APPENDIX 7C. WETLAND CONSTITUENT RELEASE MODEL

INTRODUCTION

The Biogeochemistry Work Group developed the Wetland Constituent Release Model. The model is a Microsoft Excel® spreadsheet-based model that calculates the difference in constituent mass release between the base scenario (Base1995NN) and any other hydrological scenario. The model uses daily time steps and centimeter increments of water elevation over the simulated time period (November-October water years 1976-2008). For each scenario it calculates the difference in exposed area between a test scenario and the base scenario, based on the digital elevation model developed by the Wetland Work Group (Chapter 10). This difference in area exposed is multiplied by the areal release rate for the specific constituent (Table 7C-1) and by a temperature correction factor to estimate the daily difference in mass release. For each year the Wetland Constituent Release Model sums the daily differences in potential releases to yield an annual potential difference in mass release. The model does not sum or deduct differences when the test hydrological scenario inundates a larger wetland area than the base hydrological scenario (i.e. no negative releases due to area).

The information on release rates was more limited than planned because flooding and drying events prevented completion of field studies. However, the data were sufficient to estimate site-specific release rates. In recognition of the limitations of the site-specific data, we used maximum estimates of release rates judging that overestimation of release rates was less problematic than would be underestimation (Table 7C-1). These are carbon and nutrient daily potential release or more accurately accumulation rates from Lake Poinsett soils. Estimates were determined using a soil core diameter study (Diameter) and a field core study (Field Core). Values in the “release” per day of exposure column were used as data inputs to the wetland Release Model

Table 7C-1. “Release” rates for constituents with study source and number of samples and days exposed.

Variable	Study	Days of Exposure	N	Release per day of exposure
				$mg\ m^{-2}\ d^{-1}$
DOC	Field Cores[1]	30	12	18.7[3]
TKN	Diameter[2]	61	30	2.28[3]
TP	Diameter[2]	61	30	0.59[3]

[1] The release from field cores exposed for 30 days were calculated by dividing the areal mass release ($mg\ m^{-2}$) by 30 days. The 30 days of exposure followed an inundation period of about 60 days, which followed the previous 125, 112, and 97 days of exposure.

[2] Release per day of exposure for the core diameter study was determined by dividing the mean areal release by the number of exposure days prior to flooding in the laboratory. Release per day of exposure for field cores were determined as the linear slope between areal release from soils ($mg\ m^{-2}$) and exposure days.

[3] Neither the diameter nor the field core with 30 days of exposure had data at more than one time so statistical significance is calculated as difference from zero.

AREA CALCULATION

We used the digital elevation model to construct water elevation - area relationships for each Lake Winder and Lake Poinsett and their associated wetlands (Chapter 7. – Biogeochemistry Figure.4–2). Wetland elevations were truncated at the higher elevations because the inundation frequency is so low that organic soils are either absent or are maintained by seepage instead of river levels. Wetland elevation ranges were 2.7 m to 5.7 m for Lake Winder, which encompasses 91 km^2 (35 mi^2), and 2.5 m to 5.5 m for Lake Poinsett, which encompasses 72 km^2 (28 mi^2) of wetlands. The model used these hypsographic relationships convert daily water elevations to difference in hectares inundated between scenarios.

In comparing scenarios, if both hydrologic scenarios inundated or exposed a wetland area, no value was retained. However, if the base hydrologic scenario inundated an area and the withdrawal scenario did not, the difference in area was retained because the area would be exposed under the test scenario while inundated under the base scenario. Once all affected areas were assessed, the differences were summed to provide the total areal difference in exposed wetland area between the base and the test scenario for that day. This was repeated for each day of the period of record (1976-2008).

TEMPERATURE EFFECTS CALCULATION

Carbon and nutrient release is a biologically mediated process. Therefore, accounting for temperature effects was important. In the spreadsheet, the temperature correction is handled by a simple Q_{10} coefficient, which doubles the release rate with an increase in ten degrees Celsius near 20º C. A doubling was the temperature relationship found by Kadlec and Reddy (2001). If the Q10 equals 2 then the temperature coefficient, T, to account for temperature differences is:

$$T = 2^{(temp-20)/10} \qquad \textbf{[Eq. 7C–1]}$$

Where “temp” represents the soil temperature calculated for the ordinal date or day-of-the-year. A temperature correction factor is calculated for each day of the year based on projected soil temperatures. The extra complexity of using an Arrhenius equation was not considered necessary over the small temperature range encountered in this study. It may be necessary in more temperate areas.

SOIL TEMPERATURE CALCULATION

We estimated daily soil temperatures using a fourth-order polynomial fit to fourteen years of soil data taken at the Kenansville Florida Automated Weather Network station (Figure 7C-1).

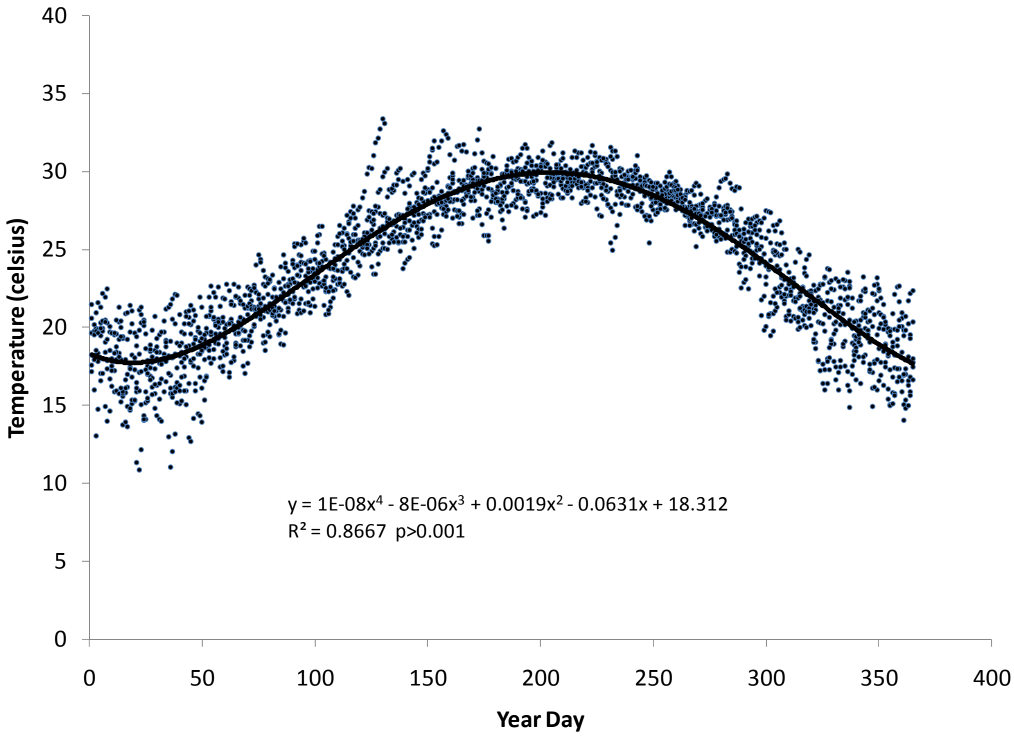

Figure 7C-1. Line fit to multiyear soil data from Kenansville Florida Automated Weather Network site.

MASS RELEASE CALCULATION

As stated above, daily differences from the base scenario in areas exposed were multiplied by the constituent release rate and by the temperature correction factor. The daily differences in release were then summed over all twelve months of the year. The model can be summarized by the following equation: We calculated the accumulation for potential release using the following equation:

$$R = \sum_1^{365} \ (r \times A \times T) \qquad \textbf{[Eq. 7D–1]}$$

Where : R = total potential accumulation for release (g)
r = daily "release" or accumulation rate when exposed (g m^{-2} d^{-1})
A = additional area exposed (m^2)
T = temperature rate correction as described above.

For each year, the calculated annual increase in mass accumulated was apportioned over the five-month period that typically comprises the rising limb of the hydrograph as a flow-weighted average. The flow and total mass accumulation for release were used as inputs to the wetland constituent Reduction Model (Appendix 7D) to calculate potential increases in lake loads and concentrations and loads.