Tidal Caloosahatchee River BMAP
Estimates of Stakeholder Loading from HSPF Model Results

Introduction

The Tidal Caloosahatchee Nutrient TMDL was adopted by FDEP in October 2009 based on modeling of the Caloosahatchee River and its watershed. The watershed was modeled using HSPF and the tidal portion was modeled with EFDC. In the BMAP process, allowable loading must be assigned to each stakeholder. Unfortunately, the HSPF model was set up by basins and subbasins, the boundaries of which did not coincide exactly with municipal, county or other stakeholder boundaries. Therefore, one of the steps in the BMAP is to divide the loading up to each stakeholder so that the total loading matches the loading from HSPF.

Loading from HSPF is based on 102 subbasins which eventually discharge to 29 load points to the EFDC model. The non-tidal part of the watershed consists of 59 subbasins, which discharge to one load point in EFDC. The other 43 subbasins discharge to 28 load points in the tidal river. Some of the subbasins discharge directly to the river load point, whereas others loaded to HSPF reaches and were routed to the load point, with the potential for some of the land-based load being lost by settling or other processes before reaching the load point. Additionally, rainfall was input via 15 NEXRAD rainfall zones. Data were also available on the land uses for 2004; these were used in HSPF to represent the "existing condition" simulation for the period 2003 to 2005. Since HSPF is a buildup-wash-off model where nutrients build up during dry periods and wash-off during rainfall at a rate depending on the land use type, calculation of stakeholder loading is complicated as the loading from each subbasin varies by land use, soil condition and rainfall history.

Provided below is an explanation of the methods used to distribute the modeled loading to each stakeholder. The methods are based on defining land use-specific unit loads such that the total loading from the land area tributary to each load point is equal to the loading from the HSPF model output.

Methods

The stakeholder loading was estimated using land use-specific unit loads determined for each EFDC loading point. For a given loading point, the total annual load (W) in pounds per year can be represented as:

$$(1) \qquad W = \sum_{1}^{10} (L_i) (AN_i + (1 - f_b)(AB_i))$$

where L_i is the uncontrolled unit load (lb/ac/yr) from land use i, AN_i is the number of acres of land use i that <u>are not served</u> by BMPs, AB_i is the number of acres of land

use i that are served by BMPs, and f_B is the fraction of load that is removed in the BMP. In the estimation of stakeholder-specific loading, land uses were categorized into 10 land use categories (see below).

HSPF model output for single land use categories were reviewed to determine relative unit load values for each land use category. The high density residential land use category was used as the basis for the relative unit load factors, presented in the table later in this document.

Using the relative load factors, equation 1 can be converted to the following:

$$W = L_{HD} \sum_{1}^{10} (f_i) (AN_i + (1 - f_b)(AB_i)) \quad (2)$$

where L_{HD} is the uncontrolled unit load for the high density residential land use, and f_i is the relative loading factor for land use i.

Equation 2 can then be rearranged to solve for the value of L_{HD}, as follows:

$$L_{HD} = \frac{W}{\sum_{1}^{10} (f_i) (AN_i + (1 - f_b)(AB_i))} \quad (3)$$

Knowing the value of L_{HD}, the value of L_{HD} with BMP, or L_i with and without BMP for any of the other land use types, can be calculated knowing the relative load factors and the percent removal for the BMP. In turn, these values are then applied to the land use distribution within each jurisdiction to calculate the load from each jurisdiction.

For this analysis, the following loading ratios were used. Zone B was applied to Node Points 2 through 15 and Zone A was applied to Node Points 16 through 29.

Land Use Type	Loading Factor	
	Zone A	Zone B
Forest/Rural Open	0.34	0.26
Urban Open	0.40	0.31
Agriculture/Pasture	0.77	0.58
Low Density Residential	0.58	0.50
Medium Density Residential	0.86	0.78
High Density Residential	1.00	1.00
Commercial	1.02	1.11
Industrial	1.02	1.11
Highway	1.02	1.11
Water Wetlands	0.31	0.25

Use of this methodology is illustrated below for the tributary area to load point 2.

Calculation of Unit Loads for Load Point 2

Land Use Category	Area (acres)		Relative		L_{HD}	L_i
	No BMP AN_i	With BMP AB_i	Load Factor f_i	$(f_i)(AN_i+(1-f_b)(AB_i))$	(lb/ac/yr)	(lb/ac/yr)
A. Forest/Rural Open	23,380	-	0.26	6,079		2.79
B. Urban Open	-	-	0.31	0		3.32
C. Agriculture/Pasture	14,431	-	0.58	8,370		6.22
D. Low Density/Residential	19	154	0.50	63		5.36
E. Medium Density/Residential	-	15	0.78	8		8.36
F. High Density/Residential	-	-	1.00	0	10.72	10.72
G. Commercial	-	-	1.11	0		11.90
H. Industrial	-	-	1.11	0		11.90
I. Highways	-	66	1.11	51		11.90
J. Water/Wetland	15,189	-	0.25	3,797		2.68
TOTAL	53,019	235		18,369		

fb = 0.3 (30%) for total N reduction with BMPs

Load point 2 annual load 2003-2005 = 196,873 lb/yr = W for this example

The table above shows the total land area tributary to the load point is 53,254 acres (columns 2 and 3). Column 4 lists the relative load factors by land use type for this load point (using Zone B values from the previous table). Column 5 shows the equation 3 denominator value calculated for each land use type, and the summation of the values for all land uses. The high density residential unit load is calculated as the total load W of 196,873 lb/yr divided by the total value of 18,369 acres in column 5, and the result is 10.72 lb/ac/yr. The unit loads for the other land uses are then calculated as the product of the high density unit load and the relative load factor for each land use.

Calculation of Load from unincorporated Lee County - Load Point 2

Land Use Category	Area (acres)		L_i	Annual Load
	No BMP AN_i	With BMP AB_i	(lb/ac/yr)	(lb/yr)
A. Forest/Rural Open	1,721	-	2.79	4,796
B. Urban Open	-	-	3.32	0
C. Agriculture/Pasture	1,209	-	6.22	7,515
D. Low Density/Residential	19	154	5.36	680
E. Medium Density/Residential	-	15	8.36	88
F. High Density/Residential	-	-	10.72	0
G. Commercial	-	-	11.90	0
H. Industrial	-	-	11.90	0
I. Highways	-	-	11.90	0
J. Water/Wetland	845	-	2.68	2,264
TOTAL	3,794	169		15,343

This table illustrates how the load at load point 2 is allocated to one of the jurisdictions tributary to the load point (unincorporated Lee County). The land use area associated with Lee County is listed in columns 2 and 3 of this table. The unit loads in column 4 are taken directly from the previous table. The annual load for each land use is the product of the land area and the unit load value, though in the case of land area with BMPs, the unit load must be adjusted to reflect the pollutant removal in the BMPs. For example, the medium density residential land use has 15 acres with BMPs. Using a 30% total N reduction for BMPs, the appropriate unit load would be 8.36 * 0.7 = 5.85 lb/ac/yr. This unit value times 15 acres yields the annual load of 88 lb/yr for medium density residential land use.