Total Maximum Daily Load

Evaluation

for

Turkey Branch

in the

Suwannee River Basin

(Cadmium)

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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1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into three categories: supporting, partially supporting, or not supporting their designated uses 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* every two years.

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) established 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 in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified 8-miles of Turkey Branch, from its headwaters to its confluence with the Willacoochee River, in the Suwannee River basin as not supporting its designated uses for the parameter cadmium. In addition, this same segment of Turkey Branch is listed as not supporting its designated uses for copper, lead, zinc, mercury, toxicity, fecal coliform, and dissolved oxygen. The listing of Turkey Branch for cadmium resulted from the assessment of water quality data from Turkey Branch measured at a bridge crossing approximately 100 yards downstream of the point source discharge from the Fitzgerald wastewater treatment plant (WWTP).

1.2 Watershed Description

The Turkey Branch watershed is located in the Suwannee River basin in south-central Georgia in Ben Hill County. The watershed is part of the Tifton upland of the Coastal Plain Physiographic Province. Turkey Branch originates approximately one mile north of the center of Fitzgerald, Georgia. Upstream of the Fitzgerald WWTP discharge point, the stream flows through areas that are predominantly urban or agricultural. Downstream of the Fitzgerald WWTP, the stream flows through a wetland area and transitions into Lake Beatrice which drains into the Willacoochee River.

The Fitzgerald WWTP is the only major point source discharger in the Turkey Branch watershed. It treats both municipal and industrial wastewater using an activated sludge system with a design capacity of 6.0 million gallons per day (MGD). Two minor industrial facilities discharge to Turkey Branch just upstream of the Fitzgerald WWTP discharge point. The Custom Profiles, Inc. WTF discharges approximately 0.05 MGD of treated wastewater to Turkey Branch consisting of contact cooling and heating water as well as stormwater runoff. The Aeroquip Corporation WTFdischarges approximately 0.08 MGD of treated wastewater to Turkey Branch consisting of contact cooling water and stormwater runoff.

The 1-day, 10-year minimum (1Q10) statistical flow value associated with Turkey Branch is 0.0 cubic feet per second (cfs). In addition, the 7-day, 10-year minimum (7Q10) statistical flow value associated with Turkey Branch is 0.0 cfs.

1.3 Water Quality Standard

The water use classification for Turkey Branch is fishing. The fishing classification, as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(c), is established to protect the "Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality."

Chapter 391-3-6-.03(5)(e)(ii) of Georgia's Rules and Regulations establishes criteria for metals which apply to all waters in the State. The established chronic criterion and acute criterion for dissolved cadmium are as follows:

$$\text{acute criteria for dissolved cadmium} = (e^{(1.128[\ln(\text{hardness})] - 3.828)})(1.136672-[(\ln \text{hardness})(0.041838)])\ \mu g/l$$

$$\text{chronic criteria for dissolved cadmium} = (e^{(0.7852[\ln(\text{hardness})] - 3.490)})(1.101672-[(\ln \text{hardness})(0.041838)])\ \mu g/l$$

where hardness is expressed as mg/l as $CaCO_3$.

This regulation requires that instream concentrations of dissolved cadmium shall not exceed the acute criteria indicated above under 1Q10 or higher stream flow conditions and shall not exceed the chronic criteria indicated above under 7Q10 or higher stream flow conditions.

In accordance with Georgia Rules and Regulations for Water Quality Control 391-3-6-.03(5)(e)(ii), guidance found in EPA's "Guidance Document of Dynamic Modeling and Translators August 1993" may be used to determine the relationship between the total recoverable concentration of a metal and the dissolved form of a metal. The metals translator is determined using default linear partition coefficient values found in an EPA document entitled, "Technical Guidance Manual for Performing Waste Load Allocations – Book II: Streams and Rivers."

In addition, Georgia Regulation 391-3-6-.06(4)(d)5.(ii)(b)(2) allows methods from this EPA guidance document to be used to translate dissolved criteria concentrations into total recoverable permit limits. Metals effluent permit limitations are required to be expressed as total recoverable metal per 40 CFR §122.45(c). Therefore, the TMDL will be expressed as both the total maximum daily load of total recoverable cadmium that will be protective of the dissolved cadmium chronic criterion and the total maximum daily load of total recoverable cadmium that will be protective of the dissolved cadmium acute criterion.

2.0 WATER QUALITY ASSESSMENT

Turkey Branch's use support determination was made for cadmium based on two water quality samples that were measured in 1999 from Turkey Branch (see Table 1) at a location approximately 100 yards downstream from the Fitzgerald WWTP discharge. Data from one sample indicated exceedance of the cadmium criteria

Table 1. Cadmium Data Collected From Turkey Branch

Date	Measured total recoverable cadmium concentration (ug/l)	Translator (total recoverable to dissolved)	Assumed dissolved cadmium concentration (ug/l)	Measured Total Hardness (mg/l as $CaCO_3$)	Acute criterion (ug/l)	Chronic Criterion (ug/l)
3/23/99	2.2	1	2.2	88.4	3.24	0.94
7/12/99	< 0.5	1	< 0.5	73.5	2.65	0.82

3.0 SOURCE ASSESSMENT

The Fitzgerald WWTP has been identified as the potential source of the cadmium in Turkey Branch. Only a small amount of information is available concerning potential sources of cadmium. Each of the three point sources which discharge to Turkey Branch are authorized to discharge through the Georgia National Pollutant Discharge Elimination System (NPDES) program. In accordance with the NPDES program, these facilities have periodically taken samples of their discharges and have analyzed for the parameter cadmium. The available results from these analyses are included in the table below. Total hardness was not measured for any of the samples that were collected.

Table 2. Cadmium Data Collected From NPDES dischargers to Turkey Branch

NPDES discharger	Date	Measured total recoverable cadmium concentration (ug/l)	Translator (total recoverable to dissolved)	Assumed dissolved cadmium concentration (ug/l)
Aeroquip Corporation	7/31/92	< 20	1	< 20
Aeroquip Corporation	10/28/92	< 5	1	< 5
Custom Profiles, Inc.	2/25/99	< 3	1	< 3
Custom Profiles, Inc.	6/18/99	< 5	1	< 5
Fitzgerald WWTP	1/18/94	18	1	18
Fitzgerald WWTP	1/20/99	< 0.5	1	< 0.5

Most of the measured concentrations were below the detection limits of the analytical method used in the laboratory. However, the detection limits for each of these samples are greater than the cadmium concentrations measured in Turkey Branch. In the case of the 1994 sample taken from the Fitzgerald WWTP effluent, the measured concentration was significantly higher than the water quality criterion for cadmium.

It is unknown whether any non-point sources potentially cause or contribute to excursions of the water quality standard for cadmium. However, there is no data available which indicates any specific non-point source of cadmium.

4.0 TMDL DEVELOPMENT APPROACH

For TMDL purposes, steady-state models are applied for "critical" environmental conditions that represent extremely low assimilative capacity. For effluent-dominated riverine systems where there are no known sources of nonpoint source pollution, critical environmental conditions correspond to drought upstream flows. The assumption behind steady-state modeling is that effluent concentrations that protect water quality during critical conditions will be protective for the large majority of environmental conditions that occur.

4.1 Critical Conditions

Since there are no known potential nonpoint source contributions to the cadmium impairment of Turkey Branch, the critical flow conditions for this TMDL are represented by scenarios where the ratio of effluent to stream flow is the greatest. For protection of the chronic criteria, this flow condition occurs when the Fitzgerald WWTP, Aeroquip Corporation WTF, and Custom Profiles, Inc. WTF are discharging at their design capacity and the stream is flowing at 7Q10 conditions. For protection of the acute criteria, this flow condition occurs when the Fitzgerald WWTP, Aeroquip Corporation WTF, and Custom Profiles, Inc. WTF are discharging at their design capacity and the stream is flowing at 1Q10 conditions.

Table 3. Critical Flow Conditions for Turkey Branch

Source of Flow	Flow value (MGD / cfs)
Aeroquip Corporation WTF	0.08 / 0.124
Custom Profiles, Inc. WTF	0.05 / 0.077
Fitzgerald WWTP	6.0 / 9.28
Turkey Branch (during 7Q10 conditions)	0.0 / 0.0
Turkey Branch (during 1Q10 conditions)	0.0 / 0.0

Based on the available hardness data measured in Turkey Branch (i.e., 73.5 mg/l and 88.4 mg/l as $CaCO_3$), the hardness value used for critical conditions is 73.5 mg/l. This hardness value corresponds to a dissolved cadmium chronic criterion of 0.82 ug/l and a dissolved cadmium acute criterion of 2.65 ug/l.

Consistent with the suggestions in the EPA guidance document referenced in Georgia's water quality standards for metals, the translator for converting total recoverable cadmium concentrations to dissolved cadmium concentrations will be expressed as follows:

A translator may be established using the methods documented in EPA's "Technical Guidance Manual for Performing Waste Load Allocations – Book II: Streams and Rivers". The partition coefficient for cadmium found in the EPA's Technical Guidance Manual is expressed as:

$$K_d = K_{po} * TSS^{+a}$$

where K_d = partition coeffiecient for cadmium in L/kg
K_{po} =4.0×10^6
TSS =total suspended solids concentration in mg/l
a =-1.1307

It is important to note that the authors of EPA's Technical Guidance Manual derived the above values for the 'K_{po}' coefficient and the 'a' exponent based on the statistical analysis of 254 data records collected from rivers and streams distributed throughout the United States.

The partitioning of cadmium between solid and dissolved phases can be determined as a function of the partition coefficient for cadmium and the concentration of solids in the water column. This function is expressed as: $C_t/C_d = 1 + K_d * TSS * (10^{-6}$ kg/mg)

where C_t = total cadmium concentration in µg/l
C_d = dissolved cadmium concentration in µg/l

Instream TSS data is not available for Turkey Branch. Since this stream is effluent dominated during low flow critical conditions, the effluent TSS concentrations from the Fitzgerald WWTP are assumed to be representative of instream TSS concentrations. Using Permit Compliance System (PCS) data from May 1995 through April 2000, the average effluent TSS concentration is determined to be 6.7 mg/l. Applying a value of 6.7 mg/l to the above relationship, the expected ratio of total cadmium to dissolved cadmium (i.e., the translation factor) is 4.12.

5.0 ALLOCATION

5.1 Total Maximum Daily Load

A TMDL is the sum of the individual WLAs for point sources and load allocations (LA) for nonpoint sources and natural background (40 CFR 130.2). The sum of these components may not result in an exceedence of water quality standards for that water body. To protect against exceedences, 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. Conceptually, a TMDL can be expressed as follows:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while maintaining water quality standards. For pollutants such as metals, TMDLs are expressed on a mass loading basis (e.g., pounds per day). In accordance with 40 CFR Part 130.2(i), "TMDLs can be expressed in terms of ... mass per time, toxicity, or other appropriate measure."

5.2 Waste Load Allocations

As is stated in Section 4.1 of this report, the dissolved cadmium chronic criterion is equal to 0.82 ug/l and the dissolved cadmium acute criterion is equal to 2.65 ug/l for the established critical conditions.

Using a translation factor equal to 4.12, the allowable instream total recoverable concentrations are 3.38 ug/l and 10.9 ug/l in order to respectively protect against chronic and acute effects of cadmium. Furthermore, the WLA is calculated using the flows established for critical conditions. Since there is no available dilution during critical conditions, the effluent concentration from each point source cannot exceed the allowable instream total recoverable chronic and acute concentrations.

Allowable total recoverable loading to protect the dissolved cadmium chronic criterion:

allowable loading = sum of the allowable loadings from the individual point sources

where the allowable loading from an individual point source is calculated as follows:

individual point source loading = (allowable effluent chronic conc.) x (effluent flow rate) x (unit conversion factor)

1. allowable loading from the Fitzgerald WWTP = 0.07676 kg/day
2. allowable loading from Aeroquip Corporation = 0.00102 kg/day
3. allowable loading from Custom Profiles, Inc. = 0.00064 kg/day

allowable loading to protect the chronic cadmium criterion = 0.07842 kg/day

Allowable total recoverable loading to protect the dissolved cadmium acute criterion:

individual point source loading = (allowable effluent acute conc.) x (effluent flow rate) x (unit conversion factor)

1. allowable loading from the Fitzgerald WWTP = 0.24754 kg/day
2. allowable loading from Aeroquip Corporation = 0.00330 kg/day
3. allowable loading from Custom Profiles, Inc. = 0.00206 kg/day

allowable loading to protect the acute cadmium criterion = 0.25290 kg/day

5.3 Load Allocations

There are currently no known cadmium contributions to Turkey Branch from nonpoint sources. In the event that nonpoint source contributions of cadmium were present, it is extremely unlikely that the WLA would need to be different than what has been established in this report, because the WLA requires that the effluent from each facility must itself be protective of the water quality criteria. Considering this information, the load allocation is established as 0.0 kg/day.

5.4 TMDL Results

The TMDL can be summarized as follows:

Table 4. TMDL SUMMARY

Parameter	Criterion	WLA	LA	MOS	TMDL
Total Recoverable Cadmium	Dissolved Chronic Criterion	Fitzgerald WWTP (0.07676 kg/day) Custom Profiles Inc. (0.00064 kg/day) Aeroquip Corporation (0.00102 kg/day) TOTAL WLA = 0.07842 kg/day	0.0 kg/day	Implicit	0.07842 kg/day
Total Recoverable Cadmium	Dissolved Acute Criterion	Fitzgerald WWTP (0.24754 kg/day) Custom Profiles Inc. (0.00206 kg/day) Aeroquip Corporation (0.00330 kg/day) TOTAL WLA = 0.25290 kg/day	0.0 kg/day	Implicit	0.25290 kg/day

5.5 Seasonal Variation

The low flow critical conditions incorporated in this TMDL represent the most critical design condition and will provide year-round protection of water quality.

5.6 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.

The MOS was implicitly incorporated into the TMDL for Turkey Branch through the use of critical conditions established in section 4.1 of this report. Through the use of low flow conditions, the lowest of available hardness values, and the methods used to develop the translators for the two TMDL scenarios, the margin of safety for this TMDL adequately accounts for the lack of knowledge concerning the relationship between effluent limitations and water quality.

6.0 POINT AND NONPOINT SOURCE APPROACHES

An allocation to an individual point source discharger does not automatically result in a permit limit or a monitoring requirement. Through its NPDES permitting process, Georgia will determine whether each of these three permitted dischargers to Turkey Branch has a reasonable potential of discharging cadmium 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 1995 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.

7.0 PUBLIC PARTICIPATION

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

REFERENCES

GAEPD, NPDES Reasonable Potential Procedures. Atlanta, GA. January 1995.

GAEPD, *Rules and Regulations For Water Quality Control, Chapter 391-3-6, April 2000*, Georgia Department of Natural Resources, Environmental Protection Division.

USEPA. Technical Guidance Manual for Performing Waste Load Allocations: Book II Streams and Rivers - Chapter 3 Toxic Substances. U.S. Environmental Protection Agency, Office of Water, Regulations and Standards, Monitoring and Data Support Division, Washington, D.C. June 1984.

USEPA. 1991a. *Technical Support Document for Water Quality – based Toxics Control.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-505/2-90-001, April 1991.

USEPA. 1991b. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

USEPA. Appendix J of Water Quality Standards Handbook: Second Edition (i.e., "Guidance Document on Dynamic Modeling and Translators August 1993"). U.S. Environmental Protection Agency, Office of Water, Washington, D.C. EPA/823/B-94-005a. August 1994.

USEPA, 1998. Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), Version 2.0 User's Manual, U.S. Environmental Protection Agency, Office of Water, Washington D.C.