Revised

Total Maximum Daily Load

Evaluation

for the

St. Marys River

in the

St. Marys River Basin

for

Dissolved Oxygen

Submitted to:
The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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EXECUTIVE SUMMARY

The State of Georgia assesses its water bodies for compliance with water quality criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories, supporting designated use, not supporting designated use, or assessment pending, depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list, as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* (GA EPD, 2014).

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, also named after that section of the CWA. Water bodies on the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality standard. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and to restore and maintain water quality.

In 2004, the State of Georgia identified one stream segment, located in the St. Marys River Basin, as water quality limited due to dissolved oxygen (DO). The water use classification of the impacted stream is Fishing. The general and specific water quality criteria for Fishing streams are stated in Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03, Sections (5) and (6). The St. Marys River from Catfish Creek to Millers Branch in Camden County was originally included in the State's 2004 303(d) list. The TMDL is being revised to allocate the available load identified in the original TMDL for future growth.

Part of the TMDL analysis is the identification of potential source categories. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of oxygen demanding substances on land surfaces that wash off as a result of storm events.

The process of developing the dissolved oxygen TMDL for the St. Marys River Basin included developing computer models for the listed segment. Georgia Estuary, a steady-state tidally averaged water quality model developed by the GA EPD, was used for the estuary segments that are influenced by tidal actions. These models were calibrated to data collected in the St. Marys River Basin in the summer of 2003.

Management practices may be used to help reduce and/or maintain the Ultimate Oxygen Demand (UOD) loads. These include:

- Compliance with the requirements of the NPDES permit program; and
- Application of Best Management Practices (BMPs) appropriate to nonpoint sources.

The amount of oxygen demanding substances delivered to a stream is difficult to determine. However, by requiring and monitoring the implementation of these practices, such efforts will improve stream water quality and represent a beneficial measure of TMDL implementation.

1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories, supporting designated use, not supporting designated use, or assessment pending, depending on water quality assessment results. These water bodies are found on Georgia's 305(b) list, as required by that section of the CWA that defines the assessment process, and are published in *Water Quality in Georgia* (EPD, 2014).

Some of the 305(b) partially and not supporting water bodies are also assigned to Georgia's 303(d) list, named after that section of the CWA. Water bodies on the 303(d) list are denoted by a Category of 5, and are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality criteria. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and in-stream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

On the 2004 303(d) list, the State of Georgia identified one stream segment located in the St. Marys River Basin as water quality limited due to dissolved oxygen (DO). Table 1 presents the stream in the St. Marys River Basin that was included on the 2004 303(d) list for exceedance of the DO criteria. This TMDL is being revised to allocate the available load identified in the original TMDL for future growth.

Table 1. Waterbody Listed For Dissolved Oxygen in the St. Marys River Basin

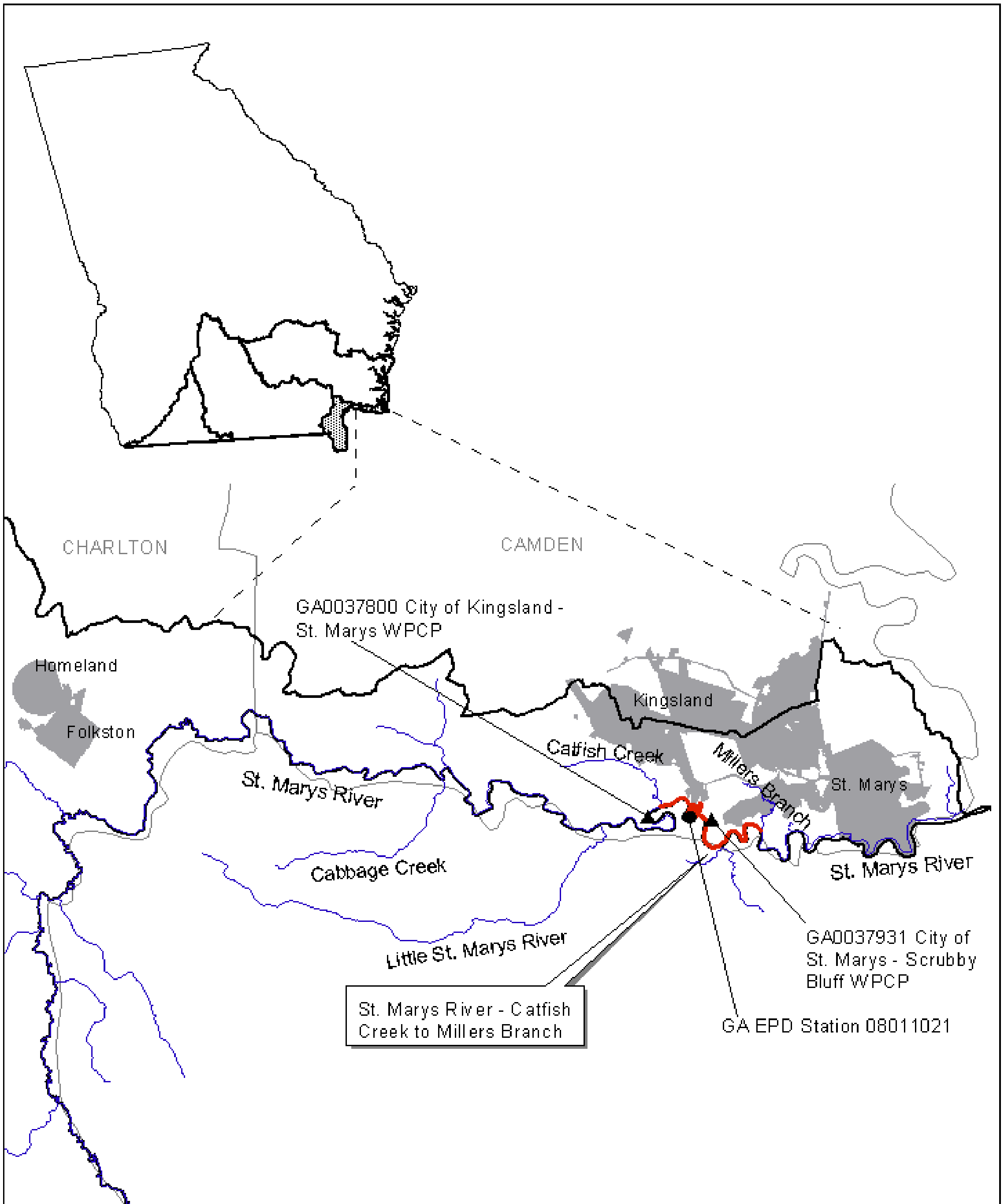
Stream Segment	Location	Segment Length (miles)	Designated Use	Listing
St. Marys River	Catfish Creek to Millers Branch (Camden Co.)	6	Fishing	NS

Note:
NS = Not Supporting designated use

1.2 Watershed Description

The St. Marys River basin is located in the southeastern part of Georgia, occupying an area of approximately 1,500 square miles with approximately 765 square miles of the basin in Georgia. The basin lies within the Coastal Plain physiographic province, which extends throughout the southeastern United States. The St. Marys River drains into the Atlantic Ocean. The St. Marys River Basin is comprised of one USGS Hydrologic Unit Code (HUC), 03070204. Figure 1 shows the location of the listed dissolved oxygen segment in the St. Marys River Basin.

The land use characteristics of the St. Marys River Basin watersheds were determined using data from the National Land Cover Dataset (NLCD) for Georgia. This coverage is based on Landsat Thematic Mapper digital images developed in 1995. The classification is based on a modified Anderson level one and two system. Table 2 lists the land cover distribution and associated percent land cover.



TMDL Evaluation - Dissolved Oxygen St. Marys River Basin	Figure 1. Impaired Stream Segment in HUC 03070204

Table 2. St. Marys River Basin Land Coverage

Stream/Segment	Land use Categories - Acres (Percent)												
	Open Water	Residential	High Intensity Commercial, Industrial, Transportation	Bare Rock, Sand, Clay	Quarries, Strip Mines, Gravel Pits	Transitional	Forest	Row Crops	Pasture, Hay	Other Grasses (Urban, recreational; e.g. parks, lawns)	Woody Wetlands	Emergent Herbaceous Wetlands	Total
St. Marys River Catfish Creek to Millers Branch	4,680 (0.8)	6,070 (1.0)	1,386 (0.2)	167 (0.0)	60 (0.0)	56,354 (9.4)	290,958 (48.5)	4,716 (0.8)	807 (0.1)	160 (0.1)	210,389 (35.1)	24,158 (4.0)	599,905 (100.0)

1.3 Regional Water Planning Councils

The 2008 Comprehensive State-wide Water Management Plan established Georgia's ten Regional Water Planning Councils (RWPCs). The boundaries of these ten RWPCs, in addition to the Metropolitan North Georgia Water Planning District or MNGWPD, established under a separate statute, are shown in Figure 2. In 2011, each RWPC developed and adopted Regional Water Plans, which identify ranges of actions or management practices to help meet the state's water quality challenges. Implementation of these plans is critical to meeting Georgia's water resource challenges. The specific regional plan(s) applicable to this TMDL are discussed in Sections 6 and 7.

1.4 Water Quality Standards

The Georgia water use classification for the listed stream segment in the St. Marys River Basin is Fishing. The criterion violated is listed as dissolved oxygen, and the potential cause listed is urban runoff. The use classification water quality standards for dissolved oxygen, as stated in Georgia's *Rules and Regulations for Water Quality Control* (GA EPD, 2004), Chapter 391-3-6-.03(6)(c)(i) are:

> A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

Certain waters of the State may have conditions where dissolved oxygen is naturally lower than the numeric criteria specified above and therefore cannot meet these standards unless naturally occurring loads are reduced or streams are artificially or mechanically aerated. This is addressed in Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(7) (GA EPD, 2004):

> *Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

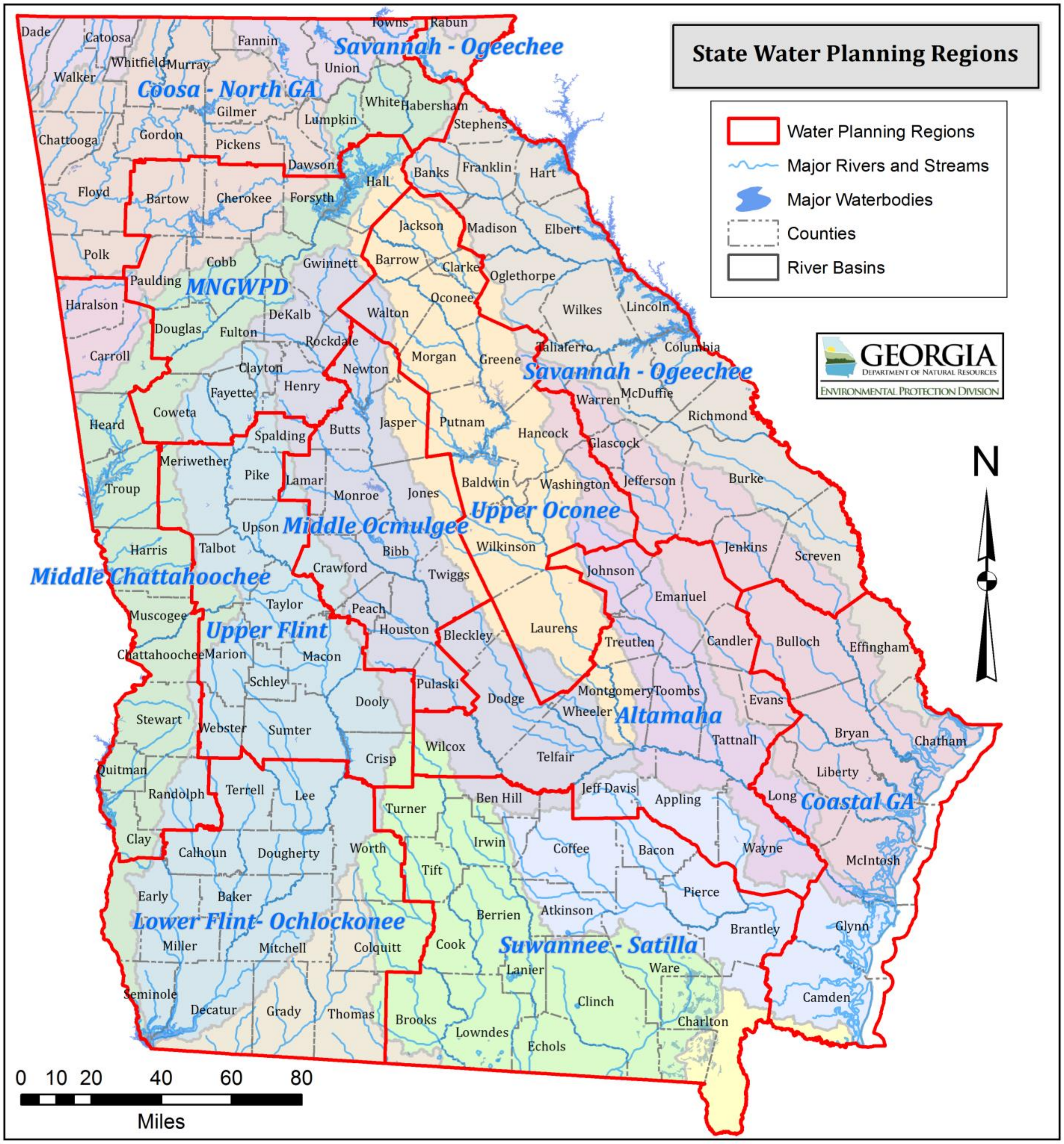


Figure 2. Boundaries of the Regional Water Planning Councils and the Metropolitan North Georgia Water Planning District

EPA dissolved oxygen criteria are used to address these situations. Alternative EPA limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions (USEPA, 1986).

> Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration.

Accordingly, if the naturally occurring DO exceeds GA EPD numeric limits at critical conditions, then the GA EPD numeric limits apply. If naturally occurring DO is lower than the GA EPD numeric limits, then 90% of the natural DO will become the minimum allowable DO, unless the natural DO is less than 3.3 mg/L, then a 0.1 mg/L deficit is allowed.

As the Saint Marys River is a shared waterbody, the Florida DO criteria shall also be applied. The Florida DO criteria (62-302.533) for predominately marine waters, or Class III Waters, is as follows:

> (2) Class II, Class III predominantly marine waters, and Class III-Limited predominantly marine waters.
>
> > (a) Minimum DO saturation levels shall be as follows:
> > 1. The daily average percent DO saturation shall not be below 42 percent saturation in more than 10 percent of the values;
> > 2. The seven-day average DO percent saturation shall not be below 51 percent more than once in any twelve week period; and
> > 3. The 30-day average DO percent saturation shall not be below 56 percent more than once per year.
> >
> > (b) To calculate a seven-day average DO percent saturation, there shall be a minimum of three full days of diel data collected within the seven-day period, or a minimum of ten grab samples collected over at least three days within that seven-day period, with each sample measured at least four hours apart.
> >
> > (c) To calculate a 30-day average DO percent saturation, there shall be a minimum of three full days of diel data with at least one day of data collected in three different weeks of the 30-day period, or grab samples collected from a minimum of ten different days of the 30-day period.
> >
> > (d) A full day of diel data shall consist of 24 hours of measurements collected at a regular time interval of no longer than one hour.
>
> (3) If it is determined that the natural background DO saturation in the waterbody (including values that are naturally low due to vertical stratification) is less than the applicable criteria stated above, the applicable criteria shall be 0.1 mg/l below the DO concentration associated with the natural background DO saturation level
>
> .

2.0 WATER QUALITY ASSESSMENT

Stream segments are placed on the 303(d) list as not supporting their water use classification based on water quality sampling data. Historically, a stream was placed on the partial support list if more than 10% of the samples exceed the dissolved oxygen criteria and on the not support list if more than 25% of the samples exceed the standard.

During 2003, the Georgia EPD collected water quality data at EPD Station 08011021 on the St. Marys River at Interstate 95 (Figure 1). Appendix A provides the water quality data for this station, and includes DO and temperature data. In general, these data show that low dissolved oxygen values usually occurred during the summer months. When the water temperatures are critical, DO levels in the St. Marys River at Interstate 95 are well below the Georgia Fishing DO criteria of a daily average of 5.0 mg/L, not less than 4.0 mg/L.

All field data relevant to the St. Marys River Basin were compiled by GA EPD and included in electronic database files. The data are managed using either the Water Resources Database (WRDB), a software database that was developed by GA EPD, or the EXCEL database management software.

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of the potential sources of pollutants. A source assessment characterizes the known and suspected sources of oxygen demanding substances in the watershed for development of the TMDL. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of pollutants on land surfaces that wash off as a result of storm events.

3.1 Point Source Assessment

Title IV of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) permit program. Basically, there are two categories of NPDES permits: 1) municipal and industrial wastewater treatment facilities, and 2) regulated storm water discharges.

3.1.1 Wastewater Treatment Facilities

In general, industrial and municipal wastewater treatment facilities have NPDES permits with effluent limits. These permit limits are either based on federal and state effluent guidelines (technology-based limits) or water quality standards (water quality-based limits).

The United States Environmental Protection Agency (USEPA) has developed technology-based guidelines, which establish a minimum standard of pollution control for municipal and industrial discharges without regard for the quality of the receiving waters. These are based on Best Practical Control Technology Currently Available (BPT), Best Conventional Control Technology (BCT), and Best Available Technology Economically Achievable (BAT). The level of control required by each facility depends on the type of discharge and the pollutant.

The USEPA and the States have also developed numeric and narrative water quality standards. Typically, these standards are based on the results of aquatic toxicity tests and/or human health criteria and include a margin of safety. Water quality-based effluent limits are set to protect the receiving stream. These limits are based on water quality standards that have been established for a stream based on its intended use and the prescribed biological and chemical conditions that must be met to sustain that use.

For purposes of this TMDL, NPDES permitted wastewater treatment facilities are considered point sources, and include municipal, industrial, private, and federal facilities. Wastewater treatment facility discharges may contribute oxygen-demanding substances to the receiving waters. There are two (2) NPDES permitted discharges with effluent limits for oxygen demanding substances identified in the St. Marys River Basin watershed upstream from or within the listed segment. One of these is classified as a major discharger, with a discharge of 1.0 million gallons per day (MGD) or more. Figure 1 provides the locations of NPDES discharges and Table 3 provides the permitted flows, as well as the 5-day Biochemical Oxygen Demand (BOD_5), ammonia (NH_3), and DO concentrations for the municipal treatment facilities.

Combined sewer systems convey a mixture of raw sewage and storm water in the same conveyance structure to the wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage and storm water

Table 3. NPDES Facilities in the St. Marys River Basin

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits			
			Average Monthly Flow (MGD)	Average Monthly BOD_5 (mg/L)	Average Monthly NH_3 (mg/L)	Minimum DO (mg/L)
St. Marys River Basin						
City of Kingsland – St. Marys WPCP	GA0037800	St. Marys River	4.4	30	10.0	5
City of St. Marys – Scrubby Bluff WPCP	GA0037931	Casey Creek, tributary to St. Marys River	0.5	20[1]	5.0[1]	5

Note: [1] Permit values for the months of May through October

exceed the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no permitted CSO outfalls in the St. Marys River Basin.

3.1.2 Regulated Storm Water Discharges

Some storm water runoff is covered under the NPDES Permit Program as a point source. It is considered a diffuse source of pollution. Unlike other NPDES permits that establish end-of-pipe pollutant limits, storm water NPDES permits establish controls that are intended to reduce the quantity of pollutants that storm water picks up and carries into storm sewer systems during rainfall events “to the maximum extent practicable” (MEP). Currently, regulated storm water discharges that may contain oxygen demanding substances consist of those associated with industrial activities and large and medium municipal separate storm sewer systems (MS4s), and small MS4s serving urbanized areas.

3.1.2.1 Industrial General Storm Water NPDES Permit

Storm water discharges associated with industrial activities are currently covered under Georgia’s General Industrial Storm Water NPDES Permit (GAR050000). This permit requires visual monitoring of storm water discharges, site inspections, implementation of Best Management Practices (BMPs), preparation of a Storm Water Pollution Prevention Plan (SWPPP), and annual reporting (EPD, 2014a). The Industrial General Permit (IGP) requires that storm water discharging into an impaired stream segment or within one linear mile upstream of, and within the same watershed as, any portion of an impaired stream segment identified as “not supporting” its designated use(s), must satisfy the requirements of Appendix C of the permit if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to storm water as a result of industrial activity at the site. If a facility is covered under Appendix C of the IGP, then benchmark monitoring for the pollutant(s) of concern is required. There are no industrial facilities covered by the general storm water permit that discharge oxygen demanding substances.

3.1.2.2 MS4 NPDES Permits

The collection, conveyance, and discharge of diffuse storm water to local water bodies by a public entity are regulated in Georgia by the NPDES MS4 permits. These MS4 permits have been issued under two phases. Phase I MS4 permits cover medium and large cities, and counties with populations over 100,000. Each individual Phase I MS4 permit requires the prohibition of non-storm water discharges (i.e., illicit discharges) into the storm sewer systems and controls to reduce the discharge of pollutants to the maximum extent practicable, including the use of management practices, control techniques and systems, as well as design and engineering methods (Federal Register, 1990). A site-specific Storm Water Management Plan (SWMP) outlining appropriate controls is required by and referenced in the permit. A program to monitor and control pollutants in storm water discharges from industrial facilities, construction sites, and highly visible pollutant sources that exist within the MS4 area must be implemented under the permit. Additionally, monitoring of not supporting streams, public education and involvement, post-construction storm water controls, low impact development, and annual reporting requirements must all be addressed by the permittee on an ongoing basis.

Small MS4s serving urbanized areas are required to obtain a storm water permit under the Phase II storm water regulations. An urbanized area is defined as an area with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Thirty (30) counties, fifty-six (56) communities, seven (7) Department of Defense facilities, and the Georgia Department of Transportation (GDOT) are permitted under the Phase II regulations in Georgia. All municipal Phase II permitees are authorized to discharge under Storm Water General Permit GAG610000. Department of Defense facilities are authorized to discharge under Storm Water General Permit GAG480000. GDOT owned or operated facilities are authorized to discharge under Storm Water General Permit GAG410000. Under these general permits, each permittee must design and implement a SWMP that incorporates BMPs that focus on public education and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction storm water management, and pollution prevention in municipal operations.

The land use types that are considered urbanized and include regulated storm sewer systems are 1) developed open space, 2) developed low intensity, 3) developed medium intensity, 4) developed high intensity, 5) utility swaths, and 6) golf courses. There are no counties or communities located in the St. Marys River Basin that are covered by the Phase I or Phase II General Storm Water Permit.

3.1.3 Concentrated Animal Feeding Operations

Under the Clean Water Act, Concentrated Animal Feeding Operations (CAFOs) are defined as point sources of pollution and are therefore subject to NPDES permit regulations. From 1999 through 2001, Georgia adopted rules for permitting swine and non-swine liquid manure animal feeding operations (AFOs). Georgia rules required medium size AFOs with more than 300 animal units (AU), but less than 1,000 AU, to apply for a non-discharge State land application system (LAS) waste disposal permit. Large operations with more than 1000 AU were required to apply for an NPDES permit (also non-discharge) as a CAFO. The USEPA CAFO regulations were successfully appealed in 2005. They were revised to comply with the court's decision that NPDES permits only be required for actual discharges. Georgia's rules were amended on August 7, 2012, to reflect the USEPA revisions. The revised state rules will continue LAS permitting of medium size liquid manure AFOs and extend LAS permitting to large liquid manure AFOs with more than 1,000 AU, unless they elect to obtain an NPDES permit. There are no known liquid manure CAFOs located in the vicinity of the listed segments in the St. Marys River Basin that have NPDES or land application permits.

In 2002, the USEPA promulgated expanded NPDES permit regulations for CAFOs that added dry manure poultry operations larger than 125,000 broilers or 82,000 layers. In accordance with the Georgia rule amendment discussed above, the general permit covering these facilities has been terminated and they are no longer covered under any permit. Georgia is consistently among the top three states in the U.S. in terms of poultry operations. The majority of poultry farms are dry manure operations where the manure is stored for a time and then land applied. Freshly stored litter can be a nonpoint source of oxygen demanding substances. However, land-applied litter that was previously stored for an extended length of time typically exhibits very low levels of oxygen demanding substances. There are no known dry manure poultry operations located in the vicinity of the listed segments in the St. Marys River Basin.

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a water body through a discrete conveyance at a single location. In urban areas, a large portion of the storm water contribution may enter waterways as point sources from MS4 NPDES permitted outfalls, or from industrial sites covered under the Georgia Industrial General Permit. The remainder of the storm water runoff will come from nonpoint sources. Typical nonpoint sources of oxygen demanding substances come from materials being washed into the rivers and streams during storm events. Constituents may wash off of land surfaces and either: 1) are flushed out of the system along with the water column flow; or 2) are settled out and become part of the stream channel bottom.

In this manner, historic wash off of settleable materials accumulates and exerts sediment oxygen demand (SOD). Constituents of concern from surface washoff include the fractions of ammonia and BOD_5 that become an integral part of channel bottom sediments, thus becoming a potential source of SOD. Table 2 provides the land cover distributions for the listed St. Marys River watershed. These data show that the watershed is predominately forested, with 48.5 percent forest land use. Woody wetlands is the next predominate land use, accounting for 35.1 percent of the watershed.

In addition to nonpoint sources of SOD associated with land disturbing activities, most of the streams in the St. Marys River Basin receive significant natural contributions of oxygen demanding organic materials from local wetlands and forested stream corridors. The following sources of naturally occurring organic materials have been identified:

- Adjacent wetlands, swamps, and marshes with organically rich bottom sediments; and
- Direct leaf litterfall onto water surfaces and adjacent floodplains from overhanging trees and vegetation.

Leaf litterfall is a major contributor to the amount of dissolved organic matter in the stream water column and the amount of SOD being exerted. Many streams in southern Georgia are also referred to as “blackwater” streams because of highly colored humic substances leached from surrounding marshes and swamps. In addition, low dissolved oxygen in blackwater streams is very common in the summer months when the temperatures are high and the flows are low (Meyer, 1992). The oxygen demanding effects of leaf litterfall are reflected in two ways: 1) by lowering the DO saturation of water entering the channel from adjacent swampy areas caused by decaying vegetation; and 2) by increasing SOD associated with vegetation decaying on stream channel bottoms.

3.2.1 Land Application Systems

Some communities and industries use land application systems (LAS) for wastewater disposal. These facilities are required through LAS permits to dispose of their treated wastewater by land application, and to operate as non-discharging systems that do not contribute wastewater effluent runoff to surface waters. However, sometimes the soil’s percolation rate is exceeded when applying the wastewater, or encountering excess precipitation, resulting in runoff. This runoff could contribute oxygen demanding substances to nearby surface waters. Runoff of stormwater might also carry surface residual containing oxygen demanding substances. There is one permitted LAS system located in the St. Marys River Basin at the U.S. Navy Base at Kings Bay in Camden County. This facility has a permitted flow of 1.5 MGD.

4.0 TECHNICAL APPROACH

An important component of TMDL development is to establish relationships between source loadings and in-stream water quality. In this section, the mathematical modeling techniques used to develop the TMDL are discussed. The first step of the technical approach is to select the appropriate model that can effectively be used to analyze the St. Marys River DO resources. After the appropriate model is selected, data is gathered to develop and calibrate the model. The calibrated model is then used to establish the TMDL during critical conditions. The modeling approach is described in the following sections.

4.1 Model Selection and Structure

Various analyses were performed to correlate the measured low DO concentrations to basic causes such as point and nonpoint contributions, flow conditions, stream and watershed characteristics, seasonal temperature effects, and others. From these analyses, the low DO values were found to coincide with high temperatures. Inflows of very low DO waters from adjacent marshes compounded the situation. Based on the geographic, hydrologic, and water quality characteristics of the St. Marys River, and considering that it is tidally influenced, Georgia Estuary was selected as the appropriate model for the listed stream segment.

USGS quadrangle maps and navigational maps, along with Arcview and MapInfo spatial graphics files, were used to develop drainage areas, stream lengths, bed slopes, segment geometry, and other physical input data for each model. Appendix B provides a summary of the model structure.

4.1.1 Georgia Estuary

Georgia Estuary is a one-dimensional water quality model developed by GA EPD. This model may be used for saline estuaries, as well as non-saline tidal rivers where both freshwater flow and tidal mixing are significant mechanisms in the transport of wastes in the water. Georgia Estuary is a steady state tidally averaged water quality model. The concentrations in the estuary vary spatially, but are assumed to be constant in time. Because an estuary has cyclical tidal variations that effect depth, cross-sectional area, and volume, an average mean water model is developed that is the average of the high water and low water slack tides.

In Georgia estuaries, the natural DO can drop below the freshwater standard of 5.0 mg/L. The Coastal DO Criteria for fishing use classification is given in Table 4.

Table 4. Coastal DO Criteria for Fishing Use Classification

If the natural DO is		The Maximum Allowable DO Deficit (mg/L)
Greater than or equal to (mg/L)	But less than (mg/L)	
2.0	3.0	0.1
3.0	3.3	Never less than 3.0 mg/L
3.3	4.0	0.3
4.0	5.0	0.4
5.0	5.5	0.5
5.5	---	Never less than 5.0 mg/L

Georgia Estuary models are tidally averaged and cannot accept model segments lateral to the main channel. One Estuary model was developed to represent the tidally influenced listed segment of the St. Marys River from Catfish Creek to Millers Branch.

4.2 Model Calibration

The model calibration period was determined from an examination of the GA EPD 2003 water quality data for the listed segment. The data examined included streamflow, DO, and water temperature. The combination of the lowest DO and highest water temperature defined the critical modeling period.

For the listed segment, June 2003 was found to be the critical period. The calibration models were run to simulate an average DO from this period. The average summer DO was 3.2 mg/L (ranging from 2.9 mg/L to 3.7 mg/L) at an average summer temperature of 28 ^{o}C (ranging from 27.3 ^{o}C to 28.5 ^{o}C). Headwater and tributary water quality boundaries were developed from these instream field data, expected low DO saturation values (Meyer, 1992), and GA EPD standard modeling practices (GA EPD, 1978).

Average monthly discharge flows, BOD_5, NH_3, and DO concentrations for the discharges were obtained from June 2003 Discharge Monitoring Reports (DMRs). These data were input into the calibration model. BOD_5 was converted to $CBOD_U$ by multiplying by an f-ratio of 2, if the BOD_5 is greater than 20 mg/L, and an f-ratio of 3, if the BOD_5 is 20 mg/L or less (GA EPD, 1978). Ammonia was converted to $NBOD_U$ by multiplying by 4.57. Table 5 provides a summary of the actual discharges from these facilities for June 2003.

Table 5. Summary of NPDES Discharges during 2003

Facility Name	NPDES Permit No.	Actual Discharge for June 2003			
		Flow (MGD)	BOD_5 (mg/L)	NH_3 (mg/L)	DO (mg/L)
City of Kingsland - St. Marys WPCP	GA0037800	1.75	10	16.9	5.44
City of St. Marys - Scrubby Bluff WPCP*	GA0037931	0	N/A	N/A	N/A

* The City of St. Marys - Scrubby Bluff WPCP facility, although permitted to discharge to Casey Creek, has not yet gone online in 2003.

In shallow streams, SOD is an important part of the oxygen budget. However, there are no field SOD measurements in the St. Marys River Basin. In the South 4 Basins, there are several SOD measurements that ranged from 0.9 to 1.9 g/m^2/day. An examination of South 4 SOD results was performed to develop realistic SOD values that could be applied to the St. Marys Estuary model. An SOD value of 0.95 g/m^2/day was adopted for the St. Marys River model.

The kinetic rates and input parameters developed during model calibration are provided in Table 6. These parameters include the carbonaceous BOD (CBOD) decay rate, nitrogenous BOD (NBOD) decay rate, SOD rate, and the Tsivoglou reaeration coefficient used to determine stream reaeration. In addition, GA Estuary requires a dispersion coefficient.

Table 6. Modeling Parameters

Parameter	GA Estuary Values
CBOD Decay Rate (1/day)	0.08
NBOD Decay Rate (1/day)	0.1
SOD (g/m^2/day)	0.95
Reaeration Coefficient	0.16-0.19
Dispersion Coefficient (mi^2/day)	18

The St. Marys River Estuary model was calibrated at Interstate 95, where GA EPD collected discrete water quality data during 2003. Appendix C provides the DO calibration curves plotted with the data from monitoring stations in the listed segments.

4.3 Critical Conditions Model

Steady-state models are applied for "critical" environmental conditions that represent extremely low assimilative capacity. Critical environmental conditions correspond to drought flows. The assumption behind steady-state modeling is that point and nonpoint source discharge concentrations that protect water quality during low-flow critical conditions will be protective for the large majority of environmental conditions that occur.

The critical conditions model was used to assess the dissolved oxygen standard and to determine if problems exist that require regulatory intervention. Model critical conditions were developed in accordance with GA EPD standard practices (GA EPD, 1978). Critical water temperatures were determined by examining historic water quality data. The highest summer-time temperature was used to represent each of the listed segments.

Point sources were incorporated into the critical conditions model at their current NPDES permit limits. Although the City of St. Marys – Scrubby Bluff WPCP facility has not begun discharging to Casey Creek under their existing NPDES permit, their permitted limits were used in the critical conditions model. Water quality boundaries, the SOD rate, and all other modeling rates and constants were the same as those in the calibrated model.

4.4.1 Natural Conditions Model

For the natural conditions models, all point source discharges were completely removed from the critical conditions model. All other model parameters remained the same. This model was used to determine the natural dissolved oxygen concentrations during critical conditions. This model predicted the natural dissolved oxygen concentrations, during the critical summer months, to be less than 5.0 mg/L. Results of the natural condition runs are plotted in the graphs in Appendix C along with the calibration, critical conditions and TMDL results for comparison. The model results indicate that the natural background DO saturation in the waterbody are less than the applicable Florida criteria, and therefore the applicable criteria shall be 0.1 mg/l below the DO concentration associated with the natural background DO saturation level.

5.0 TOTAL MAXIMUM DAILY LOAD

A Total Maximum Daily Load (TMDL) is the amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard. The TMDLs for DO in the St. Marys River Basin are based on the coastal DO criteria. A TMDL is the sum of the individual waste load allocations (WLAs) from point sources and load allocations (LAs) from nonpoint sources, as well as the natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For oxygen demanding substances, the TMDL is expressed in lbs/day.

A TMDL can be expressed as follows:

$$\text{TMDL} = \Sigma\text{WLAs} + \Sigma\text{LAs} + \text{MOS}$$

The TMDL calculates the WLAs and LAs with margins of safety to meet the stream's water quality standards. The allocations are based on estimates that use the best available data and provide the basis to establish or modify existing controls so that water quality standards can be achieved. In developing a TMDL, it is important to consider whether adequate data exists to identify the sources, fate, and transport of the pollutant to be controlled.

TMDLs may be developed using a phased approach. Under a phased approach, the TMDL includes: 1) WLAs that confirm existing limits and controls or lead to new limits, and 2) LAs that confirm existing controls or include implementing new controls (USEPA, 1991). A phased TMDL requires that additional data be collected to determine if load reductions required by the TMDL lead to the attainment of water quality standards.

The TMDL Implementation Plan establish a schedule or timetable for the installation and evaluation of point and nonpoint source control measures, data collection, assessment of water quality standard attainment, and if needed, additional modeling. Future monitoring of the listed segments' water quality will then be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads.

5.1 Waste Load Allocations

5.1.1 Wastewater Treatment Facilities

The waste load allocation (WLA) is the portion of the receiving water's loading capacity that is allocated to existing or future point sources represented by municipal and industrial wastewater treatment systems that have NPDES effluent limits. There are two NPDES permitted facilities in the St. Marys River watershed that effect instream dissolved oxygen. Waste load allocations are provided to the point sources from these municipal wastewater treatment systems.

The Georgia ESTUARY critical conditions model was used to determine the WLAs for the discharges upstream from or within the listed segments in order to meet the DO standards. Allocations are based on EPA Dissolved Oxygen Criteria, which states that if the natural dissolved oxygen is less than the standard, then only a 10 percent reduction in the natural condition is allowed. The target limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions and is also the TMDL target, unless the natural DO is less than 3.3 mg/L then a 0.1 mg/L deficit is allowed.

Table 7 lists the allowable WLAs to meet the target coastal DO criteria. This TMDL requires no reductions in the wasteload allocations. In fact, the ESTUARY model indicates that there is additional assimilative capacity in the St. Marys River segment. The additional assimilative capacity was determined by modeling additional loads at various locations until all available assimilative capacity was used up. Appendix D has the results of the following GA EST model runs: natural, 2006 St Marys DO TMDL WLAs, and the revised 2017 St Marys DO TMDL allocation with the future growth at various locations. Depending on the location of the future WLA, the available load can range for 10,750-14,800 lbs/day of Ultimate Oxygen Demand (UOD). This additional capacity can be used for future growth. The BOD_5 was converted to Ultimate Carbonaceous Biochemical Oxygen Demand ($CBOD_U$) by multiplying by an f-ratio of 3.0 (standard GA EPD modeling practice) and ammonia was converted to Ultimate Nitrogenous Biochemical Oxygen Demand ($NBOD_U$) by multiplying by the stoichiometric conversion factor of 4.57. It should be noted that the SOD rates used in the TMDL allocation models were based on model predictions and may need to be verified before WLAs are implemented.

Table 7. St. Marys River Basin WLAs

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits				Ultimate Oxygen Demand (lbs/day)
			Average Monthly Flow (MGD)	Average Monthly BOD_5 (mg/L)	Average Monthly NH_3 (mg/L)	Minimum DO (mg/L)	
St. Mary's River Basin							
City of Kingland – St. Marys WPCP	GA0037800	St. Marys River	4.4	30	10	5	4,980
City of St. Marys - Scrubby Bluff WPCP*	GA0037931	Casey Creek	0.5	20[1]	5.0[1]	5	345
Future Growth Allowance	--	St. Marys River	--	--	--	--	10,750-14,800[2]

Note: 1 Permit values for the months of May through October.
2 Range is the due to variations in the location of where the future source will be allocated

5.1.2 Regulated Storm Water Discharges

State and federal Rules define storm water discharges covered by NPDES permits as point sources. However, storm water discharges are from diffuse sources and there are multiple storm water outfalls. Storm water sources (point and nonpoint) are different than traditional NPDES permitted sources in four respects: 1) they do not produce a continuous (pollutant loading) discharge; 2) their pollutant loading depends on the intensity, duration, and frequency of rainfall events, over which the permittee has no control; 3) the activities contributing to the pollutant loading may include various allowable activities of others, and control of these activities is not solely within the discretion of the permittee; and 4) they do not have wastewater treatment plants that control specific pollutants to meet numerical limits.

The intent of storm water NPDES permits is not to treat the water after collection, but to reduce the exposure of storm water to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to try to control pollutant discharges from each storm water outfall. Therefore, storm water NPDES permits require the establishment of controls or BMPs to reduce pollutants from entering the environment.

The Georgia ESTUARY model was run under critical conditions, assuming mid-tide dry weather conditions. Because the critical conditions occur when there are no storm events, no numeric allocation is given to the waste load allocations from storm water discharges associated with MS4s (WLAsw).

5.2 Load Allocations

The load allocation (LA) is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Nonpoint sources are identified in 40 CFR 130.6 as follows:

- Residual waste
- Land disposal
- Agricultural and silivicultural
- Mines
- Construction
- Saltwater intrusion
- Urban storm water (non-permitted)

The nonpoint source loads for the existing LA and TMDL were computed from the model boundary conditions, which include the stream, tributary, and headwater model boundaries under critical conditions. The partitioning of allocations between point (WLA) and nonpoint (LA) sources shown in Table 8 is based on modeling results and professional judgment.

Table 8. TMDL Loads for the St. Marys River Basin under Critical Conditions

Stream Segment	WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL (lbs/day)	% Reduction
St. Marys River – Catfish Creek to Millers Branch	16,075 - 20,125	NA	2,685	18,760 – 22,870*	0

Note: TMDL expressed as Ultimate Oxygen Demand (UOD), which includes the Carbonaceous Biochemical Oxygen Demand (CBOD) and the Nitrogenous Biochemical Oxygen Demand (NBOD).
* Range is the due to variations in the location of where the future source will be allocated
NA = no storm water discharges associated with MS4s contributing to the listed segment during critical conditions

5.2 Seasonal Variation

The mid-tide, high temperature critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions and to provide year-round protection of water quality. This TMDL is expressed as a total load during the critical low flow period.

5.3 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the margin of safety must account for any lack of knowledge concerning the relationship between effluent limitations and water quality. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

For this TMDL, the MOS was implicitly incorporated in the use of the following conservative modeling assumptions:

- Mid-tide conditions;
- High summer temperatures;
- Conservative reaction rates; and
- The assumption that all point sources continuously discharge at their NPDES permit limits for the same critical period.

6.0 RECOMMENDATIONS

The TMDL process consists of an evaluation of the sub-watersheds for each 303(d) listed stream segment to identify, as best as possible, the sources of oxygen demanding substances causing the stream to exceed instream DO standards. The TMDL analysis was performed using the best available data to specify WLAs and LAs that will meet the coast DO criteria so as to support the use classification specified for the listed segment.

This TMDL represents part of a long-term process to reduce loading of oxygen demanding substances to meet water quality standards in the St. Marys River Basin. Implementation strategies will be reviewed and the TMDLs will be refined as necessary. The phased approach will support progress toward water quality standards attainment in the future. In accordance with USEPA TMDL guidance, these TMDLs may be revised based on the results of future monitoring and source characterization data efforts. The following recommendations emphasize further source identification and involve the collection of data to support the current allocations and subsequent source reductions.

6.1 Monitoring

Water quality monitoring is conducted at a number of locations across the State each year. Based on monitoring conducted by USGS and GA EPD in the St. Marys, it appears that this segment is listed as assessment pending. EPD needs to determine the natural DO for the area before it can determine whether the DO criteria is being met. Therefore, it is recommended that sampling be continued to monitor DO concentrations. If exceedances of the DO criteria are measured, then the sources should be determined and corrective actions may be needed. In the case where a watershed based plan has been developed for a listed stream segment, an appropriate water quality monitoring program will be outlined. The monitoring program will be developed to help identify the various sources of oxygen demanding substances. The monitoring program may be used to verify the 305(b)/303(d) stream segment listings. This will be especially valuable for those segments where limited data resulted in the listing.

6.2 Reasonable Assurance

An allocation to a point source discharger does not automatically result in a permit limit or a monitoring requirement. Through its NPDES permitting process, GA EPD will determine whether the permitted dischargers to the listed watersheds have a reasonable potential of discharging oxygen demanding substances levels equal to or greater than the allocated load. The results of this reasonable potential analysis will determine the specific type of requirements in an individual facility's NPDES permit. As part of its analysis, the GA EPD will use its EPA-approved 2001 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary.

If effluent limitations are determined to be necessary for any or all of these facilities, they should be established in accordance with *Georgia Rules and Regulations for Water Quality Control*, Section 391-3-6-.06(4)(d)5.(ii)(b)(2). This regulation establishes that to protect against chronic effects, an effluent limitation should be imposed as a monthly average limit. To protect against acute effects, an effluent limitation should be imposed as a daily maximum limit. Additionally, if effluent limitations or monitoring requirements are determined through a reasonable potential analysis to be necessary for any or all of these facilities, it is recommended that concentration limits or concentration monitoring requirements should be imposed in addition to any loading limits or monitoring requirements.

All industrial sites that have a storm water discharge associated with their primary industrial activity are required to submit a Notice of Intent under the NPDES General Industrial Permit for Storm Water. This authorizes them to discharge storm water in accordance with the conditions and monitoring requirements established in the Industrial General Permit. Storm water from industrial sites that discharge within one linear mile of a 303(d) listed stream that might potentially contain the listed constituent must be monitored to determine that benchmarks levels are met.

EPD is working with local governments to foster the implementation of BMPs to address nonpoint sources. In addition, public education efforts will be targeted to individual stakeholders to provide information regarding the use of BMPs to protect water quality.

6.3 Public Participation

A thirty-day public notice was provided for these TMDLs. During this time, the availability of these TMDLs was public noticed, a copy of the TMDLs was provided as requested, and the public was invited to provide comments on the TMDLs.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

7.1 Initial TMDL Implementation Plan

This plan identifies applicable state-wide programs and activities that may be employed to manage point and nonpoint sources of oxygen demanding substances for the impaired stream segments in the St. Marys River Basin. Local watershed planning and management initiatives will be fostered, supported, or developed through a variety of mechanisms. Implementation may be addressed by watershed improvement projects, assessments for Section 319 (h) grants, the local development of watershed protection plans, or "Targeted Outreach" initiated by EPD. These initiatives will supplement or possibly replace this initial implementation plan. Implementation actions should also be guided by the recommended management practices and actions contained within each applicable Regional Water Plan developed as part of Georgia's Comprehensive State-wide Water Management Plan implementation (Georgia Water Council, 2008).

7.2 Impaired Segments

This initial plan is applicable to the DO impaired stream segments in the St. Marys River Basin, which were added to Georgia's 2004 303(d) list, which is available on EPD's website (www.gaepd.org). Table 1 presents the stream in the St. Marys River Basin that was included on the 2004 303(d) list for exceedance of the DO criteria

Table 1. Waterbody Listed For Dissolved Oxygen in the St. Marys River Basin

Stream Segment	Location	Segment Length (miles)	Designated Use	Listing
St. Marys River	Catfish Creek to Millers Branch (Camden Co.)	6	Fishing	NS

Note: NS = Not Supporting designated use

The criterion violated is listed as dissolved oxygen, and the potential cause listed is urban runoff. The use classification water quality standards for dissolved oxygen, as stated in Georgia's *Rules and Regulations for Water Quality Control* (GA EPD, 2004), Chapter 391-3-6-.03(6)(c)(i) are:

> A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

Certain waters of the State may have conditions where dissolved oxygen is naturally lower than the numeric criteria specified above and therefore cannot meet these standards unless naturally occurring loads are reduced or streams are artificially or mechanically aerated. This is addressed in Georgia's *Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(7) (GA EPD, 2004):

> *Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best

> Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.

EPA dissolved oxygen criteria are used to address these situations. Alternative EPA limits are defined as 90 percent of the naturally occurring dissolved oxygen concentration at critical conditions (USEPA, 1986).

> Where natural conditions alone create dissolved oxygen concentrations less than 110 percent of the applicable criteria means or minima or both, the minimum acceptable concentration is 90 percent of the natural concentration.

Accordingly, if the naturally occurring DO exceeds GA EPD numeric limits at critical conditions, then the GA EPD numeric limits apply. If naturally occurring DO is lower than the GA EPD numeric limits, then 90% of the natural DO will become the minimum allowable DO, unless the natural DO is less than 3.3 mg/L, then a 0.1 mg/L deficit is allowed.

As the Saint Marys River is a shared waterbody, the Florida DO criteria shall also be applied. The Florida DO criteria (62-302.533) for predominately marine waters, or Class III Waters, is as follows:

> (2) Class II, Class III predominantly marine waters, and Class III-Limited predominantly marine waters.
>
> > (a) Minimum DO saturation levels shall be as follows:
> > 1. The daily average percent DO saturation shall not be below 42 percent saturation in more than 10 percent of the values;
> > 2. The seven-day average DO percent saturation shall not be below 51 percent more than once in any twelve week period; and
> > 3. The 30-day average DO percent saturation shall not be below 56 percent more than once per year.
> >
> > (b) To calculate a seven-day average DO percent saturation, there shall be a minimum of three full days of diel data collected within the seven-day period, or a minimum of ten grab samples collected over at least three days within that seven-day period, with each sample measured at least four hours apart.
> >
> > (c) To calculate a 30-day average DO percent saturation, there shall be a minimum of three full days of diel data with at least one day of data collected in three different weeks of the 30-day period, or grab samples collected from a minimum of ten different days of the 30-day period.
> >
> > (d) A full day of diel data shall consist of 24 hours of measurements collected at a regular time interval of no longer than one hour.
>
> (3) If it is determined that the natural background DO saturation in the waterbody (including values that are naturally low due to vertical stratification) is less than the applicable criteria stated above, the applicable criteria shall be 0.1 mg/l below the DO concentration associated with the natural background DO saturation level. If for any reason the GA EPD Contractor does not complete one or more elements of a Revised

TMDL Implementation Plan, GA EPD will be responsible for getting that (those) element(s) completed, either directly or through another contractor.

7.3 Potential Sources

An important part of the TMDL analysis is the identification of potential source categories. A source assessment characterizes the known and suspected sources for oxygen demanding substances in the watershed. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point sources of oxygen demanding substances may include discharges from wastewater treatment facilities and storm water discharges through permitted storm water systems. Nonpoint sources of these substances are diffuse and cannot be identified as entering the water body at a single location. These sources generally involve land use activities that contribute the oxygen demanding substance being discharged to streams during rainfall events. However, other potential nonpoint sources exist such as direct deposition of particulates from CAFOs, LAS, and seepage of contaminated groundwater.

7.4 Management Practices and Activities

The NPDES permit program provides a basis for municipal, industrial, and storm water permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations. In accordance with EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times.

EPD is responsible for administering and enforcing laws to protect the waters of the state and is the lead agency for implementing the state's Nonpoint Source Management Program. Georgia is working with federal, county, and local governments, and other state and county agencies to foster implementation of BMPs that address nonpoint source pollution. The following management practices are recommended to reduce oxygen demanding substances to the impaired stream segments:

- Sustain compliance with the Industrial General Storm Water Permit requirements. Require that outfall discharges from industrial NPDES permitted wastewater treatment facilities be characterized to confirm the presence of oxygen demanding substances, and to determine if limits should be included as part of the permit in the future.

- Implementation of recommended Water Quality management practices in the *Coastal Regional Water Plan* (2011);

- Ensure that storm water management plans are in place and being implemented by the local governments, and by the industrial facilities located in the watershed. These Plans are designed to control storm water runoff and to identify and implement BMPs to reduce the discharge of pollutants associated with storm water;

- EPD should continue working with federal, state, and local agencies and owners of sites where oxygen demanding substances can be released, and in developing control measures to prevent future releases of oxygen demanding substances into waterbodies.

- Further develop and streamline mechanisms for reporting and correcting illicit discharges, breaks, surcharges, and general sanitary sewer system problems;
- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;
- Adoption of local ordinances (i.e. septic tanks, storm water, etc.) that address local water quality;
- Continue efforts to increase public awareness and education towards the impact of human activities in urban settings on water quality, ranging from the consequences of industrial and municipal discharges to the activities of individuals in residential neighborhoods.

Public education efforts target individual stakeholders to provide information regarding the use of BMPs to protect water quality. EPD will continue efforts to increase awareness and educate the public about the impact of human activities on water quality.

7.5 Monitoring

EPD encourages local governments and municipalities to develop instream water quality monitoring programs. These programs can help pinpoint various pollutant sources, as well as verify the 303(d) stream segment listings. EPD recommends that monitoring of DO be continued for the St. Marys River to determine if implementation of BMPs results in the improvement of water quality over time. EPD is available to assist in completing a monitoring plan, preparing a Sampling Quality Assurance Plan (SQAP), and/or providing necessary training as needed.

7.6 Future Action

This Initial TMDL Implementation Plan includes a general approach to pollutant source identification, as well as management practices to address pollutants. In the future, EPD will continue to determine and assess the appropriate point and non-point source management measures needed to achieve the TMDLs and also to protect and restore water quality in impaired water bodies.

For point sources, any future waste load allocations for wastewater treatment plant facilities will be implemented in the form of water-quality based effluent limitations in NPDES permits. Any wasteload allocations for regulated storm water will be implemented in the form of BMPs in the NPDES permits. Contributions of oxygen demanding substances from regulated communities may also be managed using permit requirements such as watershed assessments, watershed protection plans, and long term monitoring. These measures will be directed through current point source management programs.

EPD will work to support watershed improvement projects that address non-point source pollution. This is a process whereby EPD and/or Regional Commissions or other agencies or local governments, under a contract with EPD, will develop a Watershed Management Plan intended to address water quality at the small watershed level (HUC 10 or smaller). These plans will be developed as resources and willing partners become available. The development of these plans may be funded via several grant sources, including but not limited to, Clean Water Act Section 319(h), Section 604(b), and/or Section 106 grant funds. These plans are intended for implementation upon completion.

Any Watershed Management Plan that specifically addresses water bodies contained within this TMDL will supersede the Initial TMDL Implementation Plan once EPD accepts the plan. Future Watershed Management Plans intended to address this TMDL and other water quality concerns, written by EPD and for which EPD and/or the EPD Contractor are responsible, will contain at a minimum the USEPA's 9 Elements of Watershed Planning:

1) An identification of the sources or groups of similar sources contributing to nonpoint source pollution to be controlled to implement load allocations or achieve water quality standards. Sources should be identified at the subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers industrial sites needing upgrading, Y acres of contaminated soils needing remediation, or Z linear miles of eroded stream bank needing restoration);

2) An estimate of the load reductions expected for the management measures;

3) A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards;

4) An estimate of the sources of funding needed, and/or authorities that will be relied upon, to implement the plan;

5) An information/education component that will be used to enhance public understanding of and participation in implementing the plan;

6) A schedule for implementing the management measures that is reasonably expeditious;

7) A description of interim, measurable milestones (e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;

8) A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

9) A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item 8.

The public will be provided an opportunity to participate in the development of Watershed Management Plans that address impaired waters and to comment on them before they are finalized.

EPD will continue to offer technical and financial assistance (when and where available) to complete Watershed Management Plans that address the impaired water bodies listed in this and other TMDL documents. Assistance may include but will not be limited to:

- Assessments of pollutant sources within watersheds;
- Determinations of appropriate management practices to address impairments;
- Identification of potential stakeholders and other partners;
- Developing a plan for outreach to the general public and other groups;
- Assessing the resources needed to implement the plan upon completion; and

- Other needs determined by the lead organization responsible for plan development.

EPD will also make this same assistance available, if needed, to proactively address water quality concerns. This assistance may be in the way of financial, technical, or other aid and may be requested and provided outside of the TMDL process or schedule.

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APPENDIX A

Water Quality Data

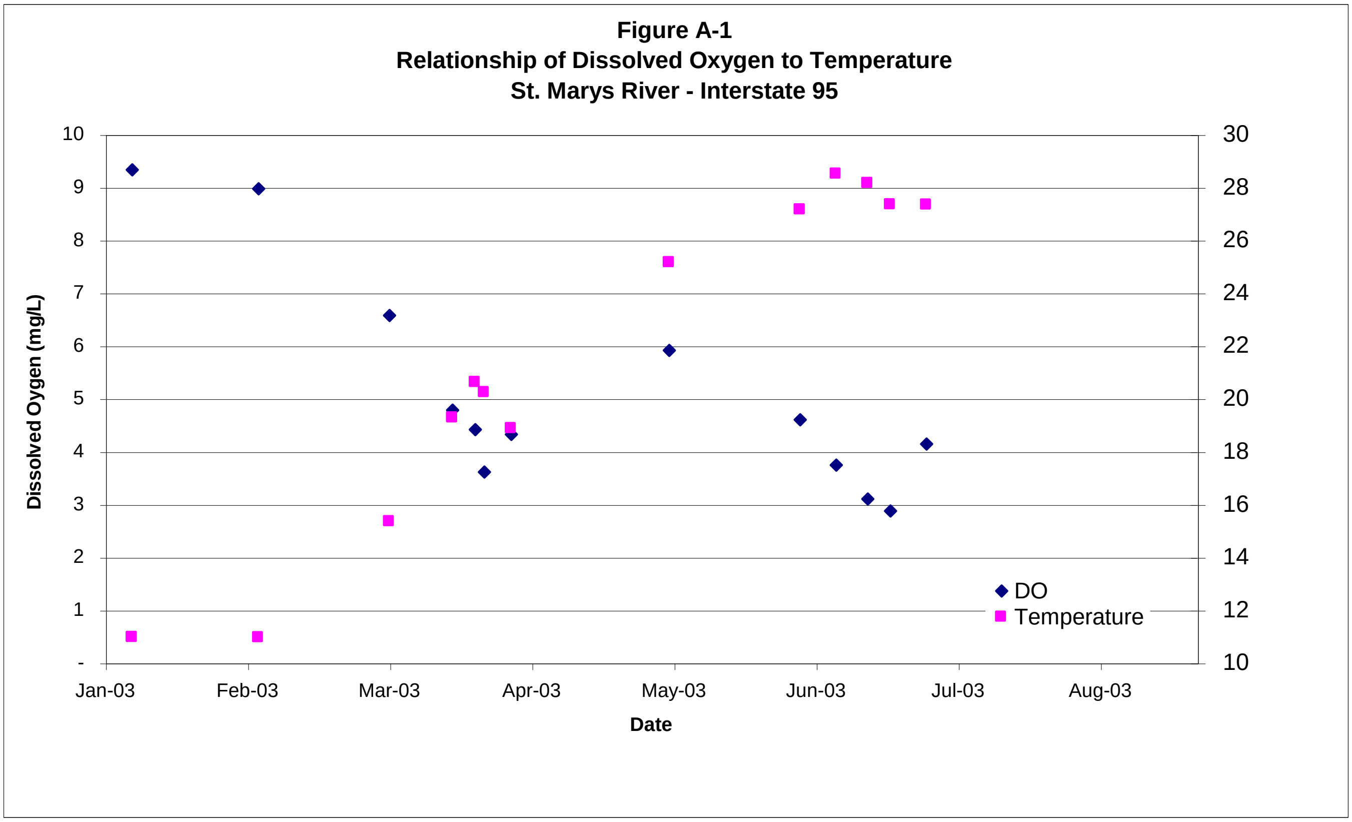


Table A-1. Data for Figure A-1

Date	Dissolved Oxygen (mg/L)	Water Temperature (deg C)
07-Jan-03	9.33	10.96
04-Feb-03	8.97	10.95
05-Mar-03	6.57	15.34
19-Mar-03	4.78	19.27
24-Mar-03	4.41	20.61
26-Mar-03	3.61	20.23
01-Apr-03	4.32	18.86
06-May-03	5.91	25.14
04-Jun-03	4.60	27.14
12-Jun-03	3.74	28.50
19-Jun-03	3.10	28.14
24-Jun-03	2.87	27.33
02-Jul-03	4.14	27.32

APPENDIX B

Model Structure

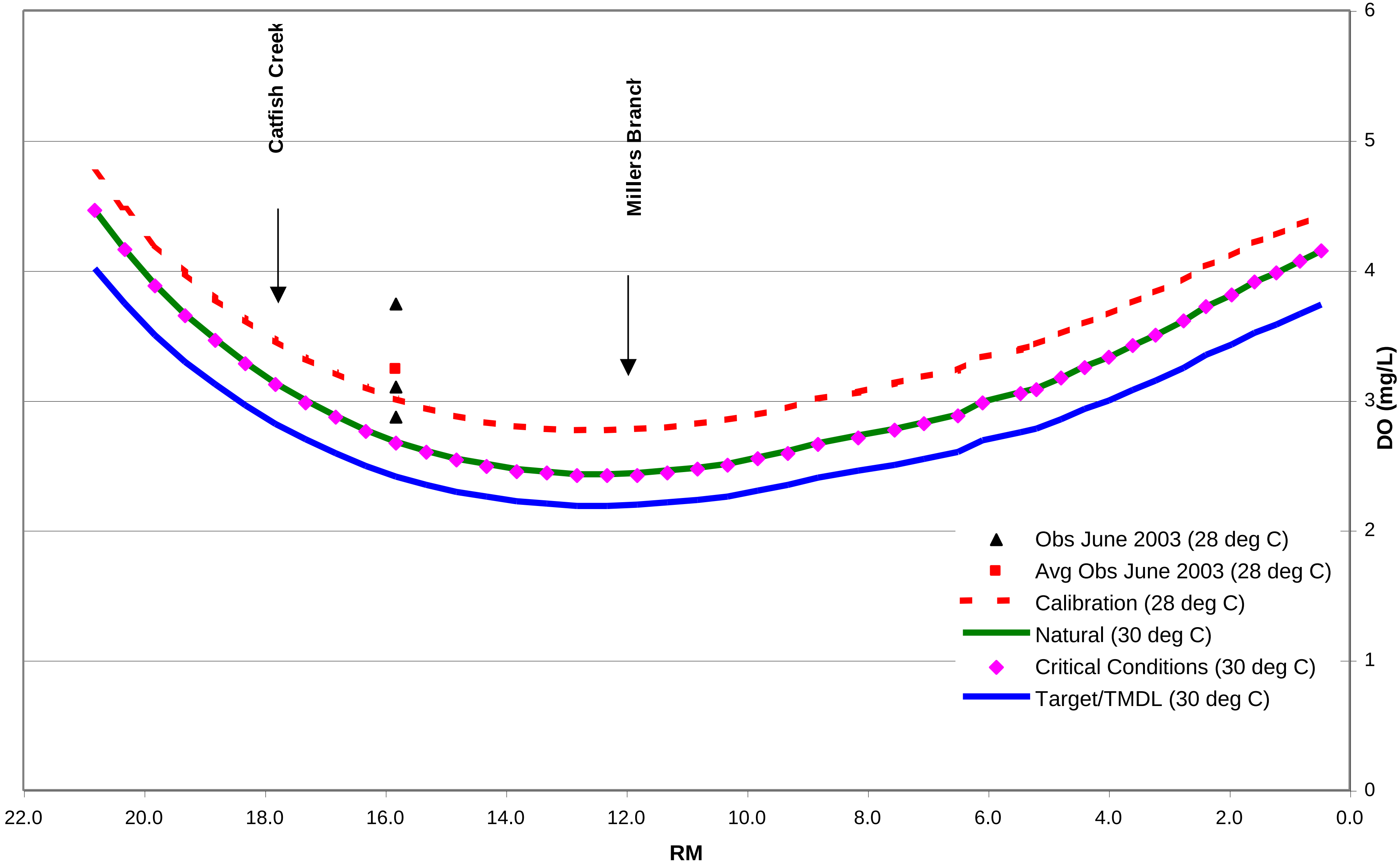
Table B-1. St. Marys River Estuary Model Structure

Segment	Segment Name	Reach Length (feet)	Volume (million gallons)	Depth (ft)
1	USGS 02231253 at RM 21.1	2640	177.8	15.0
2	St. Marys at RM 20.5	2640	177.8	15.0
3	St. Marys at RM 20.0	2640	177.8	15.0
4	St. Marys at RM 19.5	2640	192.6	15.0
5	St. Marys at RM 19.0	2640	207.4	15.0
6	St. Marys at Kingsland WPCP outfall	2640	213.3	16.0
7	St. Marys above Catfish Creek RM 18	2640	205.4	16.0
8	St. Marys at RM 17.5	2640	213.3	16.0
9	St. Marys at RM 17.0	2640	221.2	16.0
10	St. Marys at RM 16.5	2640	213.3	16.0
11	St. Marys at I-95 RM 16.0	2640	218.2	17.0
12	St. Marys above Casey Creek RM 15.5	2640	226.6	17.0
13	St. Marys at RM 15.0	2640	235.0	17.0
14	St. Marys above Sister Cks RM 14.5	2640	235.0	17.0
15	St. Marys at RM 14.0	2640	235.0	17.0
16	St. Marys at RM 13.5	2640	311.1	17.5
17	St. Marys at RM 13.0	2640	380.2	17.5
18	St. Marys above Millers Brch RM 12.5	2640	345.6	17.5
19	St. Marys at RM 12.0	2640	311.1	17.5
20	St. Marys at RM 11.5	2640	293.8	17.5
21	St. Marys at RM 11.0	2640	276.5	17.5
22	St. Marys at RM 10.5	2640	276.5	17.5
23	St. Marys at RM 10.0	2640	276.5	17.5
24	St. Marys at RM 9.5	2640	320.0	18.0
25	St. Marys below Sta. M7 at RM 8.82	3510	492.7	17.8
26	St. Marys at RM 8.15	3200	487.2	19.2
27	St. Marys below Sta. M6 at RM 7.55	2560	399.8	18.6
28	St. Marys at RM 7.06	2970	520.4	16.7
29	St. Marys above Burrell’s Ck RM 6.5	2180	344.1	19.2
30	Between Bell/Burrell below Sta. M5	3310	580.5	18.7
31	Below Bells River at RM 5.46	1390	309.6	22.2
32	St. Marys at RM 5.2	2170	453.1	29.8
33	St. Marys at RM 4.78	2050	361.0	18.0
34	Above St. Marys Dock RM 4.4	2130	420.1	21.0
35	Below St. Marys Dock above Sta. M4	2090	422.0	16.2
36	St. Marys at RM 3.6	1990	408.2	19.2
37	St. Marys at RM 3.22	2470	504.6	17.5
38	St. Marys at RM 2.75	1950	358.2	17.9
39	Above St. Marys WTF RM 2.33	2260	495.0	21.2
40	Above North Riv. & Sta. M3	1990	492.0	23.7
41	Below North Riv. at RM 1.56	1920	435.6	15.7
42	St. Mary at RM 1.21	2060	419.2	16.3
43	Below Sta. M2 & Pt. Peter Pier	1870	442.7	20.0
44	St. Marys at RM 0.47	2480	583.5	15.2
45	St. Marys at Sta. M1 & Cumbl. Sound	-	-	-

APPENDIX C

Calibration, Critical Conditions Permitted, Natural Conditions, and TMDL Model Curves

Figure C-1
DOSAG Model Results
St. Marys River



APPENDIX D

GA ESTUARY Model Results
Natural Conditions, 2006 TMDL, Revised 2017 TMDL with Allocation for Future Growth at Three Locations

WLAs

Original TMDL 2006	Flow MGD	BOD5 mg/L	NH3 mg/L	DO mg/L	F ratio	CBODu mg/L	NBODu mg/L	UOD mg/L
City of Kingsland	2.2	30	17.4	2	3	90	79.518	3110
St Marys Scrubby Bluff WPCP	0.5	20	5	5	3	60	22.85	345
								3,455

Revised TMDL								
City of Kingsland	4.4	30	10	5	3	90	45.7	4,980
St Marys Scrubby Bluff WPCP	0.5	20	5	5	3	60	22.85	345
Future Growth / Kingsland	13.1	30	10	5	3	90	45.7	14,826
								20,151

Revised TMDL								
City of Kingsland	4.4	30	10	5	3	90	45.7	4,980
St Marys Scrubby Bluff WPCP	0.5	20	5	5	3	60	22.85	345
Future Growth / Scrubby Bluff	14.5	20	10	5	3	60	45.7	12,782
								18,107

Revised TMDL								
City of Kingsland	4.4	30	10	5	3	90	45.7	4,980
St Marys Scrubby Bluff WPCP	0.5	20	5	5	3	60	22.85	345
Future Growth / Weed Street	9.5	30	10	5	3	90	45.7	10,752
								16,077

Natural DO Model Run

Branch 1: Main Stem	RM	Cum Flow MGD	Natural DO mg/L	DO Deficit mg/L	% DO Sat	CBOD u mg/L	NBODu mg/L	Salinity mg/L	Allowable DO Deficit mg/L	Target DO TMDL mg/L
St. Marys USGS at RM 21.1	21.1	83	4.45	2.89	60.62	5.41	0.38	4793	0.445	4.005
St. Mary at RM 20.5	20.5	83	4.14	3.16	56.77	5.23	0.36	5793	0.414	3.726
St. Mary at RM 20.0	20	83	3.86	3.4	53.21	5.06	0.33	6799	0.386	3.474
St. Mary at RM 19.5	19.5	83	3.62	3.6	50.18	4.91	0.32	7734	0.362	3.258
St. Mary at RM 19.0	19	83	3.42	3.76	47.61	4.78	0.3	8607	0.342	3.078
St. Mary at Kingsland WPCP outfall		83	3.24	3.91	45.36	4.65	0.29	9460	0.324	2.916
St. Mary above Catfish Creek RM 18	18	83.1	3.08	4.04	43.26	4.54	0.27	10352	0.1	2.98
St. Marys at RM 17.5	17.5	83.1	2.94	4.15	41.46	4.43	0.26	11214	0.1	2.84
St. Marys at RM 17.0	17	83.1	2.82	4.23	39.95	4.33	0.24	12051	0.1	2.72
St Marys at RM 16.5	16.5	83.1	2.71	4.31	38.59	4.24	0.23	12923	0.1	2.61
St Marys at RM 16.0	16	83.1	2.62	4.37	37.45	4.16	0.22	13780	0.1	2.52
St Marys at Scrubby Bluff outfall		83.2	2.54	4.41	36.54	4.08	0.21	14609	0.1	2.44
St Mary at RM 15.0	15	83.2	2.48	4.44	35.83	4.02	0.2	15413	0.1	2.38
St Marys above Sister Cks RM 14.5	14.5	83.3	2.43	4.46	35.3	3.96	0.19	16221	0.1	2.33
St Marys at RM 14.0	14	83.3	2.4	4.46	34.95	3.91	0.18	17033	0.1	2.3
St Marys at RM 13.5	13.5	83.3	2.38	4.46	34.82	3.88	0.18	17649	0.1	2.28
St Marys at RM 13.0	13	83.3	2.36	4.45	34.71	3.86	0.17	18155	0.1	2.26
St Marys above Millers Brch RM 12.5	12.5	83.4	2.36	4.42	34.82	3.84	0.17	18714	0.1	2.26
St Marys at RM 12.0	12	83.4	2.37	4.39	35.06	3.83	0.17	19336	0.1	2.27
St Marys at RM 11.5	11.5	83.4	2.39	4.35	35.45	3.83	0.16	19998	0.1	2.29
St Marys at RM 11.0	11	83.4	2.42	4.3	36.02	3.83	0.16	20704	0.1	2.32
St Marys at RM 10.5	10.5	83.4	2.46	4.23	36.73	3.84	0.16	21412	0.1	2.36
St Marys at RM 10.0	10	83.4	2.51	4.16	37.61	3.86	0.15	22124	0.1	2.41
St Marys at RM 9.5	9.5	83.4	2.56	4.08	38.51	3.88	0.15	22742	0.1	2.46
St Marys below M7 at R.M. 8.82	8.82	83.4	2.63	3.97	39.83	3.91	0.15	23583	0.1	2.53
St Mary at RM 8.15	8.15	83.4	2.69	3.89	40.84	3.95	0.15	24126	0.1	2.59
St Mary below M6 at RM 7.55	7.55	83.4	2.75	3.8	41.97	4	0.15	24772	0.1	2.65
St Mary at RM 7.06	7.06	83.5	2.8	3.73	42.9	4.04	0.15	25203	0.1	2.7
above Burrell's Creek RM 6.5	6.5	84.5	2.87	3.65	43.99	4.09	0.15	25651	0.1	2.77
betw.Bell/Burrell below M5	6	84.6	2.96	3.53	45.66	4.16	0.15	26248	0.1	2.86
below Bells River at RM 5.46	5.46	84.6	3.03	3.44	46.84	4.22	0.16	26631	0.1	2.93

St. Marys at RM 5.2	5.2	84.6	3.07	3.39	47.53	4.26	0.16	26869	0.1	2.97
St Marys at RM 4.78	4.78	84.6	3.15	3.29	48.95	4.33	0.16	27270	0.1	3.05
above St. Marys Dock RM 4.40	4.4	84.7	3.24	3.19	50.4	4.4	0.16	27654	0.1	3.14
below St. Marys Dock above M4	4	84.7	3.32	3.1	51.7	4.47	0.16	27977	0.332	2.988
St. Mary at RM 3.6	3.6	84.7	3.41	3	53.24	4.55	0.17	28334	0.341	3.069
St. Marys at RM 3.22	3.22	84.8	3.49	2.9	54.61	4.62	0.17	28630	0.349	3.141
St. Marys at RM 2.75	2.75	84.8	3.6	2.78	56.4	4.71	0.18	28979	0.36	3.24
above St. Marys Weed St. RM 2.33	2.33	86.8	3.71	2.66	58.29	4.8	0.18	29324	0.371	3.339
above North Riv. & Sta. M3	2	89.1	3.81	2.56	59.82	4.87	0.18	29569	0.381	3.429
below North Riv. at RM 1.56	1.56	89.1	3.91	2.45	61.49	4.95	0.19	29815	0.391	3.519
St. Mary at RM 1.21	1.21	89.2	3.98	2.37	62.62	5	0.19	29975	0.398	3.582
below Sta. M2 & Pt. Peter Pier	1	89.2	4.07	2.28	64.05	5.07	0.19	30155	0.407	3.663
St. Marys at RM 0.47	0.45	89.2	4.15	2.2	65.32	5.13	0.2	30313	0.415	3.735
Downstream Boundary		89.2								

Original 2006 St Marys DO TMDL

Branch 1: Main Stem	RM	Cum Flow MGD	Original 2006 TMDL DO mg/L	DO Deficit mg/L	% DO Sat	CBODu mg/L	NBODu mg/L	Salinity mg/L	Allowable DO Deficit mg/L	Target DO TMDL mg/L	Additional Assimilative Capacity mg/L
St. Marys USGS at RM 21.1	21.1	83	4.45	2.89	60.58	5.42	0.39	4790	0.445	4.005	0.445
St. Mary at RM 20.5	20.5	83	4.14	3.16	56.69	5.25	0.37	5787	0.414	3.726	0.414
St. Mary at RM 20.0	20	83	3.85	3.4	53.09	5.09	0.36	6790	0.386	3.474	0.376
St. Mary at RM 19.5	19.5	83	3.61	3.61	50.03	4.95	0.35	7722	0.362	3.258	0.352
St. Mary at RM 19.0	19	83.33	3.41	3.78	47.44	4.83	0.34	8593	0.342	3.078	0.332
St. Mary at Kingsland WPCP outfall		84.1	3.23	3.92	45.16	4.71	0.33	9444	0.324	2.916	0.314
St. Mary above Catfish Creek RM 18	18	84.97	3.06	4.05	43.04	4.6	0.32	10333	0.1	2.98	0.08
St. Marys at RM 17.5	17.5	85.3	2.92	4.16	41.23	4.49	0.31	11194	0.1	2.84	0.08
St. Marys at RM 17.0	17	85.3	2.8	4.25	39.7	4.39	0.29	12030	0.1	2.72	0.08
St Marys at RM 16.5	16.5	85.36	2.69	4.33	38.33	4.3	0.28	12901	0.1	2.61	0.08
St Marys at RM 16.0	16	85.46	2.6	4.39	37.18	4.21	0.26	13757	0.1	2.52	0.08
St Marys at Scrubby Bluff outfall		85.74	2.52	4.43	36.26	4.14	0.25	14586	0.1	2.44	0.08
St Mary at RM 15.0	15	85.84	2.46	4.46	35.56	4.07	0.24	15390	0.1	2.38	0.08
St Marys above Sister Cks RM 14.5	14.5	86	2.41	4.48	35.03	4.01	0.23	16198	0.1	2.33	0.08
St Marys at RM 14.0	14	86	2.38	4.48	34.68	3.95	0.22	17010	0.1	2.3	0.08
St Marys at RM 13.5	13.5	86	2.36	4.48	34.55	3.92	0.21	17627	0.1	2.28	0.08
St Marys at RM 13.0	13	86	2.34	4.46	34.44	3.89	0.2	18133	0.1	2.26	0.08
St Marys above Millers Brch RM 12.5	12.5	86.1	2.35	4.44	34.56	3.88	0.2	18692	0.1	2.26	0.09
St Marys at RM 12.0	12	86.1	2.35	4.41	34.81	3.86	0.19	19315	0.1	2.27	0.08
St Marys at RM 11.5	11.5	86.1	2.37	4.37	35.2	3.86	0.18	19977	0.1	2.29	0.08
St Marys at RM 11.0	11	86.1	2.4	4.31	35.78	3.86	0.18	20684	0.1	2.32	0.08
St Marys at RM 10.5	10.5	86.1	2.44	4.25	36.5	3.87	0.17	21393	0.1	2.36	0.08
St Marys at RM 10.0	10	86.1	2.49	4.17	37.39	3.88	0.17	22106	0.1	2.41	0.08
St Marys at RM 9.5	9.5	86.1	2.54	4.1	38.3	3.9	0.17	22725	0.1	2.46	0.08
St Marys below M7 at R.M. 8.82	8.82	86.1	2.62	3.98	39.64	3.93	0.16	23567	0.1	2.53	0.09
St Mary at RM 8.15	8.15	86.1	2.68	3.9	40.66	3.96	0.16	24111	0.1	2.59	0.09

St Mary below M6 at RM 7.55	7.55	86.1	2.74	3.81	41.81	4.01	0.16	24758	0.1	2.65	0.09
St Mary at RM 7.06	7.06	86.2	2.79	3.74	42.75	4.05	0.16	25190	0.1	2.7	0.09
above Burrell's Creek RM 6.5	6.5	87.2	2.86	3.66	43.85	4.1	0.16	25639	0.1	2.77	0.09
betw.Bell/Burrell below M5	6	87.3	2.96	3.54	45.53	4.17	0.16	26238	0.1	2.86	0.1
below Bells River at RM 5.46	5.46	87.3	3.03	3.45	46.72	4.23	0.16	26621	0.1	2.93	0.1
St. Marys at RM 5.2	5.2	87.3	3.06	3.4	47.42	4.27	0.16	26860	0.1	2.97	0.09
St Marys at RM 4.78	4.78	87.3	3.15	3.3	48.85	4.34	0.16	27261	0.1	3.05	0.1
above St. Marys Dock RM 4.40	4.4	87.4	3.24	3.2	50.31	4.41	0.17	27646	0.1	3.14	0.1
below St. Marys Dock above M4	4	87.4	3.31	3.11	51.62	4.47	0.17	27970	0.332	2.988	0.322
St. Mary at RM 3.6	3.6	87.4	3.41	3	53.17	4.55	0.17	28328	0.341	3.069	0.341
St. Marys at RM 3.22	3.22	87.5	3.49	2.91	54.55	4.62	0.17	28625	0.349	3.141	0.349
St. Marys at RM 2.75	2.75	87.5	3.6	2.79	56.35	4.71	0.18	28975	0.36	3.24	0.36
above St. Marys Weed St. RM 2.33	2.33	89.5	3.71	2.66	58.25	4.8	0.18	29320	0.371	3.339	0.371
above North Riv. & Sta. M3	2	91.8	3.8	2.56	59.78	4.88	0.18	29566	0.381	3.429	0.371
below North Riv. at RM 1.56	1.56	91.8	3.91	2.45	61.47	4.95	0.19	29813	0.391	3.519	0.391
St. Mary at RM 1.21	1.21	91.9	3.98	2.37	62.61	5.01	0.19	29973	0.398	3.582	0.398
below Sta. M2 & Pt. Peter Pier	1	91.9	4.07	2.28	64.04	5.07	0.19	30154	0.407	3.663	0.407
St. Marys at RM 0.47	0.45	91.9	4.15	2.2	65.31	5.13	0.2	30312	0.415	3.735	0.415
Downstream Boundary		91.9									

Revised St Marys DO TMDL with Allocation for Future Growth at Kingsland

Branch 1: Main Stem	RM	Cum Flow MGD	DO mg/L	DO Deficit mg/L	% DO Sat	CBODu mg/L	NBODu mg/L	Salinity mg/L	Allowable DO Deficit mg/L	Target DO TMDL mg/L	Additional Assimilative Capacity mg/L
St. Marys USGS at RM 21.1	21.1	83	4.43	2.91	60.41	5.49	0.42	4773	0.445	4.005	0.425
St. Mary at RM 20.5	20.5	83	4.11	3.19	56.35	5.39	0.43	5752	0.414	3.726	0.384
St. Mary at RM 20.0	20	83	3.82	3.44	52.58	5.3	0.45	6738	0.386	3.474	0.346
St. Mary at RM 19.5	19.5	83	3.57	3.66	49.37	5.22	0.47	7653	0.362	3.258	0.312
St. Mary at RM 19.0	19	85.63	3.35	3.84	46.64	5.16	0.49	8508	0.342	3.078	0.272
St. Mary at Kingsland WPCP outfall		91.75	3.17	3.99	44.24	5.09	0.5	9345	0.324	2.916	0.254
St. Mary above Catfish Creek RM 18	18	97.98	2.99	4.13	42.03	4.99	0.5	10224	0.1	2.98	0.01
St. Marys at RM 17.5	17.5	100.6	2.85	4.24	40.16	4.88	0.48	11080	0.1	2.84	0.01
St. Marys at RM 17.0	17	100.6	2.72	4.33	38.59	4.76	0.45	11912	0.1	2.72	0
St Marys at RM 16.5	16.5	100.66	2.61	4.41	37.18	4.64	0.42	12780	0.1	2.61	0
St Marys at RM 16.0	16	100.76	2.52	4.47	36.01	4.53	0.4	13634	0.1	2.52	0
St Marys at Scrubby Bluff outfall		101.04	2.44	4.52	35.07	4.43	0.38	14462	0.1	2.44	0
St Mary at RM 15.0	15	101.14	2.38	4.55	34.36	4.35	0.35	15266	0.1	2.38	0
St Marys above Sister Cks RM 14.5	14.5	101.3	2.33	4.56	33.83	4.27	0.33	16074	0.1	2.33	0
St Marys at RM 14.0	14	101.3	2.3	4.57	33.48	4.19	0.31	16887	0.1	2.3	0
St Marys at RM 13.5	13.5	101.3	2.28	4.56	33.36	4.14	0.3	17505	0.1	2.28	0
St Marys at RM 13.0	13	101.3	2.27	4.55	33.26	4.11	0.29	18013	0.1	2.26	0.01
St Marys above Millers Brch RM 12.5	12.5	101.4	2.27	4.52	33.4	4.08	0.28	18573	0.1	2.26	0.01
St Marys at RM 12.0	12	101.4	2.28	4.49	33.68	4.05	0.27	19199	0.1	2.27	0.01
St Marys at RM 11.5	11.5	101.4	2.3	4.44	34.11	4.03	0.25	19864	0.1	2.29	0.01
St Marys at RM 11.0	11	101.4	2.33	4.39	34.73	4.02	0.24	20575	0.1	2.32	0.01
St Marys at RM 10.5	10.5	101.4	2.38	4.32	35.5	4.01	0.23	21289	0.1	2.36	0.02
St Marys at RM 10.0	10	101.4	2.43	4.24	36.44	4.02	0.22	22007	0.1	2.41	0.02
St Marys at RM 9.5	9.5	101.4	2.48	4.16	37.4	4.02	0.22	22630	0.1	2.46	0.02
St Marys below M7 at R.M. 8.82	8.82	101.4	2.56	4.04	38.81	4.04	0.21	23480	0.1	2.53	0.03
St Mary at RM 8.15	8.15	101.4	2.62	3.96	39.88	4.06	0.2	24028	0.1	2.59	0.03
St Mary below M6 at RM 7.55	7.55	101.4	2.69	3.86	41.09	4.1	0.19	24682	0.1	2.65	0.04
St Mary at RM 7.06	7.06	101.5	2.75	3.78	42.07	4.13	0.19	25119	0.1	2.7	0.05

above Burrell's Creek RM 6.5	6.5	102.5	2.82	3.7	43.22	4.17	0.19	25572	0.1	2.77	0.05
betw.Bell/Burrell below M5	6	102.6	2.92	3.57	44.97	4.24	0.18	26178	0.1	2.86	0.06
below Bells River at RM 5.46	5.46	102.6	2.99	3.49	46.2	4.29	0.18	26566	0.1	2.93	0.06
St. Marys at RM 5.2	5.2	102.6	3.03	3.43	46.93	4.32	0.18	26808	0.1	2.97	0.06
St Marys at RM 4.78	4.78	102.6	3.12	3.33	48.4	4.38	0.18	27214	0.1	3.05	0.07
above St. Marys Dock RM 4.40	4.4	102.7	3.21	3.22	49.92	4.45	0.18	27604	0.1	3.14	0.07
below St. Marys Dock above M4	4	102.7	3.29	3.13	51.27	4.51	0.18	27932	0.332	2.988	0.302
St. Mary at RM 3.6	3.6	102.7	3.39	3.02	52.87	4.58	0.18	28296	0.341	3.069	0.321
St. Marys at RM 3.22	3.22	102.8	3.47	2.92	54.28	4.65	0.18	28597	0.349	3.141	0.329
St. Marys at RM 2.75	2.75	102.8	3.58	2.8	56.12	4.73	0.19	28951	0.36	3.24	0.34
above St. Marys Weed St. RM 2.33	2.33	104.8	3.7	2.67	58.08	4.82	0.19	29302	0.371	3.339	0.361
above North Riv. & Sta. M3	2	107.1	3.8	2.57	59.65	4.89	0.19	29552	0.381	3.429	0.371
below North Riv. at RM 1.56	1.56	107.1	3.9	2.46	61.36	4.96	0.19	29803	0.391	3.519	0.381
St. Mary at RM 1.21	1.21	107.2	3.97	2.38	62.53	5.01	0.19	29965	0.398	3.582	0.388
below Sta. M2 & Pt. Peter Pier	1	107.2	4.07	2.29	63.99	5.07	0.2	30148	0.407	3.663	0.407
St. Marys at RM 0.47	0.45	107.2	4.14	2.2	65.29	5.13	0.2	30309	0.415	3.735	0.405
Downstream Boundary		107.2									

Revised St Marys DO TMDL with Allocation for Future Growth at Scrubby Bluff

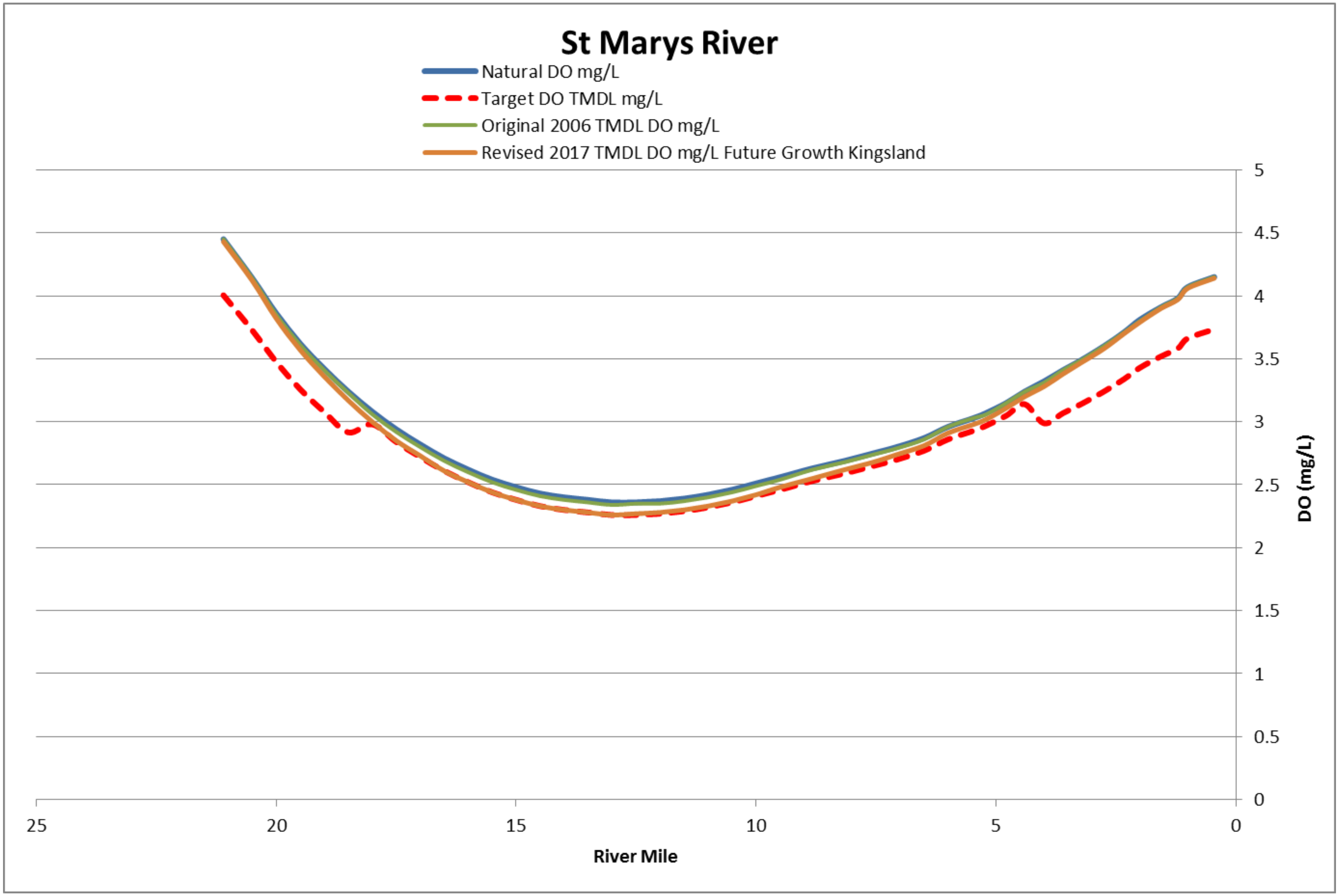
Branch 1: Main Stem	RM	Cum Flow MGD	DO mg/L	DO Deficit mg/L	% DO Sat	CBOD u mg/L	NBODu mg/L	Salinity mg/L	Allowable DO Deficit mg/L	Target DO TMDL mg/L	Additional Assimilative Capacity mg/L
St. Marys USGS at RM 21.1	21.1	83	4.44	2.9	60.45	5.46	0.4	4774	0.445	4.005	0.435
St. Mary at RM 20.5	20.5	83	4.12	3.18	56.43	5.33	0.4	5754	0.414	3.726	0.394
St. Mary at RM 20.0	20	83	3.83	3.43	52.69	5.21	0.4	6741	0.386	3.474	0.356
St. Mary at RM 19.5	19.5	83	3.58	3.65	49.51	5.1	0.4	7657	0.362	3.258	0.322
St. Mary at RM 19.0	19	83.66	3.37	3.82	46.8	5.01	0.4	8513	0.342	3.078	0.292
St. Mary at Kingsland WPCP outfall		85.2	3.18	3.98	44.42	4.93	0.4	9350	0.324	2.916	0.264
St. Mary above Catfish Creek RM 18	18	86.84	3.01	4.12	42.2	4.85	0.4	10225	0.1	2.98	0.03
St. Marys at RM 17.5	17.5	87.5	2.86	4.23	40.3	4.76	0.39	11074	0.1	2.84	0.02
St. Marys at RM 17.0	17	87.5	2.73	4.33	38.69	4.69	0.39	11897	0.1	2.72	0.01
St Marys at RM 16.5	16.5	89.38	2.62	4.41	37.24	4.62	0.38	12755	0.1	2.61	0.01
St Marys at RM 16.0	16	92.38	2.52	4.47	36.03	4.55	0.38	13601	0.1	2.52	0
St Marys at Scrubby Bluff outfall		97.73	2.44	4.52	35.07	4.48	0.37	14422	0.1	2.44	0
St Mary at RM 15.0	15	100.73	2.38	4.55	34.34	4.4	0.35	15223	0.1	2.38	0
St Marys above Sister Cks RM 14.5	14.5	102.7	2.33	4.57	33.79	4.33	0.33	16032	0.1	2.33	0
St Marys at RM 14.0	14	102.7	2.3	4.57	33.44	4.25	0.31	16847	0.1	2.3	0
St Marys at RM 13.5	13.5	102.7	2.28	4.56	33.31	4.2	0.3	17466	0.1	2.28	0
St Marys at RM 13.0	13	102.7	2.26	4.55	33.21	4.16	0.29	17975	0.1	2.26	0
St Marys above Millers Brch RM 12.5	12.5	102.8	2.27	4.53	33.34	4.13	0.28	18537	0.1	2.26	0.01
St Marys at RM 12.0	12	102.8	2.28	4.49	33.62	4.1	0.27	19164	0.1	2.27	0.01
St Marys at RM 11.5	11.5	102.8	2.3	4.45	34.05	4.07	0.25	19831	0.1	2.29	0.01
St Marys at RM 11.0	11	102.8	2.33	4.39	34.67	4.06	0.24	20543	0.1	2.32	0.01
St Marys at RM 10.5	10.5	102.8	2.37	4.32	35.44	4.05	0.23	21259	0.1	2.36	0.01
St Marys at RM 10.0	10	102.8	2.43	4.24	36.38	4.05	0.22	21979	0.1	2.41	0.02
St Marys at RM 9.5	9.5	102.8	2.48	4.16	37.34	4.05	0.21	22604	0.1	2.46	0.02
St Marys below M7 at R.M. 8.82	8.82	102.8	2.56	4.04	38.75	4.07	0.2	23456	0.1	2.53	0.03
St Mary at RM 8.15	8.15	102.8	2.62	3.96	39.82	4.09	0.2	24007	0.1	2.59	0.03
St Mary below M6 at RM 7.55	7.55	102.8	2.69	3.86	41.04	4.12	0.19	24663	0.1	2.65	0.04
St Mary at RM 7.06	7.06	102.9	2.74	3.79	42.02	4.15	0.19	25100	0.1	2.7	0.04

above Burrell's Creek RM 6.5	6.5	103.9	2.81	3.7	43.17	4.19	0.19	25555	0.1	2.77	0.04
betw.Bell/Burrell below M5	6	104	2.92	3.58	44.92	4.25	0.18	26163	0.1	2.86	0.06
below Bells River at RM 5.46	5.46	104	2.99	3.49	46.16	4.3	0.18	26552	0.1	2.93	0.06
St. Marys at RM 5.2	5.2	104	3.03	3.43	46.89	4.33	0.18	26795	0.1	2.97	0.06
St Marys at RM 4.78	4.78	104	3.12	3.33	48.37	4.39	0.18	27203	0.1	3.05	0.07
above St. Marys Dock RM 4.40	4.4	104.1	3.21	3.22	49.88	4.46	0.18	27594	0.1	3.14	0.07
below St. Marys Dock above M4	4	104.1	3.29	3.13	51.24	4.52	0.18	27923	0.332	2.988	0.302
St. Mary at RM 3.6	3.6	104.1	3.39	3.02	52.84	4.59	0.18	28288	0.341	3.069	0.321
St. Marys at RM 3.22	3.22	104.2	3.47	2.93	54.26	4.65	0.18	28590	0.349	3.141	0.329
St. Marys at RM 2.75	2.75	104.2	3.58	2.8	56.11	4.74	0.19	28946	0.36	3.24	0.34
above St. Marys Weed St. RM 2.33	2.33	106.2	3.7	2.67	58.07	4.82	0.19	29298	0.371	3.339	0.361
above North Riv. & Sta. M3	2	108.5	3.8	2.57	59.63	4.89	0.19	29548	0.381	3.429	0.371
below North Riv. at RM 1.56	1.56	108.5	3.9	2.46	61.35	4.96	0.19	29800	0.391	3.519	0.381
St. Mary at RM 1.21	1.21	108.6	3.97	2.38	62.52	5.01	0.19	29963	0.398	3.582	0.388
below Sta. M2 & Pt. Peter Pier	1	108.6	4.07	2.29	63.98	5.07	0.2	30147	0.407	3.663	0.407
St. Marys at RM 0.47	0.45	108.6	4.14	2.2	65.28	5.13	0.2	30309	0.415	3.735	0.405
Downstream Boundary		108.6									

Revised St Marys DO TMDL with Allocation for Future Growth at Weed Street

Branch 1: Main Stem	RM	Cum Flow MGD	Revised 2017 TMDL DO mg/L	DO Deficit mg/L	% DO Sat	CBODu mg/L	NBODu mg/L	Salinity mg/L	Allowable DO Deficit mg/L	Target DO TMDL mg/L	Additional Assimilative Capacity mg/L
St. Marys USGS at RM 21.1	21.1	83	4.43	2.9	60.43	5.47	0.41	4776	0.445	4.005	0.425
St. Mary at RM 20.5	20.5	83	4.12	3.18	56.39	5.35	0.41	5759	0.414	3.726	0.394
St. Mary at RM 20.0	20	83	3.82	3.44	52.64	5.24	0.42	6749	0.386	3.474	0.346
St. Mary at RM 19.5	19.5	83	3.57	3.65	49.44	5.15	0.43	7667	0.362	3.258	0.312
St. Mary at RM 19.0	19	83.66	3.36	3.83	46.73	5.07	0.44	8526	0.342	3.078	0.282
St. Mary at Kingsland WPCP outfall	18.5	85.2	3.17	3.98	44.34	5	0.45	9365	0.324	2.916	0.254
St. Mary above Catfish Creek RM 18	18	86.84	3	4.12	42.11	4.92	0.46	10242	0.1	2.98	0.02
St. Marys at RM 17.5	17.5	97	2.85	4.24	40.21	4.85	0.46	11093	0.1	2.84	0.01
St. Marys at RM 17.0	17	97	2.73	4.33	38.63	4.73	0.44	11926	0.1	2.72	0.01
St Marys at RM 16.5	16.5	97.06	2.61	4.41	37.21	4.62	0.41	12794	0.1	2.61	0
St Marys at RM 16.0	16	97.16	2.52	4.47	36.03	4.51	0.39	13649	0.1	2.52	0
St Marys at Scrubby Bluff outfall	16.5	97.44	2.44	4.52	35.08	4.42	0.37	14476	0.1	2.44	0
St Mary at RM 15.0	15	97.54	2.38	4.55	34.36	4.34	0.35	15279	0.1	2.38	0
St Marys above Sister Cks RM 14.5	14.5	97.7	2.33	4.56	33.81	4.26	0.33	16087	0.1	2.33	0
St Marys at RM 14.0	14	97.7	2.3	4.57	33.46	4.19	0.31	16900	0.1	2.3	0
St Marys at RM 13.5	13.5	97.7	2.28	4.56	33.33	4.14	0.3	17517	0.1	2.28	0
St Marys at RM 13.0	13	97.7	2.26	4.55	33.22	4.11	0.29	18024	0.1	2.26	0
St Marys above Millers Brch RM 12.5	12.5	97.8	2.27	4.53	33.35	4.08	0.28	18584	0.1	2.26	0.01
St Marys at RM 12.0	12	97.8	2.28	4.49	33.62	4.06	0.27	19208	0.1	2.27	0.01
St Marys at RM 11.5	11.5	97.8	2.3	4.45	34.04	4.04	0.26	19873	0.1	2.29	0.01
St Marys at RM 11.0	11	97.8	2.33	4.39	34.65	4.03	0.25	20582	0.1	2.32	0.01
St Marys at RM 10.5	10.5	97.8	2.37	4.32	35.41	4.03	0.24	21295	0.1	2.36	0.01
St Marys at RM 10.0	10	97.8	2.42	4.24	36.34	4.04	0.23	22011	0.1	2.41	0.01
St Marys at RM 9.5	9.5	97.8	2.48	4.17	37.29	4.05	0.23	22633	0.1	2.46	0.02
St Marys below M7 at R.M. 8.82	8.82	97.8	2.55	4.05	38.68	4.07	0.22	23480	0.1	2.53	0.02
St Mary at RM 8.15	8.15	97.8	2.62	3.97	39.75	4.09	0.21	24027	0.1	2.59	0.03
St Mary below M6 at RM 7.55	7.55	97.8	2.68	3.87	40.95	4.13	0.21	24679	0.1	2.65	0.03

St Mary at RM 7.06	7.06	97.9	2.74	3.79	41.93	4.17	0.21	25114	0.1	2.7	0.04
above Burrell's Creek RM 6.5	6.5	98.9	2.81	3.71	43.08	4.21	0.21	25567	0.1	2.77	0.04
betw.Bell/Burrell below M5	6	99	2.91	3.58	44.82	4.28	0.2	26170	0.1	2.86	0.05
below Bells River at RM 5.46	5.46	99	2.98	3.5	46.06	4.33	0.2	26557	0.1	2.93	0.05
St. Marys at RM 5.2	5.2	99	3.02	3.44	46.79	4.36	0.2	26798	0.1	2.97	0.05
St Marys at RM 4.78	4.78	99	3.11	3.34	48.26	4.43	0.21	27203	0.1	3.05	0.06
above St. Marys Dock RM 4.40	4.4	99.1	3.2	3.23	49.78	4.5	0.21	27591	0.1	3.14	0.06
below St. Marys Dock above M4	4	99.58	3.28	3.14	51.14	4.56	0.21	27919	0.332	2.988	0.292
St. Mary at RM 3.6	3.6	100.29	3.38	3.03	52.74	4.63	0.21	28281	0.341	3.069	0.311
St. Marys at RM 3.22	3.22	101.34	3.47	2.93	54.17	4.7	0.21	28581	0.349	3.141	0.329
St. Marys at RM 2.75	2.75	102.76	3.58	2.81	56.02	4.78	0.21	28936	0.36	3.24	0.34
above St. Marys Weed St. RM 2.33	2.33	107.14	3.7	2.68	57.99	4.87	0.21	29288	0.371	3.339	0.361
above North Riv. & Sta. M3	2	110.86	3.79	2.57	59.57	4.93	0.21	29539	0.381	3.429	0.361
below North Riv. at RM 1.56	1.56	111.81	3.9	2.46	61.31	4.99	0.21	29793	0.391	3.519	0.381
St. Mary at RM 1.21	1.21	112.63	3.97	2.38	62.48	5.04	0.21	29957	0.398	3.582	0.388
below Sta. M2 & Pt. Peter Pier	1	113.1	4.06	2.29	63.96	5.09	0.2	30143	0.407	3.663	0.397
St. Marys at RM 0.47	0.45	113.1	4.14	2.2	65.27	5.14	0.2	30306	0.415	3.735	0.405
Downstream Boundary		113.1									


St Marys River
Natural DO mg/L
Target DO TMDL mg/L
Original 2006 TMDL DO mg/L
Revised 2017 TMDL DO mg/L Future Growth Kingsland
DO (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
25
20
15
10
5
0
River Mile

APPENDIX E

Daily Oxygen Demanding Substances Load Summary Memorandum

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
St. Marys River

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Camden**
Major River Basin:	**St. Marys**
8-Digit Hydrologic Unit Code(s):	**03070204**
Waterbody Name:	**St. Marys River**
Location:	**Catfish Creek to Millers Branch**
Stream Length:	**6 miles**
Watershed Area:	**1,360 square miles**
Flows into:	**Atlantic Ocean**
Ecoregion:	**Atlantic Coast Flatwoods**
Constituent(s) of Concern:	**Dissolved Oxygen**
Designated Use:	**Fishing (not supporting designated use)**

Applicable Water Quality Standards:

A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish.

***Natural Water Quality*. It is recognized that certain natural waters of the State may have a quality that will not be within the general or specific requirements contained herein. These circumstances do not constitute violations of water quality standards. This is especially the case for the criteria for dissolved oxygen, temperature, pH and fecal coliform. NPDES permits and Best Management Practices will be the primary mechanisms for ensuring that the discharges will not create a harmful situation.**

2. TMDL Development

Analysis/Modeling:	**Georgia Estuary – Steady state tidally averaged water quality model developed by Georgia Environmental Protection Division.**
Calibration Data:	**Georgia EPD field data from summer 2003.**
Critical Conditions:	**(1) Mid-tide conditions; (2) High summer temperatures, based on historic water quality data; (3) Conservative reaction rates; and (4) Incorporation of point sources discharging at their NPDES permit limits.**

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA): **16,075 - 20,125 lbs/day**

Wasteload Allocations (WLAsw): **NA**

Load Allocation (LA): **2,685 lbs/day**

TMDL **18,760 - 22,810 lbs/day**

*** TMDL expressed as Ultimate Oxygen Demand (UOD), which includes Carbonaceous Biochemical Oxygen Demand (CBOD) and Nitrogenous Biochemical Oxygen Demand (NBOD).**

Margin of Safety (MOS): **Implicit, based on the following conservative assumptions:**
(1) Mid-tide conditions;
(2) High summer temperatures, based on the historical record, persist for the same critical period;
(3) Conservative reaction rates; and
(4) All point sources discharge continuously at their NPDES permit limits for the same critical period.