbor, is allowed under this TMDL as long as the total TMDL is not exceeded. The TMDL Calculator will allow the States' to evaluate and determine UOD (CBOD5 and Ammonia) load and oxygen injection trading in accordance with EPA's Trading Policy.

7.1. EPA Trading Policy

Water quality trading (also called effluent trading) is an innovative way for water quality agencies and community stakeholders to develop cost-effective solutions to address water quality problems in their watersheds. EPA's regulatory requirement under Section 303(d) of the Clean Water Act to establish Total Maximum Daily Loadings (TMDLs) for each impaired water body provides a tremendous opportunity to apply market-based conservation strategies. Water quality trading may achieve these environmental goals at a lower cost than other regulatory approaches.

A TMDL provides a method for allocating pollutant discharges among sources, by establishing waste load allocations for each point source, and a load allocation for non-point (non-permitted) sources as a whole. These allocations quantify the relationship between pollutant sources and water quality. More specifically, a TMDL is the sum of the waste load allocations to point sources, the load allocations to non-point sources, and natural background, which are set at a level needed to ensure achievement of water quality standards in the impaired water body. A margin of safety is also included in the TMDL to account for any lack of knowledge concerning the relationship between the pollutant loads and the quality of the receiving water body. One result of the TMDL allocation is that discharge sources with the ability to reduce at the lowest cost are not necessarily encouraged to make substantial reductions, since they need only reduce to the level of their load allocation. Other sources may need to make considerable reductions, but their costs may be very high.

Water quality trading allows sources to use the marketplace to determine who will reduce and by how much, by allowing the buying and selling of the assigned allotments. For example, a source that reduces more than what was required can quantify that amount and create a marketable "credit." That credit, in turn, can be purchased by another source, which allows them to increase their discharge by the amount of the credit. The total discharge by both sources remains the same, thereby maintaining overall water quality standards. With trading, the market price determines the most cost-effective distribution. Sources can use the trading of allotments to accommodate anticipated growth or other increases of their discharge, and avoid expensive last-minute technology investments. They may also profit from the adoption of pollution prevention techniques that reduce their discharge by selling their excess allotment in the market.

EPA issued a Water Quality Trading Policy ("policy") on January 13, 2003 to provide guidance to states and tribes on how trading can occur under the Clean Water Act and its implementing regulations. The policy discusses Clean Water Act (CWA) requirements that are relevant to water quality trading including: requirements to obtain permits, anti-backsliding provisions, development of water quality standards including antidegradation policy, National Pollutant Discharge Elimination System permit regulations, total maximum daily loads (TMDLs) and water quality management plans. (http://www.epa.gov/owow/watershed/trading/tradingpolicy.html)

7.2. Implementation Considerations

EPA also endorses the full range of administrative and regulatory tools available to the States to provide flexibility in implementing the TMDL, including the tools described in EPA's letter to the States dated August 27, 2007.

EPA recognizes that the Clean Water Act does not limit compliance schedules to the five-year permit term where a longer period is justified under Section 502(17) of the Act and 40 CFR §§ 122.2 and 122.47. With respect to implementation of the Savannah Harbor TMDL in particular, EPA recognizes that the required process alterations and improvements will vary and, in some cases, the States may need to allow long-term compliance schedules consistent with the regulatory requirements noted above.

EPA expects this TMDL be incorporated in to these Savannah Harbor and River NDPES permits as soon as practicable. This will require the States, with input from the dischargers, to develop a load distribution that meet this TMDL before NPDES permits can be reissued. The determination and rationale for the selected load distribution must be part of each impacted Savannah Harbor and River NPDES Permit.

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8. Appendix A: Savannah Harbor DO TMDL Model Critical Conditions for Savannah River Flow

The effect of NPDES oxygen demand loads on dissolved oxygen (DO) in Savannah Harbor depends on upstream flow in the Savannah River. High river flow dilutes wastewater and helps flush the estuary, which reduces impact from effluent loading. The reverse is true during low flow conditions. The TMDL model endpoint delta DO is highly sensitive to river flow, so selection of the river design condition was an important consideration in the TMDL analysis. A dynamic upstream flow condition was chosen over the traditional steady 7Q10 approach to take full advantage of available data and modeling. In the dynamic approach, the model is run using an actual flow period that represents the range and distribution of hydrologic conditions.

The USGS gage at Clyo (02198500) is the upstream boundary in the Harbor Model. Daily mean stream discharge is continuously reported from 1929 forward. The Model Technical Review Group (MTRG) evaluated the Clyo data and considered three questions: 1) what historical period from the flow record best represents existing and future conditions? 2) which year, or combination of years, from the modeled period 1997 forward best represents the historical period? and 3) what to do if future conditions change due to Drought Plan modification or reauthorization of the Corps lakes?

Historical period. The period before completion of Thurmond Dam in 1954 does not represent current or foreseeable future conditions and was excluded. The record from 1955 forward shows a change in the flow data during the 1980s, when low flows appear to decrease. Conversations with Corps staff indicated project operation might have changed during the 1980s from maintaining downstream navigation flows to maintaining summer lake levels, which could have reduced downstream flows. Savannah River flows were compared to flows on Brier Creek (02198000), an unregulated tributary. Brier Creek showed a similar pattern of reduced low flows (Figure 13). Based on the comparison to the natural stream, the MTRG concluded that basin hydrology was a significant factor in addition to any possible effects from the dam. In order to capture the full range of hydrologic variation as well as any operational changes, the historical period from 1955 forward was evaluated.

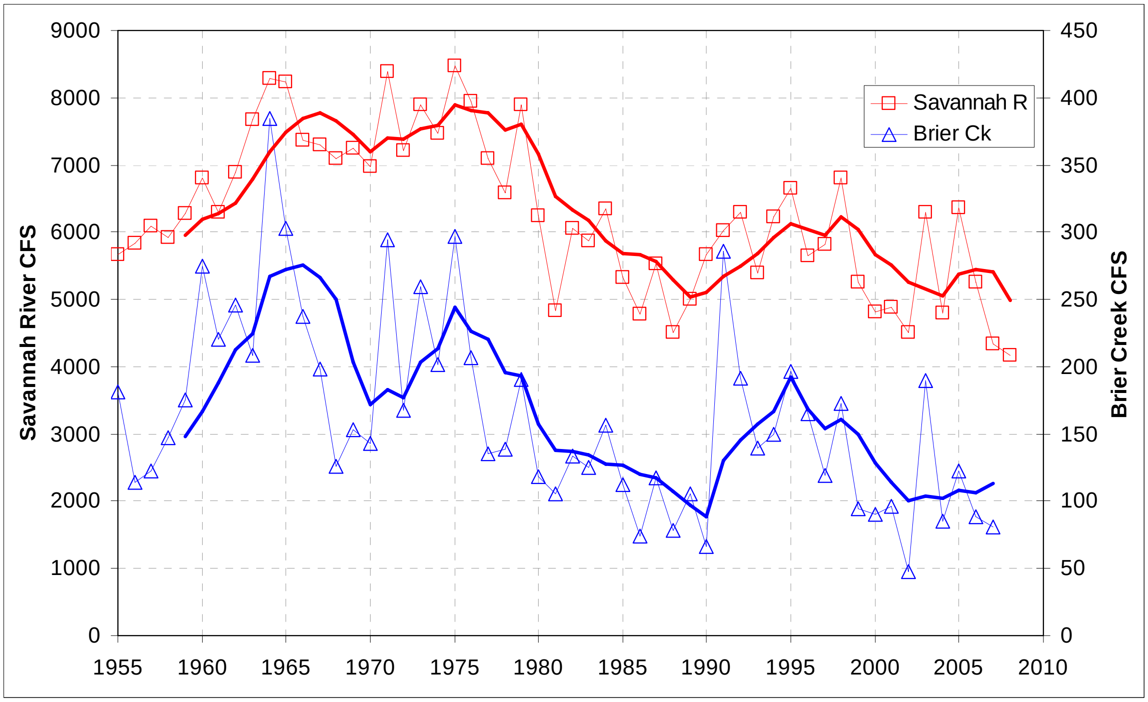

Figure 13 Savannah River and Brier Creek Flow Comparison

Representative year. It is not practical to simulate the entire period from 1955 forward in the DO model. Sufficient DO model input data are available only for recent years, and DO model runtime is a significant constraint. A representative year was selected from the modeled period in order to represent the variability in the historical record and to maximize the number of simulations that could be completed in a reasonable timeframe.

HydroQual completed a 50 year empirical modeling analysis (2010 HQI) and illustrated that 1999 was both a critical year and a year that represented the 1955 to 2008 period of record. Based on these analyses, the MTRG selected 1999 as the representative critical condition year for TMDL modeling.

Future conditions. In response to the recent drought, state and federal agencies, and other stakeholders with an interest in Savannah basin water management issues are considering a range of alternatives including modification of the Savannah Drought Plan, which balances lake levels and downstream flows during drought conditions, and changes to the Federal Authorization of the Corps lakes, which determines authorized lake uses. This TMDL is based on historical river flow conditions, which could change in the future depending on the outcome of these discussions. Proposed changes to these management plans would require NEPA review, and it is expected that TMDL issues arising from changes to the river flow regime would be addressed during the NEPA process.