Total Maximum Daily Load

Evaluation

for

Turkey Creek

in the

Flint 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 2012-2013* (GA EPD, 2014a). This document is available on the Georgia Environmental Protection Division (GA EPD) website.

The subset of the water bodies that do not meet designated uses on the 305(b) list are also assigned to Georgia's 303(d) list, named after that section of the CWA. Although the 305(b) and 303(d) lists are two distinct requirements under the CWA, Georgia reports both lists in one combined format called the Integrated 305(b)/303(d) List, which is found in Appendix A of *Water Quality in Georgia 2012-2013*. Water bodies on the 303(d) list are denoted as Category 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 standard. The TMDLs in this document are based on the 2014 303(d) listing, which is available on the GA EPD website. The TMDL process establishes the allowable pollutant loadings or other quantifiable parameters for a water body based on the relationship between pollutant sources and instream water quality conditions. This allows water quality-based controls to be developed to reduce pollution and restore and maintain water quality.

In 2014, the State of Georgia identified one stream segment, located in the Flint 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* (GA EPD, 2015), Chapter 391-3-6-.03, Sections (5) and (6). Based on Georgia's 305(b)/303(d) Listing Assessment Methodology, Turkey Creek from Rogers Branch to Pennahatchee Creek in Dooly County was included in the State's 2014 303(d) list.

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 DO TMDL for the Flint River Basin included constructing a computer model for the listed segment. Georgia DoSag (GaDosag), is a steady-state, one-dimensional Streeter-Phelps water quality model developed by the EPD to estimate the dissolved oxygen concentrations along the length of the listed stream segment under low-flow critical conditions. This model was calibrated to data collected in the Flint River Basin in the summer of 2017. The Ultimate Oxygen Demand (UOD) load and required reduction for Turkey Creek are summarized in the table below.

TMDL Load for Turkey Creek under Critical Conditions

Stream Segment	Existing Load (lbs/day)	WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL (lbs/day)	Percent Reduction
Turkey Creek – Rogers Branch to Pennahatchee Creek	172	53	NA	54	107	37.8

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.

Management practices may be used to help reduce and/or maintain the UOD loads. These include:

- Compliance with NPDES (wastewater, construction, industrial stormwater, and/or MS4) permit limits and requirements;
- Implementation of recommended Water Quality management practices in the *Upper Flint Regional Water Plan* (GA EPD, 2017) ;
- Implementation of *Georgia's Best Management Practices for Forestry* (GFC, 2009);
- Implementation of *Best Management Practices for Georgia Agriculture* (GSWCC, 2013) and Adoption of National Resource Conservation Service (NRCS) Conservation Practices for agriculture;
- Implementation of the *Georgia Better Back Roads Field Manual* (GA RCDC, 2009) and adoption of additional practices for proper unpaved road maintenance;
- Implementation of individual Erosion and Sedimentation Control Plans for land disturbing activities; and application of the *Manual for Erosion and Sediment Control in Georgia* (GSWCC, 2016)
- Implementation of the *Georgia Stormwater Management Manual* (ARC, 2016) to facilitate prevention and mitigation of stream bank erosion due to increased stream flow and velocities caused by urban runoff through structural storm water BMP installation.

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* (GA EPD, 2014a).

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.

In 2014, the State of Georgia identified one stream segment, located in the Flint River Basin, as water quality limited due to dissolved oxygen (DO). Table 1 presents the stream in the Flint River Basin that was included on the 2014 303(d) list for exceedance of the DO criteria.

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

Reach ID	Stream Segment	Location	Segment Length (miles)	Designated Use	Listing
GAR031300060407	Turkey Creek	Rogers Branch to Pennahatchee Creek (Dooly Co.)	9	Fishing	NS

Note: NS = Not Supporting designated use

1.2 Watershed Description

The Flint River Basin is located in the western third of the State of Georgia, and is entirely within the boundaries of the State. The River drains an area of approximately 8,460 square miles (GA EPD, 1997). The United States Geologic Survey (USGS) has divided the Flint River Basin into six sub-basins, or Hydrologic Unit Codes (HUCs). These are numbered as HUCs 03130005 through 03130010. Figure 1 shows the location of the Flint River Basin in Georgia. Figure 2 shows the sub-basins of the Flint River, and Figure 3 shows the location of the impaired stream segment within the Flint River Basin.

The Basin contains parts of the Piedmont and Coastal Plain physiographic provinces that extend throughout the southeastern United States. The Flint River originates in the south side of Fulton County, in metropolitan Atlanta, by Hartsfield Jackson Atlanta International Airport (Figure 1). The River flows south to Lake Blackshear, passes through Albany and Bainbridge, and then enters Lake Seminole. At this point, the Flint converges with the Chattahoochee River in Lake Seminole at the Georgia-Florida border. The outflow from Lake Seminole forms the

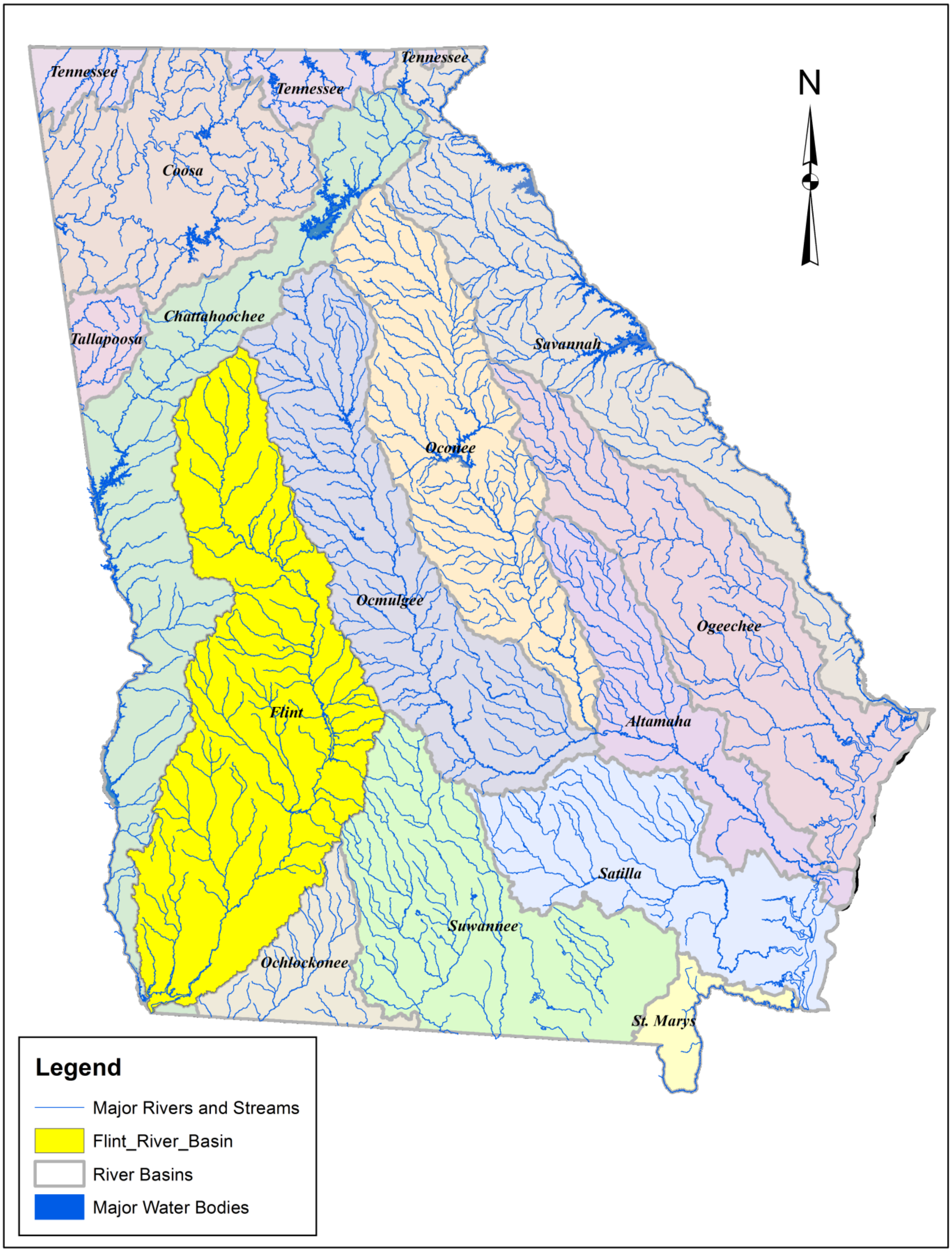

Figure 1. Location of the Flint River Basin in the State of Georgia

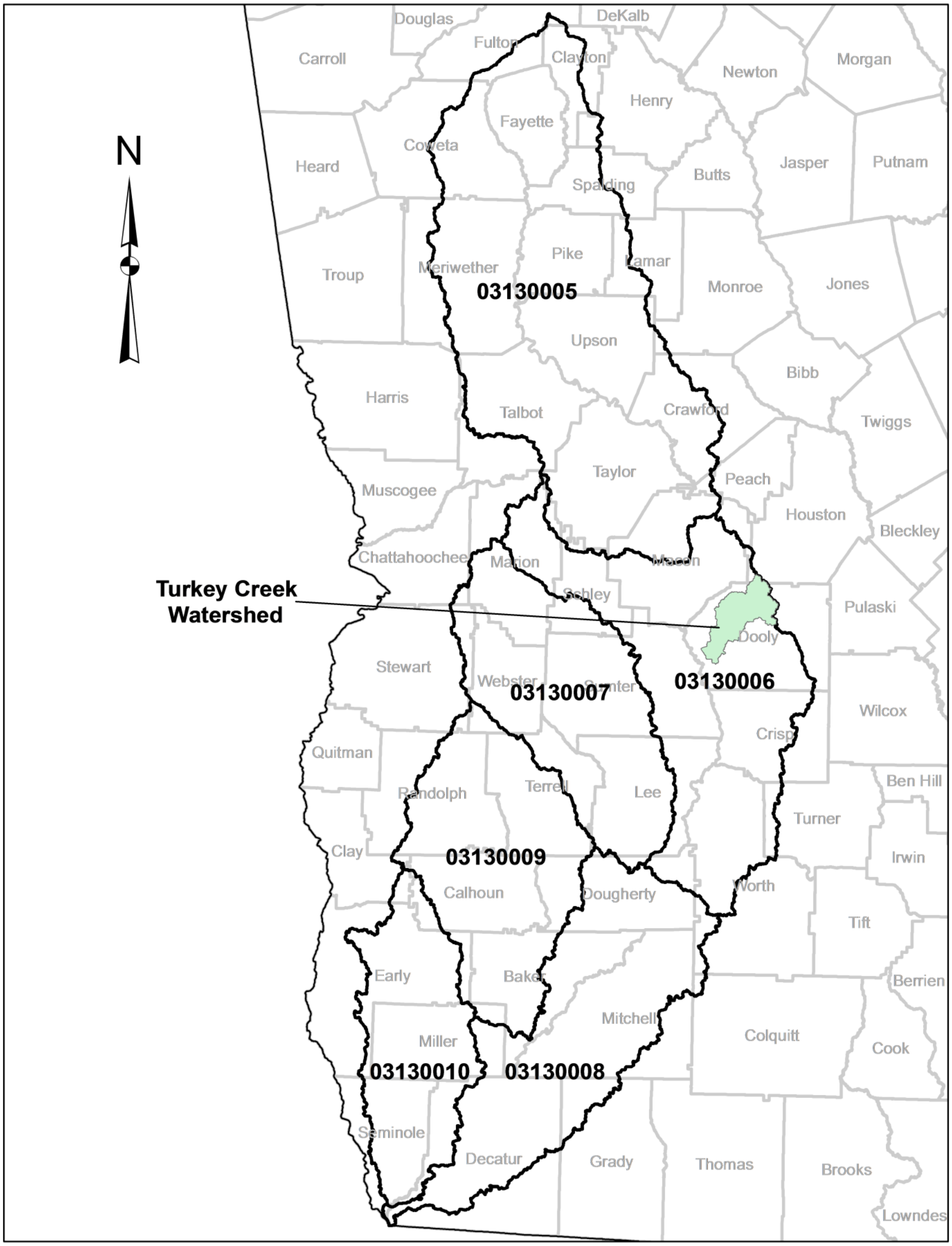

Figure 2. Location of the Six USGS 8-Digit Hydrologic Units and the Turkey Creek Watershed of the Flint River Basin

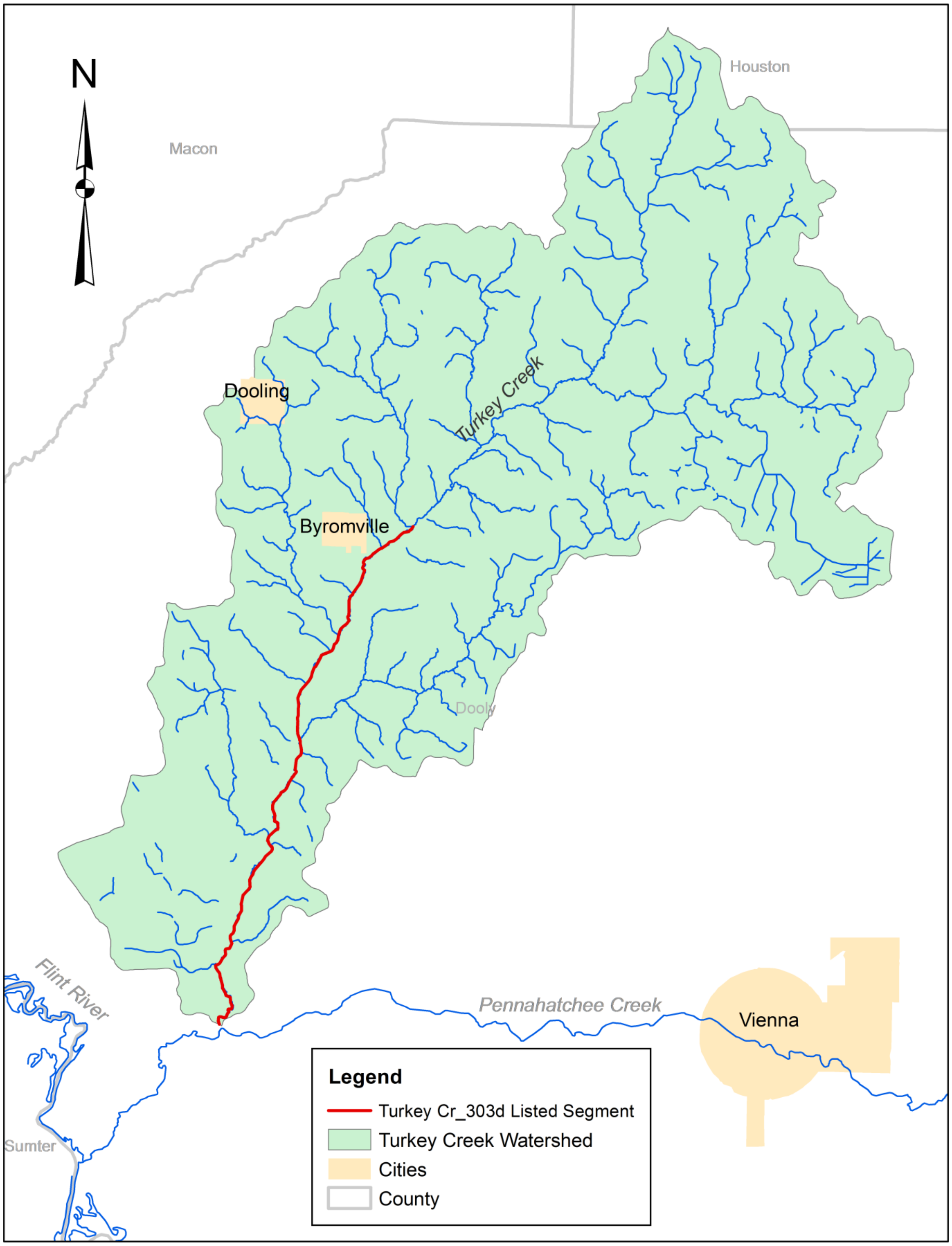

Figure 3. Location of the Turkey Creek 303(d) Stream Segment Listed for Dissolved Oxygen in the Flint River Basin

Apalachicola River in Florida, which ultimately discharges to the Gulf of Mexico.

The land use characteristics of the Flint River Basin watersheds were determined using data from the Georgia Land Use Trends (GLUT) for Year 2008. This raster land use trend product was developed by the University of Georgia – Natural Resources Spatial Analysis Laboratory (NARSAL) and follows land use trends for years 1974, 1985, 1991, 1998, 2001, 2005 and 2008. The raster data sets were developed from Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+). Some of the NARSAL land use types were reclassified, aggregated into similar land use types, and used in the final watershed characterization. Table 2 lists the watershed land use distribution for the drainage areas of the twelve stream segments.

1.3 State Water Planning

The Georgia Legislature enacted the Metropolitan North Georgia Water Planning District Act in 2001 to create the Metropolitan North Georgia Water Planning District (MNGWPD) to preserve and protect water resources in the 15-county metropolitan Atlanta area. The MNGWPD is charged with the development of comprehensive regional and watershed specific water resource management plans to be implemented by local governments in the metropolitan Atlanta area. The MNGWPD issued its first water resource management plan documents in 2003.

In 2004, the Georgia Legislature enacted the Comprehensive State-wide Water Management Planning Act to ensure management of water resources in a sustainable manner to support the state's economy, to protect public health and natural systems, and to enhance the quality of life for all citizens on a state-wide level. GA EPD later developed the 2008 Comprehensive State-wide Water Management Plan, which established Georgia's ten Regional Water Planning Councils (RWPCs) and laid the groundwork for the RWPCs to develop their own Regional Water Plans. The boundaries of these ten RWPCs, in addition to the MNGWPD, are shown in Figure 4. The listed segment is located within the boundaries of the Upper Flint Regional Water Planning Council.

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 Upper Flint Regional Council updated its Water Plan in June 2017, which was adopted by EPD in July 2017.

1.4 Water Quality Standards

The Georgia water use classification for the listed stream segment in the Flint 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, 2015), 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, 2015):

> *"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 EPD numeric limits at critical conditions, then the EPD numeric limits apply. If naturally occurring DO is lower than the EPD numeric limits, then 90% of the natural DO will become the minimum allowable DO, unless the natural DO is less than 3.0 mg/L, then a 0.1 mg/L deficit is allowed.

Table 2. Turkey Creek Watershed Land Cover Distribution

Stream/ Segment	Land Use Categories - Acres (Percentage)													
	Open Water	Low Intensity Residential	High Intensity 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
Turkey Creek	214	748	48	11	131	0	827	11,536	26,128	4,362	1,903	5,663	288	51,859
	(0.4%)	(1.4%)	(0.1%)	(0.0%)	(0.3%)	(0.0%)	(1.6%)	(22.2%)	(50.4%)	(8.4%)	(3.7%)	(10.9%)	(0.6%)	(100.0%)

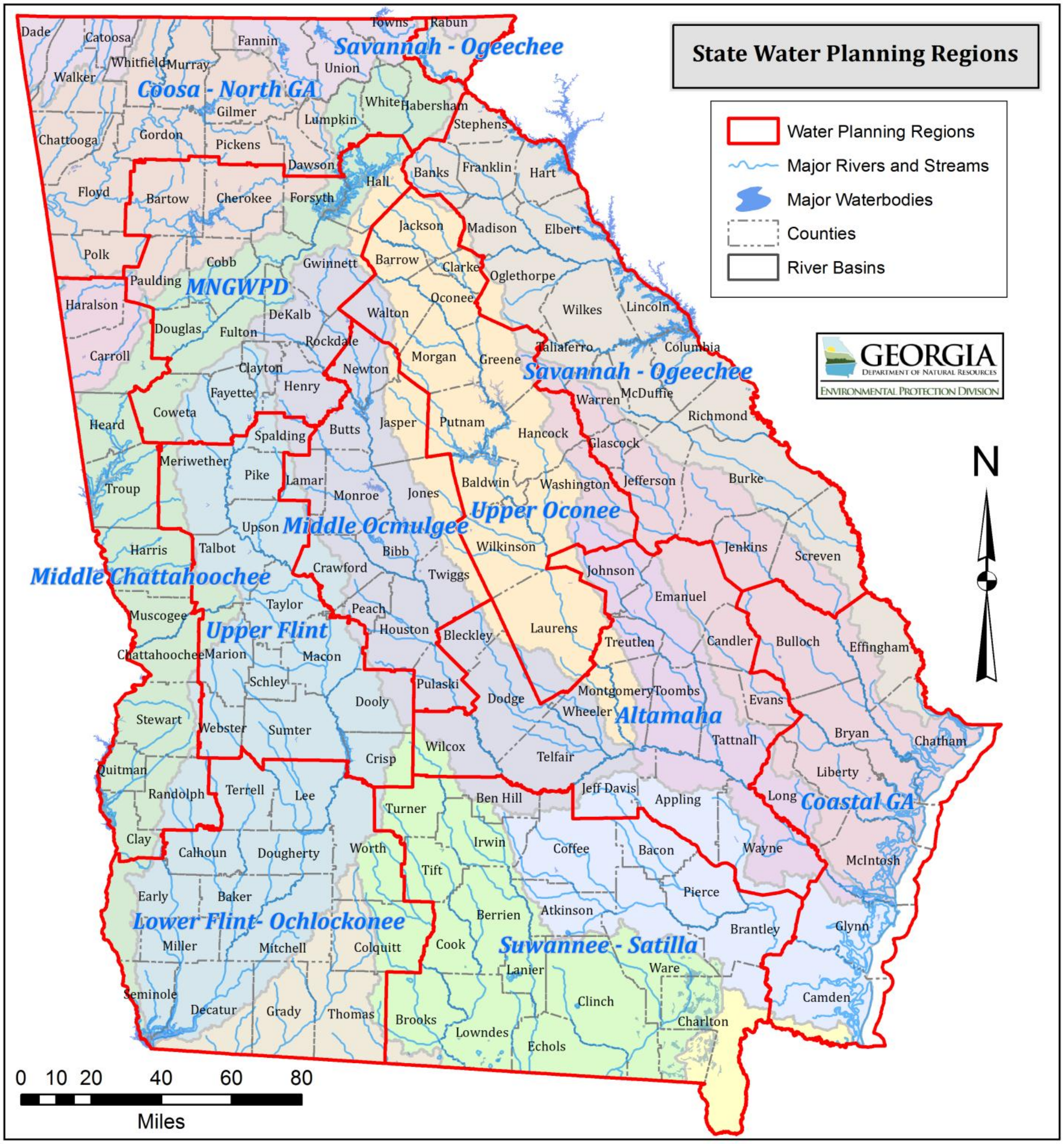

Figure 4. Boundaries of the Regional Water Planning Councils and the Metropolitan North Georgia Water Planning District

2.0 WATER QUALITY ASSESSMENT

One impaired stream segment in the Flint River Basin was determined as not supporting its designated use due to DO based on water quality samples taken by the Georgia Environmental Protection Division (EPD) Watershed Planning and Monitoring Program. A stream segment is placed on the 303(d) list if more than ten percent of the samples fall below the minimum dissolved oxygen criterion.

The water quality data for the listed segment is provided in Table 3. The sample results presented in Table 3 include DO, stream temperature, 5-day Biochemical Oxygen Demand (BOD_5), and ammonia (NH_3). The table indicates where DO values were below the Georgia instream minimum criterion of 4.0 mg/L.

During 2012, twenty-one samples were collected from Turkey Creek at the Georgia Highway 90 Bridge located near Byromville, GA. DO concentrations were below the minimum criterion in ten of these samples. The observed violations of the DO minimum criterion by samples collected in Turkey Creek resulted in the placement of this stream segment on Georgia's 2014 303(d) list (GA EPD, 2014a).

Table 3. Dissolved Oxygen, Temperature, BOD5, NH3-N Data Collected from Turkey Creek

Date	DO (mg/L)[1]	Temperature (°C)	BOD5 (mg/L)	NH_3-N (mg/L)
01/17/2012	6.15	10.9	< 2	0.04
02/06/2012	4.50	15.2	< 2	0.14
03/05/2012	7.45	13.0	< 2	0.07
03/19/2012	5.45	20.9	NS	NS
03/21/2012	5.39	20.9	NS	NS
04/02/2012	5.20	18.8	NS	NS
05/03/2012	4.28	20.6	NS	NS
05/31/2012	**3.59**	20.8	NS	NS
06/11/2012	5.85	20.8	< 2	0.07
06/18/2012	**1.29**	19.4	NS	NS
06/20/2012	**1.36**	19.5	NS	NS
09/04/2012	**0.97**	20.1	NS	NS
09/05/2012	**1.92**	21.3	NS	NS
09/17/2012	**3.60**	22.0	NS	NS
09/20/2012	**3.24**	21.1	NS	NS
10/02/2012	**3.01**	21.3	NS	NS
11/01/2012	4.78	13.3	NS	NS
12/03/2012	**3.90**	14.7	NS	NS
12/10/2012	**3.08**	16.1	NS	NS
12/13/2012	4.54	12.9	NS	NS
12/18/2012	4.81	14.2	NS	NS

NS = Not Sampled
[1] Bolded values indicate the measured DO value was less than the minimum instream water quality standard of 4.0 mg/L.

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 is one NPDES permitted discharge with effluent limits for oxygen demanding substances identified in the Flint River Basin watershed upstream from or within the listed segment. This facility is a minor discharger, with a discharge of 0.104 million gallons per day (MGD) or more. Figure 1 provides the location of this facility and Table 4 provides the permitted flows, as well as the BOD_5. This facility has no permit limits for NH_3 or DO.

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 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 Turkey Creek watershed.

Table 4. NPDES Permitted Discharge in the Turkey Creek Watershed

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)
Town of Byromville WPCP	GA0025623	Turkey Creek	0.104	30	NL	NL

NL = No Limit

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 demand substance 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 the 2017 NPDES General Permit for Stormwater Discharges Associated with Industrial Activity (GAR050000) also called the Industrial General Permit (IGP). 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. The IGP requires that stormwater 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 2017 IGP if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to stormwater 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. Delineations of both supporting and not supporting waterbodies are provided on the GA EPD website, and are available in ESRI ArcGIS shapefile format or in KMZ format for use in Google Earth. Interested parties may evaluate their proximity to not supporting waterbodies by utilizing these geospatial files.

Based on SIC Codes, Sector designations, and required benchmark sampling, 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 permittees 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. A portion of the Turkey Creek watershed is located in Houston County, an MS4 Phase 2 permittee (Table 5). However, the watershed does not contain any areas defined as urbanized with regulated storm sewer systems.

Table 5. Permitted MS4s in the Turkey Creek Watershed

Stream Segment	MS4 Permittees	MS4 Phase
Turkey Creek	Houston County	2

Source: Nonpoint Source Program, GA DNR, 2015

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, the settleable materials accumulate over time and exert sediment oxygen demand (SOD). Constituents of concern from surface washoff include the fractions of ammonia and BOD that become an integral part of channel bottom sediments, thus becoming a potential source of SOD.

The introduction of biodegradable constituents to streams may also occur by means other than surface runoff events. These may include leaking sanitary sewer lines, failing septic systems landfill leachate, and illicit discharges.

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**.** There are no permitted LAS systems located within the Turkey Creek watershed.

3.2.2 Urban Development

The upstream end of the listed segment of Turkey Creek begins in the vicinity of Byromville. The City of Byromville is the only urbanized area within the Turkey Creek drainage area. It is a small community of approximately 500 residents with a total area of 0.5 square miles, making up less one percent of the Turkey Creek watershed.

The potential exists for nonpoint sources originating from the Town to impact DO levels in the Creek. Nonpoint biodegradable substances are attributable to multiple sources in urban environments, including domestic animals, leaks and overflows from sanitary sewer systems, illicit discharges, and runoff from improper disposal of waste materials. These substances enter streams by direct washoff from the land surface, or the runoff may be diverted to a stormwater collection system and discharged through discrete outlet structures. For smaller urban areas such as Byromville the stormwater discharge outlets are unregulated.

3.2.3 Leaking Septic Systems

Table 6 presents the number of septic systems in Dooly and Houston counties existing at the end of 2011 and the number existing at the end of 2015. In addition, an estimate of the number of septic systems installed and repaired during the period from 2012 through 2015 is given. This is based on data provided by the Georgia Department of Human Resources, Division of Public Health, and information obtained from the U.S. Census. A portion of the contributions of biodegradable substances in the Turkey Creek watershed may be attributed to failure of septic systems and illicit discharges of raw sewage. However, the residences within the Turkey Creek drainage area are small in number and spaced widely apart as is typical of a rural farming community. The impact of septic systems in the watershed is believed to be minimal.

Table 6. Estimated Number of Septic Systems in Dooly and Houston Counties for Years 2011 and 2015

County	Existing Septic Systems (2011)	Existing Septic Systems (2015)	Number of Septic Systems Installed (2012 to 2015)	Number of Septic Systems Repaired (2012 to 2015)
Dooly	2,556	2,616	60	27
Houston	18,434	19,151	717	444

Source: The Georgia Dept. of Human Resources, Division of Public Health, 2017

3.2.4 Landfills

Leachate from landfills may contain biodegradable constituents that could at some point reach surface waters. Sanitary (or municipal) landfills are the most likely to serve as a source of these substances. These types of landfills receive household wastes, animal manure, offal, hatchery and poultry processing plant wastes, dead animals, and other types of wastes. Older sanitary landfills were not lined and most have been closed. Those that remain active and have not been lined operate as construction/demolition landfills. Currently active sanitary landfills are lined and have leachate collection systems. All landfills, excluding inert landfills, are now required to install environmental monitoring systems for groundwater and methane sampling. There are no known active or closed landfills located within the Turkey Creek watershed (GA EPD, 2017b)

3.2.5 Concentrated Animal Feeding Operations

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 fecal coliform. Table 7 presents the known dry manure poultry operations located within the Turkey Creek drainage area.

Table 7. Dry Manure Poultry Operations Located in the Turkey Creek Watershed

Name	County	Number of Animals (thousands)
Richard H. Bailey Farm	Dooly	208
Bodrey Poultry Farm	Dooly	135
B & S Farm (Windy Hill Farm)	Dooly	162
Leavens Poultry	Dooly	138
Nho Tran Farm (Tran Dang Farm)	Houston	260

Source: GA Dept. of Agriculture, 2015

3.2.6 Agricultural Sources

Table 2 provides the land cover distributions for the listed Turkey Creek River watershed. These data show that the watershed is dominated by agricultural activities, primarily consisting of the production of row crops. This form of farming involves considerable soil disturbance through tilling. Without an adequate buffer zone, washoff can carry sediment and residual plant material to nearby streams resulting in additional BOD load.

Cotton is by far the dominant row crop grown in Dooly County (USDA, 2012). The application of fertilizers is required to sustain cotton production and can result in elevated nutrient levels in adjacent streams in the form of nitrogen and phosphorus compounds. This can stimulate algal growth in the stream. As the algae die off and biodegrade, consumption of oxygen occurs that causes lower oxygen levels in the stream. It was reported during late spring sampling events conducted in 2012 by EPD that the water in Turkey Creek appeared turbid and had a green color. This suggests that algae concentrations in the creek were significant during this time.

Agricultural livestock are a potential source of biodegradable substances to streams. Animal wastes from grazing pastureland can be transported during storm events to nearby streams.

Livestock will often have direct access to streams that pass through their pastures, and can thus impact water quality in a more direct manner (USDA, 2002). In addition, the improper storage and management of the animal wastes can result in the transport of constituents to nearby streams during storm events.

Table 8 provides the estimated number of beef cattle, dairy cattle, goats, horses, swine, and chickens reported by Dooly and Houston counties. In comparison to cropland production, animal farms make up a relatively small portion of the agriculture industry in the Turkey Creek watershed. Their impact on the water quality of Turkey Creek may be more related to their proximity to the creek rather than the total number of farms in the watershed.

Table 8. Estimated Agricultural Livestock Populations in Dooly and Houston Counties

County	Livestock						
	Beef Cattle	Dairy Cattle	Swine	Horses	Goats	Chickens Layers	Chickens-Broilers Sold
Dooly	4,800	250	0	55	250	0	6,588,000
Houston	800	460	0	350	301	0	3,795,000

Source: Georgia Department of Agriculture, 2015

3.2.7 Wildlife and Other Natural Sources

The significance of wildlife as a source of oxygen demanding substances in streams varies considerably depending on the animal species present in the watershed. Based on information provided by the Georgia Wildlife Resources Division (WRD, 2007), the greatest impact are from animals that spend a large portion of their time in or around aquatic habitats. These include waterfowl, racoons, beavers, muskrats, and to a lesser extent, river otters and minks. Beaver dams can significantly impact DO levels in streams. The reduced flow from impounding of the stream and decomposing organic matter that has collected in the sediments can result in the lower DO levels often observed downstream from these dams. Based on conversations with personnel from the Georgia Wildlife Resources Division, Dooly County has a significant beaver population.

Turkey Creek receives significant natural contributions of oxygen demanding organic materials from local wetlands and its forested stream corridor. The following sources of naturally occurring organic materials have been identified:

- Adjacent wetlands 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. In addition, low DO in 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 wetland areas caused by decaying vegetation; and 2) by increasing SOD associated with vegetation decaying on stream channel bottoms.

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 Turkey Creeks 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. Based on the geographic, hydrologic, and water quality characteristics of Turkey Creek, and considering that it is a small, relatively shallow stream, GaDosag was selected as the appropriate model for the listed stream segment.

4.1.1 Georgia DoSag

GaDosag is a one-dimensional steady state water quality model that was developed by the EPD. The model was selected for the following reasons:

- It conforms to EPD standard practices for developing wasteload allocations;
- It works well for low flow and high temperature conditions;
- It can be developed with a limited dataset; and
- It is able to handle branching tributaries and both point and nonpoint source inputs.

GaDosag computes DO using an enhanced form of the Streeter-Phelps equation (Thomann and Mueller, 1987). The model applies the equation to each stream reach over small incremental distances. The model also provides a complete spatial view of a stream system, allowing the modeler to evaluate differences in stream behavior at various locations along its extent.

The structure of a GaDosag stream model consists of a mainstem and can include multiple branches. Several elements can be incorporated into the branches including tributaries, water intakes, dams, and point sources. A GaDosag model was developed to represent the listed segment of Turkey Creek beginning at Rogers Branch at the upstream end, and running downstream to the confluence with Pennahatchee Creek.

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

4.2 Model Calibration

The model calibration was conducted using water quality data collected by EPD in August 2017 for the listed segment. The data examined included streamflow, DO, water temperature, BOD_5, and NH_3. Table 9 provides a summary of the monitoring data collected on August 24^{th} used to calibrate the model.

Table 9. Monitoring Data Used for Calibration of the Turkey Creek GaDosag Model

Site ID	Site Description	Flow (cfs)	DO (mg/L)	DO Sat (%)	BOD_5 (mg/L)	NH_3-N (mg/L)	pH (SU)
TC-6	Turkey Cr at New Cut Road	ND	6.75	84.7	<2.0	<0.03	6.81
Byromville WPCP	Byromville Discharge	0.258	3.49	47.6	12.0	0.58	7.01
TC-5	Turkey Cr at SR 90	6.65 (1)	6.20	76.7	<2.0	<0.03	6.58
LC-1	Little Cr at SR 90	ND	2.89	37.3	<2.0	<0.03	6.44
TC-4	Turkey Cr at West Road	ND	7.35	89.9	NS	NS	6.78
TC-3	Turkey Cr at Godwin Road	ND	7.39	90.5	<2.0	<0.03	6.91
TC-2	Turkey Creek at Mt. Vernon Road	ND	7.23	88.7	NS	NS	6.90
PC-1	Pennahatchee Cr at Baggs Road	ND	6.76	84.7	<2.0	<0.03	7.22
TC-1	Turkey Creek at River Rd/SR 230	ND	6.30	79.2	<2.0	<0.03	7.05

ND = Not Determined
NS = Not Sampled
(1) USGS Flow Gage 02349900

Headwater and tributary water quality boundaries were developed from these instream field data, DO saturation values (Meyer, 1992), and EPD standard modeling practices (GA EPD, 1978). BOD_5 was converted to Ultimate Carbonaceous Biochemical Oxygen Demand ($CBOD_u$) by multiplying by an f-ratio of 1.90 (GA EPD, 1978), and NH_3 was converted to Ultimate Nitrogenous Biochemical Oxygen Demand ($NBOD_u$) by multiplying by the stoichiometric conversion factor of 4.57. The water temperature used was based on the measured field data. Background water quality parameters used in the model are given in Table 10.

Table 10. Water Quality Boundary Conditions

Parameter	Value
CBODU	3.0 mg/L
NBODU	0.05 mg/L
DO Saturation	75%
Temperature	25 deg C

Effluent samples were collected from the Byromville WPCP and analyzed for BOD_5 and NH_3-N. *In-situ* measurements for DO, temperature, and pH were taken. The instantaneous effluent discharge at the time samples were collected was provided by Byromville WPCP personnel. These data were input into the calibration model. Table 11 provides a summary of the Byromville effluent data at the time of the field sampling.

Table 11. Effluent Discharge Data

Facility Name	NPDES Permit No.	Facility Instantaneous Discharge at 14:20 Hrs, August 24, 2017			
		Flow (MGD)	BOD5 (mg/L)	NH3 (mg/L)	DO (mg/L)
Byromville WPCP	GA0025623	0.167	12.0	0.58	3.49

Stream velocities are calculated by GaDosag using the Velocity Coefficient Method (Roesner and Shubinski, 1978), using the following equation:

$$V = C \times Q^n$$

where:
- V = velocity at any point in stream (fps)
- C = Velocity Coefficient = 0.2
- Q_{est} = estimated instantaneous flow (cfs)
- n = Velocity Exponent = 0.4

The kinetic rates and input parameters developed during model calibration are provided in Table 12. These parameters include the carbonaceous BOD (CBOD) decay rate, nitrogenous BOD (NBOD) decay rate, SOD rate, and the Tsivoglou reaeration coefficient (Tsivoglou and Neal, 1976) used to determine stream reaeration.

Table 12. Modeling Kinetic Rates

Parameter	Rates
CBOD Decay Rate	0.15 (1/day)
NBOD Decay Rate	0.2 (1/day)
SOD	0.5 (g/m^2/day)
Reaeration Coefficient	0.11

The Turkey Creek DOSAG model was calibrated at locations where EPD collected discrete water quality data during 2017. Figure 5 provides the DO calibration curve plotted with the monitoring data collected on August 24, 2017 from stations in the listed segment of Turkey Creek.

4.3 Critical Conditions Model

The critical flow conditions for TMDLs occur during drought periods when the ratio of effluent or contaminated storm water to stream flow is the greatest. The TMDLs are presented as total daily mass loads for the low flow conditions. Steady-state models are applied for "critical" environmental conditions that represent extremely low assimilative capacity. 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.

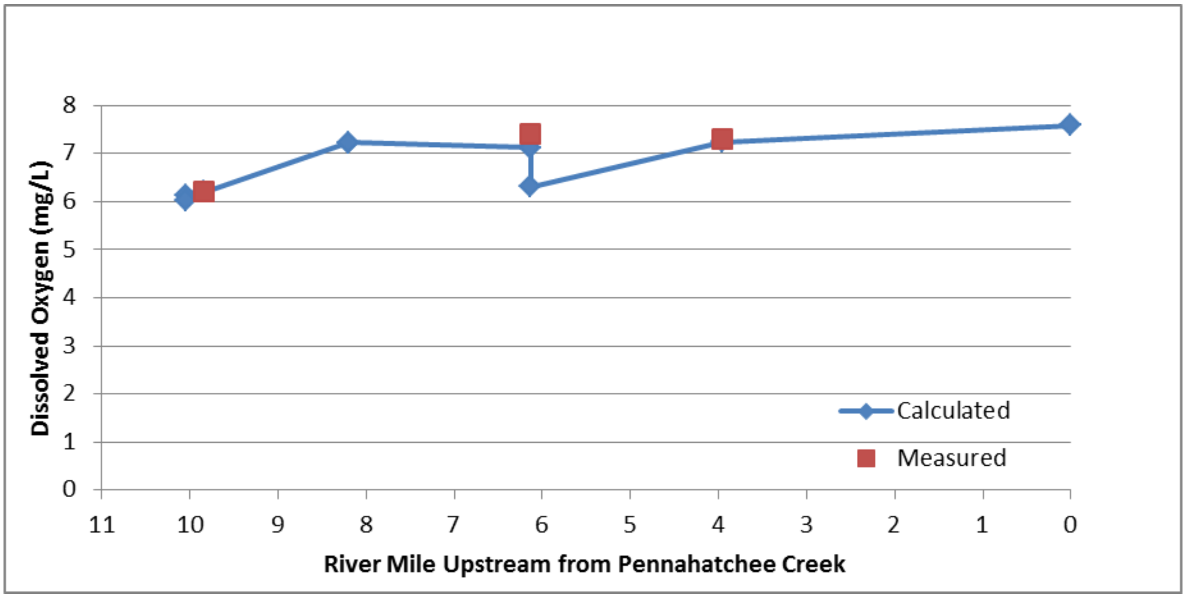

Figure 5. GaDosag Calibration Plot

The critical conditions model for Turkey Creek was used to assess the DO standard and to determine if problems exist requiring regulatory intervention. Model critical conditions were developed based on the 7-day, 10-year minimum (7Q10) low flow in accordance with EPD standard practices (GA EPD, 1978).

The published 7Q10 critical flow determined by the USGS for the USGS flow gage 02349900, located on Turkey Creek at SR 90 near Byromville, was used as the basis for critical flow conditions for the listed segment (Gotvald, 2016). Table 13 provides a summary of the low-flow analysis for the flow gage. The productivity factor (i.e., ratio of flow to drainage area) is used by the model to determine 7Q10 flows along the length of the listed segment. Please note Lake Blackshear is approximately 4.5 miles downstream from the end of the model. The DO in the lower segments of Turkey Creek may be influence by backwaters of the lake and have naturally low DO.

Table 13. Low-Flow Analysis Summary for USGS Gage 02349900 Located on Turkey Creek

DO TMDL Segment	Drainage Area (sq. miles)	7Q10 (cfs)*	Productivity Factor (cfs/sq. mile)
Turkey Creek (Rogers Branch to Pennahatchee Creek)	47.5	1.98	0.042

*Gotvald, 2016

Historical data accumulated at the USGS station 02349900, located on Turkey Creek near Byromville was used to determine the temperature used for the critical conditions model. Harmonic sine functions were developed by the USGS for the historical data (Dyar and Alhadeff, 1997). The highest summer-time temperature from the harmonic fit was used to represent the listed segment.

The Byromville WPCP NPDES permitted discharge was incorporated into the critical conditions model at its current permit limits. Because its permit does not have DO and ammonia limits, values of 2 mg/L and 17.4 mg/L were assumed, respectively. These are values used by EPD as standard procedure to represent oxidation ponds for modeling purposes when limits do not exist. Water quality boundaries, the SOD rate, and all other modeling rates and constants were the same as those in the calibrated model.

4.4 TMDL Model

The critical conditions model was used to determine the TMDL needed to meet the DO water quality standards. The Byromville's WLA was adjusted until the instream DO standard of 5.0 mg/L was met. Figure 6 shows a plot of the critical conditions and TMDL model results.

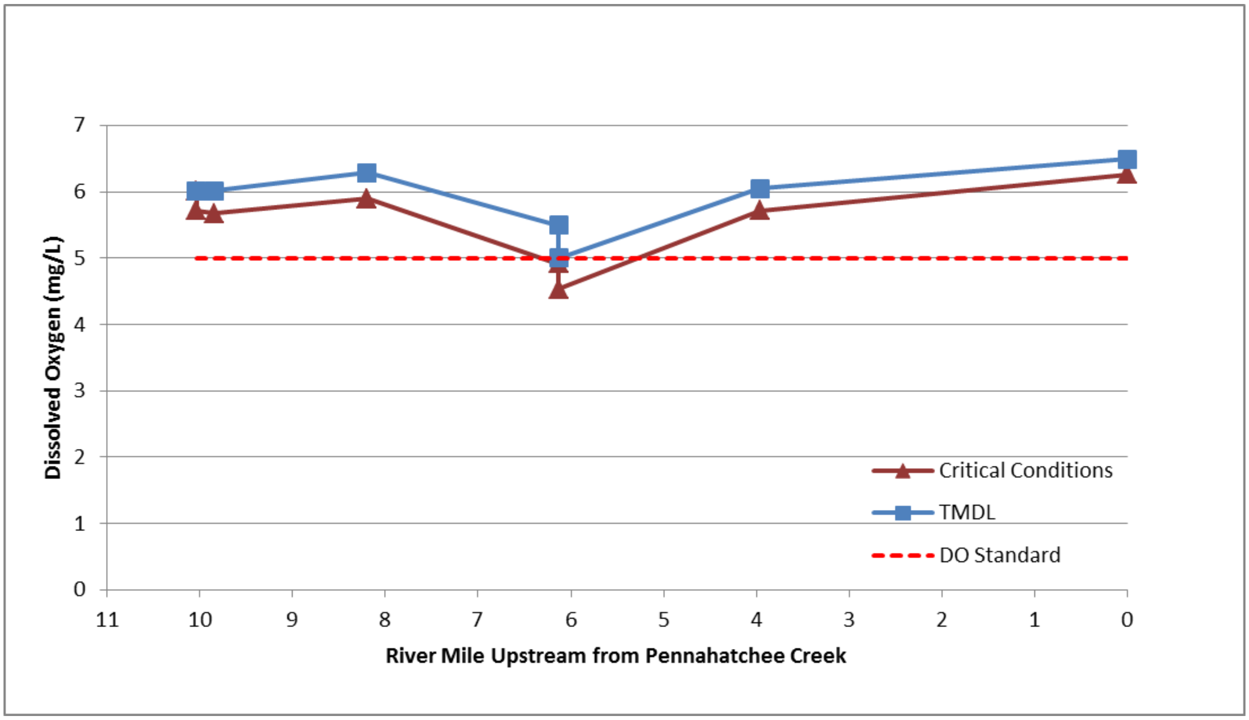

Figure 6. GaDosag Critical Condition and TMDL Plots versus the DO Standard

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. A TMDL is the sum of the individual wasteload 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 result in 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 are leading to the attainment of water quality standards.

The TMDL Implementation Plan establishes 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 segment’s water quality will then be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads.

5.1 Wasteload Allocations

5.1.1 Wastewater Treatment Facilities

The wasteload 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 is one NPDES permitted facility in the Turkey Creek watershed that affects instream DO. Wasteload allocations are provided to the point sources from this municipal wastewater treatment system.

Table 14 lists the permit limits for the WLA required to meet the TMDL. The TMDL requires a reduction in the WLA. To convert the permit limits to the TMDL WLA, the BOD_5 was converted to $CBOD_u$ by multiplying by an f-ratio of 1.9, based on the first-order decay rate of 0.15 for $CBOD_u$ (standard EPD modeling practice). Ammonia was converted to $NBOD_u$ by multiplying by the stoichiometric conversion factor of 4.57. It should be noted that the rates used in the TMDL model were based on best professional judgement and may need to be verified.

Table 14. Discharge Permit Limits and WLA

Facility Name	NPDES Permit No.	Receiving Stream	NPDES Permit Limits				WLA 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)	
Byromville WPCP	GA0025623	Turkey Creek	0.104	20	5.0	6.0	53

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 GaDosag model was run under critical conditions. Because the critical conditions occur during low flow, high temperature when there are no storm events, no numeric allocation is given to the wasteload 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.

5.3 Seasonal Variation

The low flow, 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.

5.4 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:

- Critical 7Q10 flows;
- Hot summer temperatures;
- Conservative reaction rates; and
- The assumption that all point sources continuously discharge at their NPDES permit limits for the same critical period.

5.5 TMDL Results

The current critical load and corresponding TMDL, WLA, LA, MOS, and percent load reduction for the listed segment of Turkey Creek are presented in Table 15.The TMDL is expressed as UOD, which includes $CBOD_u$ and $NBOD_u$. The existing load represents the worst-case scenario, assuming a discharge of 17.4 mg/L NH3 and a DO of 2 mg/L. The load reduction required is protective of critical conditions and thus should be sufficient to prevent exceedances of the instream DO standard for a wide range of conditions.

Table 15. TMDL Load for Turkey Creek under Critical Conditions

Stream Segment	Existing Load (lbs/day)	WLA (lbs/day)	WLAsw (lbs/day)	LA (lbs/day)	TMDL (lbs/day)	MOS	Percent Reduction
Turkey Creek – Rogers Branch to Pennahatchee Creek	172	53	NA	54	107	Implicit	37.8

NA = Not Applicable. Storm water discharges are not associated with MS4s contributing to the listed segment during critical conditions

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 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 Flint 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 EPD in Turkey Creek, this segment is listed as not supporting its designated use due to exceedance of the DO criteria. EPD needs to determine the natural DO for the stream before it can determine whether the DO criteria are 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 cases where a watershed-based plan has been prepared for a listed stream segment, a water quality monitoring program is developed to help identify the various sources of oxygen demanding substances. The monitoring program can also be used to verify the 305(b)/303(d) stream segment listing. This is especially valuable for segments where limited data resulted in the listing. To date, there has not been a watershed-based plan developed for Turkey Creek (GA EPD, 2017c).

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, EPD will determine whether the permitted dischargers to the listed watersheds have a reasonable potential of discharging oxygen demanding substances at 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 EPD will use its EPA-approved 2003 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary.

If effluent limitations are determined to be necessary for any facility, they should be established in accordance with *Georgia Rules and Regulations for Water Quality Control* (GA EPD, 2015), 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.

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 and have the potential to contain the listed constituent, must be monitored to determine that benchmarks levels are met. Also, this permit requires implementation of BMPs.

Urban sources of fecal coliform can best be addressed using a strategy that involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable. Management practices, control techniques, public education, and other appropriate methods and provisions may be employed.

The following three organizations have primary responsibility for working with the agricultural community to promote soil and water conservation, and to protect water quality:

- University of Georgia (UGA) - Cooperative Extension Service;
- Georgia Soil and Water Conservation Commission (GSWCC); and
- Natural Resources Conservation Service (NRCS).

UGA has faculty, County Cooperative Extension Agents, and technical specialists who provide services in several key areas relating to agricultural impacts on water quality.

EPD designated the GSWCC as the lead agency for agricultural Nonpoint Source Management in the State. The GSWCC develops nonpoint source management programs and conducts educational activities to promote conservation and protection of land and water devoted to agricultural uses.

The Natural Resources Conservation Service (NRCS) cooperates with federal, state, and local governments to provide financial and technical assistance to farmers. NRCS develops standards and specifications for BMPs used to improve, protect, or maintain our state's natural resources. Some of these BMPs may be used for farming operations to manage animal wastes and fertilizer use.

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 will be provided for these TMDLs. During this time, the availability of these TMDLs will be public noticed, a copy of the TMDLs will be provided as requested, and the public will be invited to provide comments on the TMDLs.

7.0 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 Flint 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).

7.1 Not Supporting Segments

This initial plan is applicable to the following water body that was added to Georgia's 2014 Integrated 305(b)/303(d) list of not supporting waters in *Water Quality in Georgia* 2012-2013 (GA EPD, 2014) available on the GA EPD website. Table 1 presents the stream in the Flint River Basin that was included on the 2014 303(d) list for exceedance of the DO criteria.

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

Reach ID	Stream Segment	Location	Segment Length (miles)	Designated Use	Listing
GAR031300060407	Turkey Creek	Rogers Branch to Pennahatchee Creek (Dooly Co.)	9	Fishing	NS

Note: NS = Not Supporting designated use

The criterion violated is DO, and the potential causes listed are nonpoint source and municipal point source discharges. The use classification water quality standards for DO, as stated in Georgia's *Rules and Regulations for Water Quality Control* (GA EPD, 2015), 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 DO 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, 2015):

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

> Where natural conditions alone create DO 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 EPD numeric limits at critical conditions, then the EPD numeric limits apply. If naturally occurring DO is lower than the EPD numeric limits, then 90% of the natural DO will become the minimum allowable DO, unless the natural DO is less than 3.0 mg/L, then a 0.1 mg/L deficit is allowed.

7.2 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 that may result in direct deposition of particulates, and seepage of contaminated groundwater.

A single NPDES permitted municipal wastewater treatment facility has been identified as a potential source of oxygen demanding substances. This facility has effluent limits for BOD_5. However, it currently does not have permit limits for NH_3-N or DO.

Potential nonpoint sources in urban areas of the Turkey Creek watershed are attributed to wastes from domestic animals, illicit discharges of sanitary waste, leaking septic systems, and runoff from improper disposal of waste materials. In rural areas, potential sources consist of agricultural crops and livestock. Runoff from row crops where phosphorus and nitrogen fertilizers have been used can contribute nutrient loads to the creek. Grazing pastures, manure storage areas, and access points for livestock can all result in contributions of biodegradable substances to the creek. Natural sources may include wildlife that resides near or in the creek, and contributions from decomposing vegetation coming from adjacent wetlands and leaf litter.

7.3 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 substance to the impaired stream segments:

- Sustain compliance with current and future NPDES treated wastewater permit requirements;

- 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 *Upper Flint Regional Water Plan* (GA EPD, 2017a);

- 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;

- 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;

- EPD should continue working with federal, state, and local agencies and owners of sites where oxygen demanding substances can be released, and in developing and implementing Best Management Practices (BMPs) appropriate to both urban and rural land uses, where applicable.

- Continue efforts to increase public awareness and education towards the impact of human activities in urban and rural settings on water quality, ranging from the consequences of industrial and municipal discharges and activities of individuals in residential neighborhoods, to the day-to-day operations of farms in agricultural communities.

7.4 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 Turkey Creek 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.

7.5 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 wasteload 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 body 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

Model Structure

Table A-1. Turkey Creek GaDosag Model Structure

Reach No.	Reach Name	Reach Type	Lateral D.A. sq. mi	Reach Length mi	River Mile
	Branch 1: Turkey Creek Headwater (Station TC-6)				
1	Byromville Pond (GA0025623)	Discharge			10.04
2	Byromville Pond to USGS Gage 02349900/SR 90/Station TC-5	Stream	0.17	0.2	10.04
3	USGS Gage 02349900/SR 90/Station TC-5 to Reedy Branch	Stream	1.28	1.64	9.84
4	Reedy Branch (Station RB-1)	Tributary			8.2
5	Reedy Branch to Little Creek	Stream	2.54	2.07	8.2
6	Little Creek (Station LC-1 Alternate)	Tributary			6.13
7	Little Creek (Station TC-4) to Unnamed Tributary	Stream	2.5	2.17	6.13
8	Unnamed Tributary to Pennahatchee Creek (Station TC-3 and TC-2)	Stream	11.92	3.96	3.96
9	Turkey Creek-Pennahatchee Creek Confluence	Tributary			0

APPENDIX B

Daily Oxygen Demanding Substances Load Summary Memorandum

SUMMARY MEMORANDUM
Average Annual Oxygen Demanding Substances Load
Turkey Creek

1. 303(d) Listed Waterbody Information

State:	**Georgia**
County:	**Dooly**
Major River Basin:	**Flint**
8-Digit Hydrologic Unit Code(s):	**03130006**
Waterbody Name:	**Turkey Creek**
Location:	**Rogers Branch to Pennahatchee Creek**
Stream Length:	**9 miles**
Watershed Area:	**81 square miles**
Flows into:	**Gulf of Mexico**
Ecoregion:	**Dougherty Plain**
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 DO, 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:	**GaDosag – Steady-state one dimensional water quality model developed by Georgia Environmental Protection Division.**
Calibration Data:	**Georgia EPD field data from August 24, 2017.**
Critical Conditions:	**(1) High summer temperatures, based on historic water quality data; (2) 7Q10 Low Flow (3) Conservative reaction rates; and (4) Incorporation of point sources discharging at their NPDES permit limits.**

3. Allocation Watershed/Stream Reach:

Wasteload Allocations (WLA):	**53 lbs/day**
Wasteload Allocations (WLAsw):	**NA**
Load Allocation (LA):	**54 lbs/day**
TMDL	**107 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) High summer temperatures, based on the historical record, persist for the same critical period;
(2) 7Q10 Low Flow
(3) Conservative reaction rates; and
(4) All point sources discharge continuously at their NPDES permit limits for the same critical period.