Basin Management Action Plan Development in Hillsborough County, Florida

Edward T. Sherwood
Jennifer Lana
Gerold Morrison

Environmental Protection Commission
of Hillsborough County
Environmental Resources Management Division
3629 Queen Palm Dr.
Tampa, FL 33619

ABSTRACT:

Federally mandated total maximum daily loads (TMDLs) have recently been adopted to reduce pollutant loading to impaired waters in Hillsborough County, Florida. Consequently, "Basin Management Action Plan" (BMAP) development, a TMDL implementation process utilized in Florida, has been initiated. The Environmental Protection Commission of Hillsborough County, as part of a local stakeholder group that is working to develop BMAPs for the impaired waters, has used ArcGIS to collate, analyze, and disseminate land use and water quality information to participating stakeholders. This work has allowed specific land areas and hydrologic sub-basins of impaired watersheds to be identified and ranked based upon their potential discharges of non-point source pollutant loadings. Using a modification of the EPA SIMPLE method, a ModelBuilder tool in ArcGIS was constructed to automate the process. These methods and application of ArcGIS capabilities offer a valuable planning tool for development of new water quality and stormwater management programs.

1. INTRODUCTION & BACKGROUND

With the adoption of Section 303(d) of the Federal Clean Water Act (CWA) in 1972, the federal government has mandated the establishment of Total Maximum Daily Loads (TMDLs) for all surface water bodies in the United States (US). In establishing TMDLs for surface water bodies, the maximum amount of a given pollutant that a particular water body can assimilate without degrading its designated use (i.e., drinking, swimming, fishing, shellfish harvesting, navigating, etc.) is defined. A TMDL is generally composed of two main source allocations (point and non-point source loads) and an allocation for error in the estimates (margin of safety). Achieving the designated use of a particular water body is generally determined by meeting state or federal water quality standards. Therefore, the establishment of TMDL(s) for a water body will effectively serve to define the pollutant load allocations necessary in achieving acceptable water quality standards.

In Florida following the adoption of the Florida Watershed Restoration Act in 1999, an additional implementation phase was defined to address impending state and federally adopted TMDLs. The Basin Management Action Plan (BMAP) implementation phase of the TMDL process is currently ongoing in several areas of the state of Florida. This implementation phase of the TMDL process provides for a local forum to:

- identify and involve effected stakeholders,
- identify and potentially allocate reductions of pollutant sources,
- define the roles and responsibilities of public and private entities,
- define timetables and develop monitoring, evaluation, and reporting strategies, and
- develop adaptive management criteria.

Currently in Hillsborough County, FL, approximately 200 TMDLs have either been proposed, finalized, or adopted for surface water bodies of the county (Figure 1). The Environmental Protection Commission of Hillsborough County (EPC) has been actively involved in the broader BMAP implementation phase addressing these established and forthcoming TMDLs since early 2006. The EPC has provided GIS resources and analyses to the BMAP Working Group to guide the development of the Basin Management Action Plan for those water bodies with established TMDLs and that are considered impaired for one or more pollutants of concern.

In Florida, as in many parts of the US, non-point source loading has become an increasingly complex and major contributor to surface water pollutant loadings. The GIS analyses conducted by the EPC focused on identifying, from a landscape level scale, land-use or land-surface non-point source loadings in the county that may be contributing to the surface water body impairments identified by TMDLs. The analyses outlined below are being used during the BMAP implementation phase to identify and focus efforts to specific areas in the county where water quality improvement projects may be most beneficial in improving identified impairments.

2. GIS TOOLS USED IN BMAP DEVELOPMENT:

a. General Basin Characterizations & Identification of Potential Land Surface Sources

Several GIS analyses were conducted to assess the adjacent land uses of stream networks considered impaired for fecal coliforms during 2006. Stream corridors (100-m buffer width after Brown and Vivas 2005) were delineated along the USGS National Hydrologic Dataset (NHD) stream network. Recent land use (SWFWMD 2004; Table 1; Figure 2), future land use (SWFWMD 2002; Table 2; Figure 3), and refined county agricultural land use data were clipped to the 100-m stream corridor to assess the percent contribution of each land use type/category along the stream corridor. This information helped the BMAP Working Group identify the most dominant land-use loading sources along the impaired stream segments in their present condition and in their near-future, built-out condition.

b. GIS Screening of Potential Fecal Coliform Loadings from Septic Tanks

Also during 2006, to assess the potential impacts of fecal coliform loading from septic tanks to the impaired stream network, GIS point data of new and repaired septic permits (FDOH 2006) were mapped along the 100-m stream corridors of the impaired water body segments with the underlying soil types (SWFWMD 2004) (Figure 4). If a high density of new or repaired septic permit points fell along the stream corridor and were in an area with well-drained soils, then additional source tracking in the stream adjacent to the points was considered during the BMAP implementation phase.

c. Determination of Land Surface Load Potential using ArcGIS ModelBuilder

To characterize and prioritize areas that had the greatest potential to contribute high loads of a given pollutant of concern, an ArcGIS ModelBuilder tool (Figure 5) was developed to calculate potential non-point source loadings from a user-selected basin (e.g., Figure 6). Using a modification of the EPA SIMPLE Method (Schueler 1987; EPA 2005), the tool merges the underlying land use, soil type, and estimated average seasonal basin rainfall to generate a 10-m raster of land surface load potential of a user-selected pollutant of concern and basin (e.g., Figure 6). The calculation is determinant on the event mean concentration (EMC) of the land use type, the seasonally-dependent runoff coefficient of the underlying land use-soil type combination, and the estimated seasonal rainfall associated with a particular water body segment in the county. Because land uses are quickly changing in the watershed, this tool was developed to provide a rapid assessment of non-point source load potential as new land use information becomes available. It also provided an indication of where water quality improvement projects could be targeted within a particular basin of concern (e.g., Figure 7).

As an extension to the results generated by the ModelBuilder Tool, the resulting basin-specific rasters could be ranked and prioritized by determining the area-weighted land surface load potential of each basin (e.g., Figure 8). The maps produced by this extension of the model could be used by the BMAP Working Group to target regional areas in the broader watershed that would benefit the most from water quality improvement projects. Lastly, as a forecasting method to steer the BMAP Working Group towards water quality improvement projects that may be needed in the future to encumber growth, the ModelBuilder Tool was applied to future land use scenarios in the basins. Subtracting the current land use estimates from the future land use estimates allowed managers to determine the areas in the watershed that would undergo the greatest change in land surface load potentials in the future (e.g. Figure 9).

3. CONCLUSIONS

These methods and application of ArcGIS capabilities offer a valuable planning tool for development of new water quality and stormwater management programs in Hillsborough County, Florida. The use of existing data sources and concatenating them in a spatial environment using ArcGIS proved to be a valuable means of cost savings. The tools and the use of existing data sources have guided the development of source tracking methodologies for pollutants of concern for the development of Basin Management Action Plans in the county without having to allocate large amounts of time to identify potential sources in the field. In all, the ArcGIS environment has offered Hillsborough County an important screening level tool to guide the BMAP Working Group in making informed planning-level decisions regarding non-point sources and their locality in the impaired water bodies of the county.

4. REFERENCES AND DATA SOURCES

Brown, M.T. and M.B. Vivas. 2005. Landscape development intensity index. Environmental Monitoring and Assessment. 101:289-309.

EPA (Environmental Protection Agency). 2005. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. EPA 841-B-05-005.

FDEP (Florida Department of Environmental Protection). Tampa Bay Water Body ID (WBID) GIS Shapefiles. http://www.dep.state.fl.us/water/basin411/tampa/download.htm

FDOH (Florida Department of Health). 2006. New and Repaired Septic Permit Database for Hillsborough County. http://www.doh.state.fl.us/Environment/ostds/index.html

Schueler, T.R. 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Publ. No. 87703. Metropolitan Washington Council of Governments, Washington, DC.

SWFWMD (Southwest Florida Water Management District). 2002. Future Land Use GIS Shapefiles for the Southwest Water Management District, FL. http://www.swfwmd.state.fl.us/gisdata/cultural/

_____. 2004. Current Land Use GIS Shapefiles for the Southwest Water Management District, FL. http://www.swfwmd.state.fl.us/data/gis/libraries/physical_dense/lu04.htm

Table 1. Example GIS summary of current (2004) land uses along the 100-m stream corridor network of the impaired water body segment of New River, Florida (WBID 1442) (Data source: SWFWMD 2004).

Land Use Description	Area (m^2)	% of Total Stream Corridor
CROPLAND AND PASTURELAND	3533749.5	26.6
FRESHWATER MARSHES	1530411.1	11.5
RESIDENTIAL LOW DENSITY < 2 DWELLING UNITS	1389691.6	10.5
PINE FLATWOODS	1193455.5	9.0
WET PRAIRIES	1068366.9	8.1
SHRUB AND BRUSHLAND	987054.0	7.4
HARDWOOD CONIFER MIXED	636311.9	4.8
STREAM AND LAKE SWAMPS (BOTTOMLAND)	606772.7	4.6
WETLAND FORESTED MIXED	516809.9	3.9
CYPRESS	493285.6	3.7
TREE PLANTATIONS	188512.3	1.4
WETLAND CONIFEROUS FORESTS	182821.7	1.4
EXTRACTIVE	155372.1	1.2
LONGLEAF PINE - XERIC OAK	144240.7	1.1
RESIDENTIAL HIGH DENSITY	119145.6	0.9
OPEN LAND	114103.5	0.9
TREE CROPS	106964.2	0.8
NURSERIES AND VINEYARDS	104784.3	0.8
OTHER OPEN LANDS <RURAL>	60650.8	0.5
UTILITIES	49322.4	0.4
GOLF COURSES	41555.2	0.3
BAY SWAMPS	26788.7	0.2
EMERGENT AQUATIC VEGETATION	13102.8	0.1
COMMERCIAL AND SERVICES	8340.6	0.1

Table 2. Example GIS summary of future (2010) land uses along the 100-m stream corridor network of the impaired water body segment of New River, Florida (WBID 1442) (Data source: SWFWMD).

Future Land Use Description	Area (m^2)	% of Total Stream Corridor
Medium Residential	7769458.7	57.6
Low Residential	3618271.6	26.8
Agriculture	1468605.3	10.9
Preservation/Conservation	514543.3	3.8
Institutional	105382.3	0.8
Mixed Use	16871.7	0.1

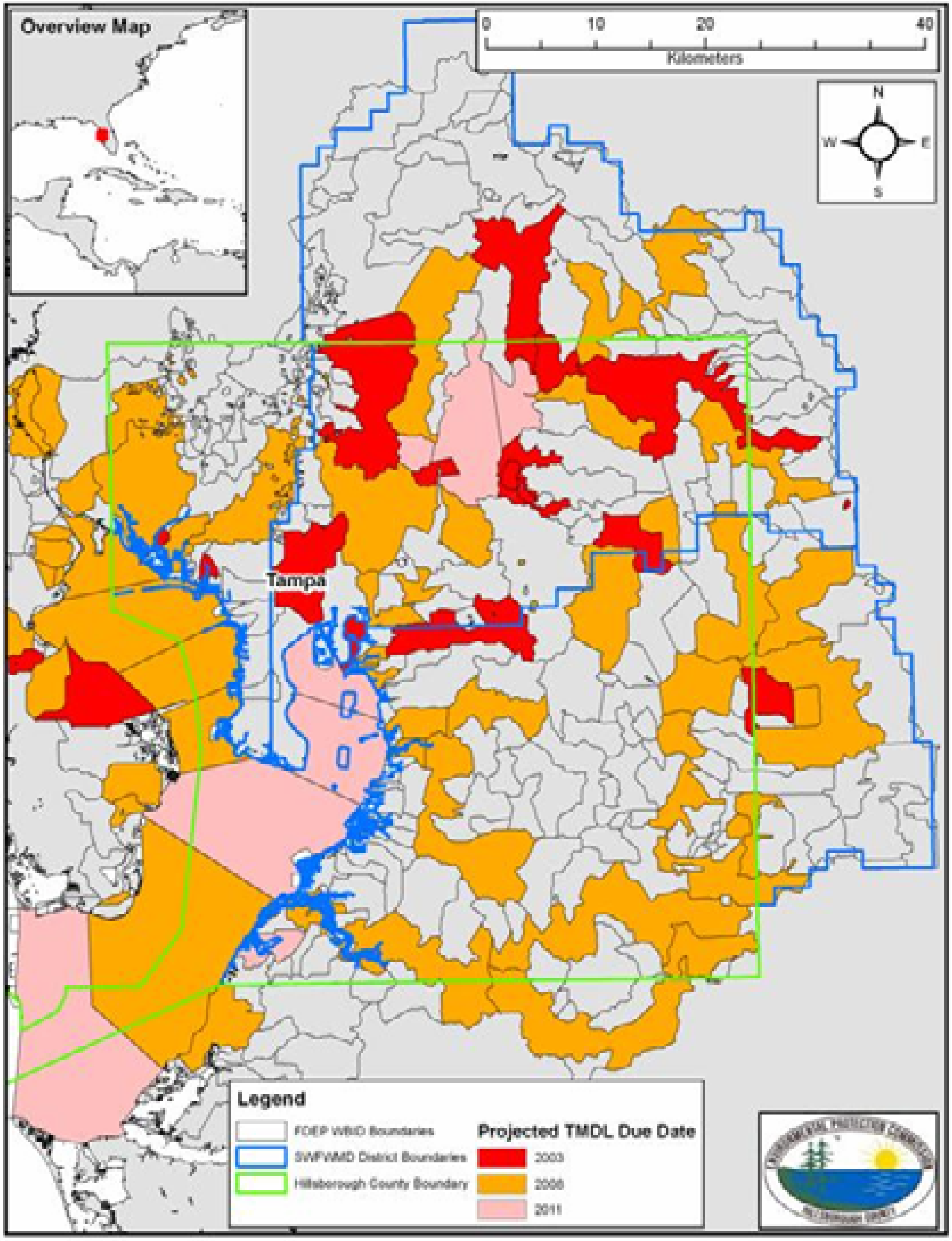

Figure 1: Overview map showing the Hillsborough County (green line) boundary, political boundaries used during the BMAP development phase (blue line), and actual impaired water body identification (WBID) boundaries. Red, orange, and pink polygons represent WBIDs that have or will have TMDLs developed.

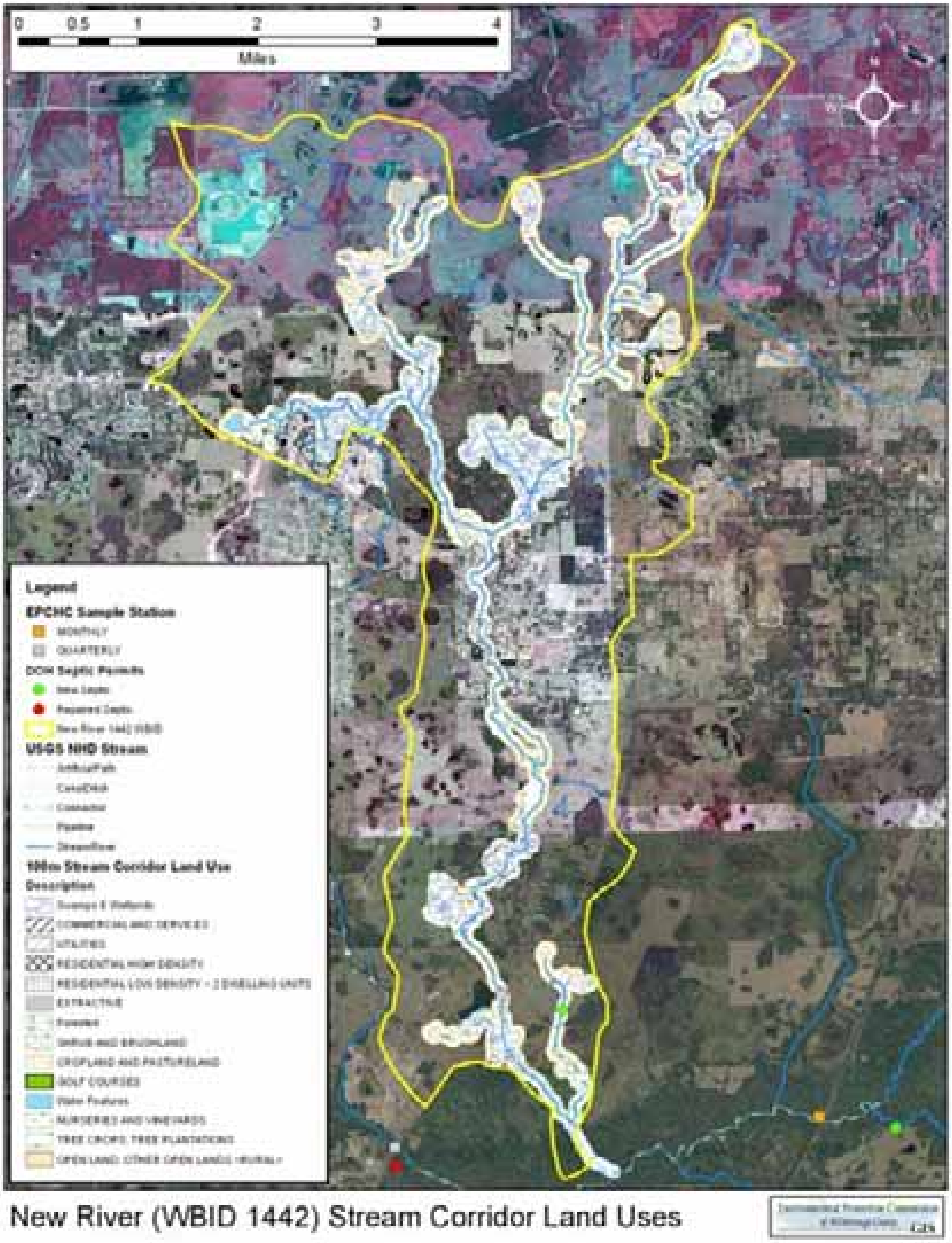

Figure 2. Example product map showing current (2004) land uses along a 100-m stream corridor network of the impaired water body segment of New River, Florida (WBID 1442 in yellow) (Data sources: EPCHC, FDEP, SWFWMD, USGS).

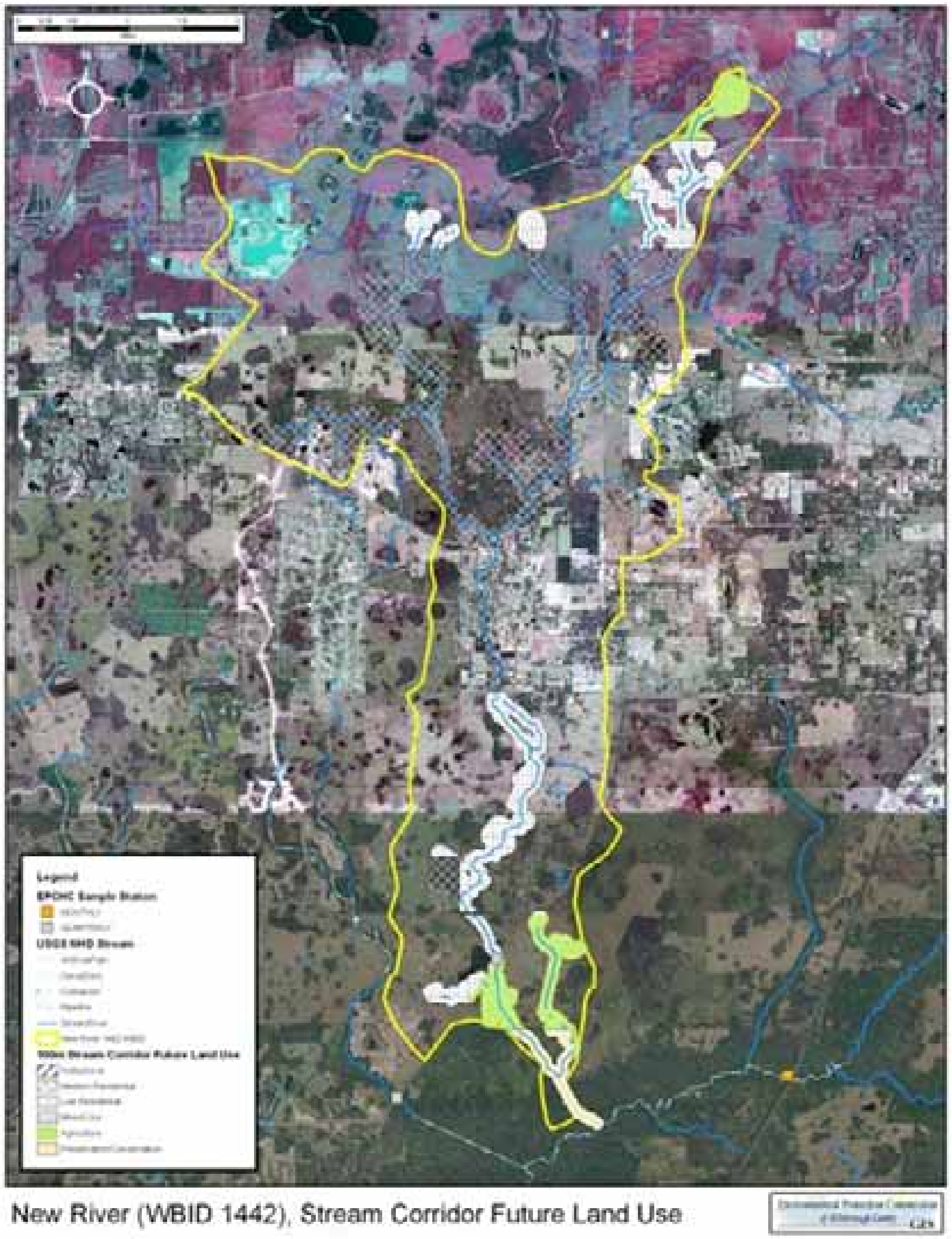

Figure 3. Example product map showing future (2010) land uses along a 100-m stream corridor network of the impaired water body segment of New River, Florida (WBID 1442 in yellow) (Data sources: EPCHC, FDEP, SWFWMD, USGS).

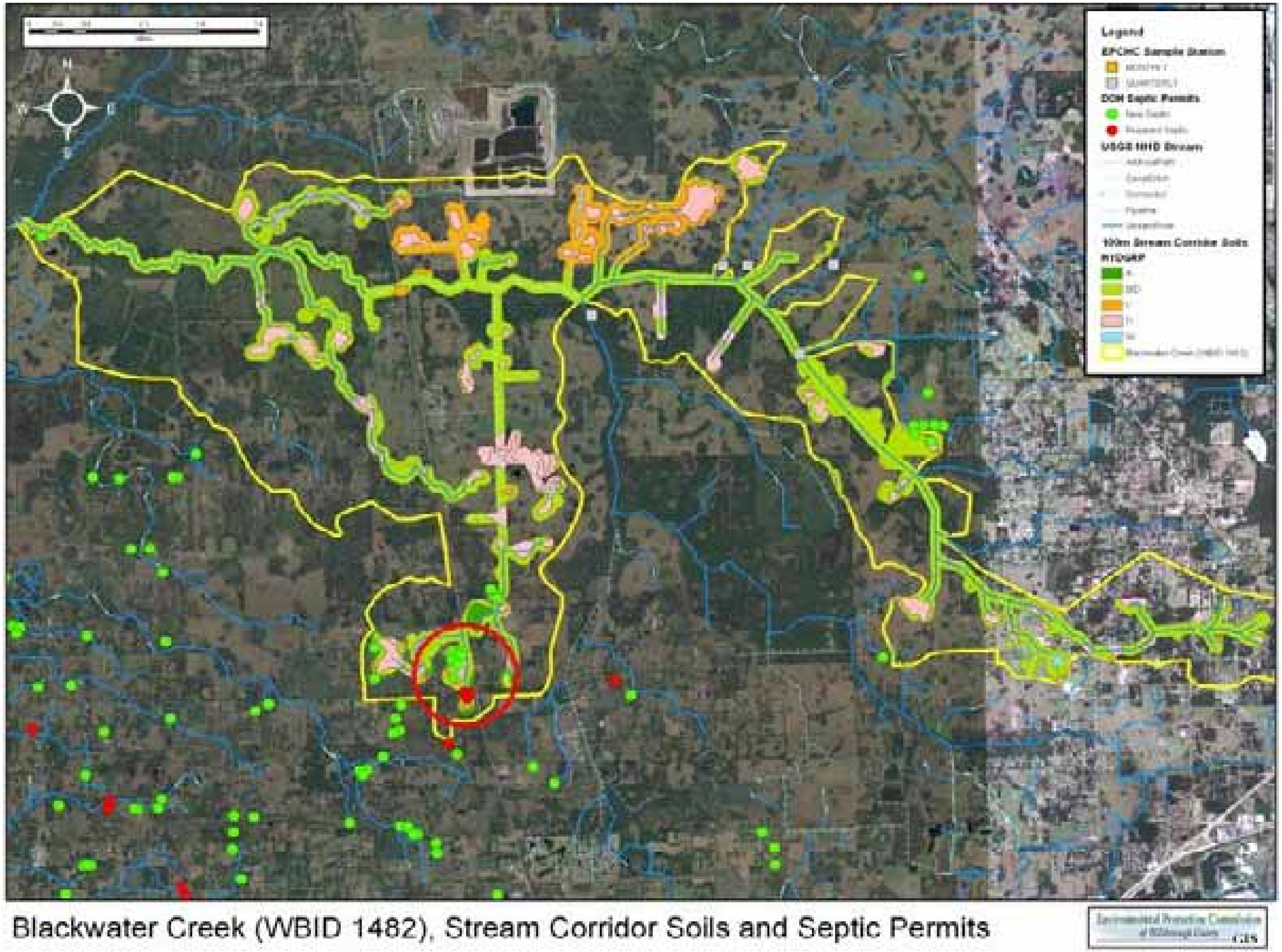

Figure 4. Example product map showing new and repaired septic permit points along a 100-m stream corridor of the impaired water body segment of Blackwater Creek, Florida (WBID 1482 in yellow). The red circle indicates an area of high septic tank density with underlying hydric soils (Data: EPCHC, FDEP, SWFWMD, USGS).

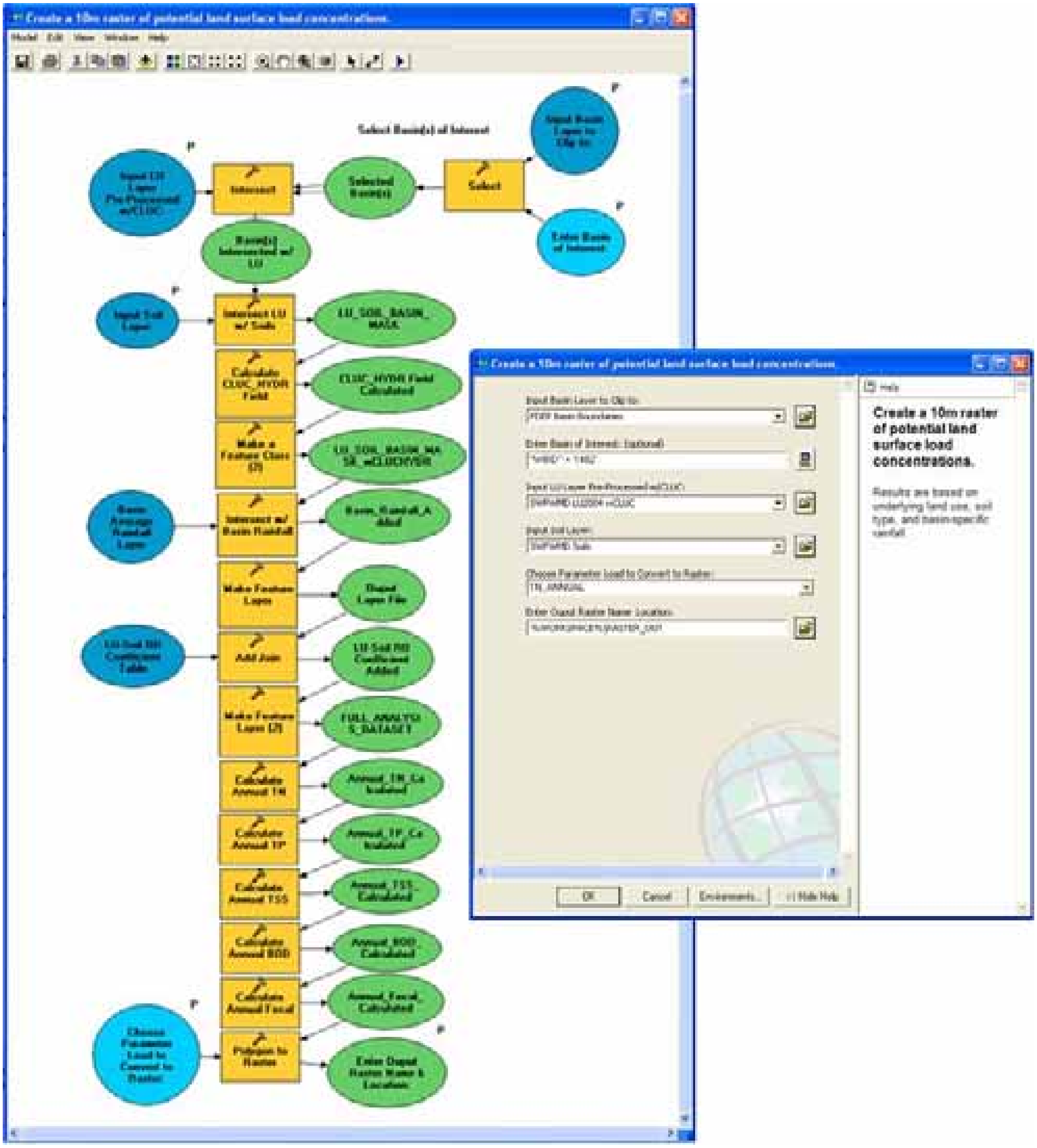

Figure 5. ArcMap ModelBuilder tool developed to automatically calculate land surface load potentials for any water body segment in Hillsborough County, Florida.

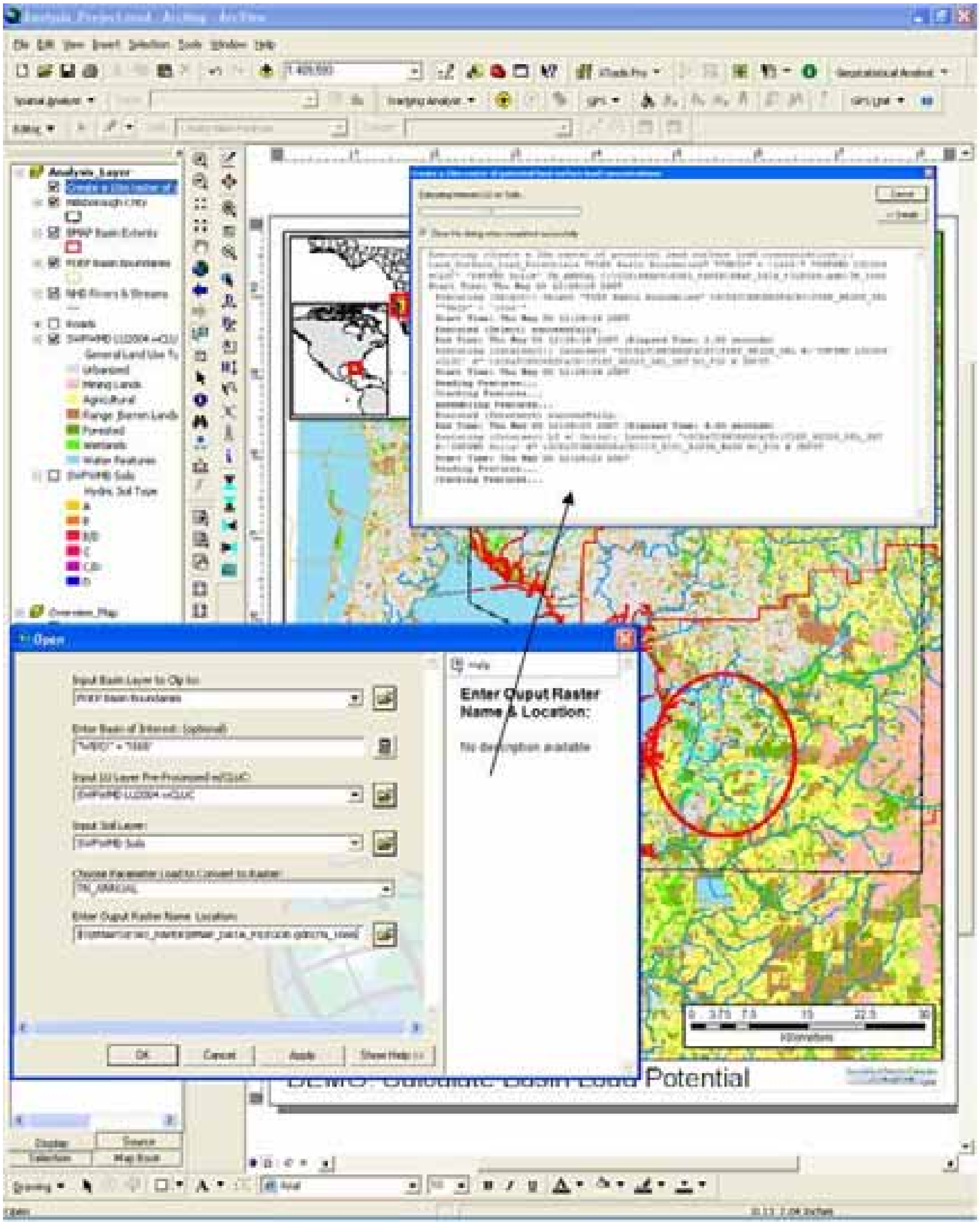

Figure 6. Overview map of the project area with a water body segment of interest selected (WBID=1666, Bullfrog Creek, FL in red oval) and the ArcMap ModelBuilder Tool open and set to calculate annual total nitrogen land surface load potential (TN_ANNUAL) for the water body segment.

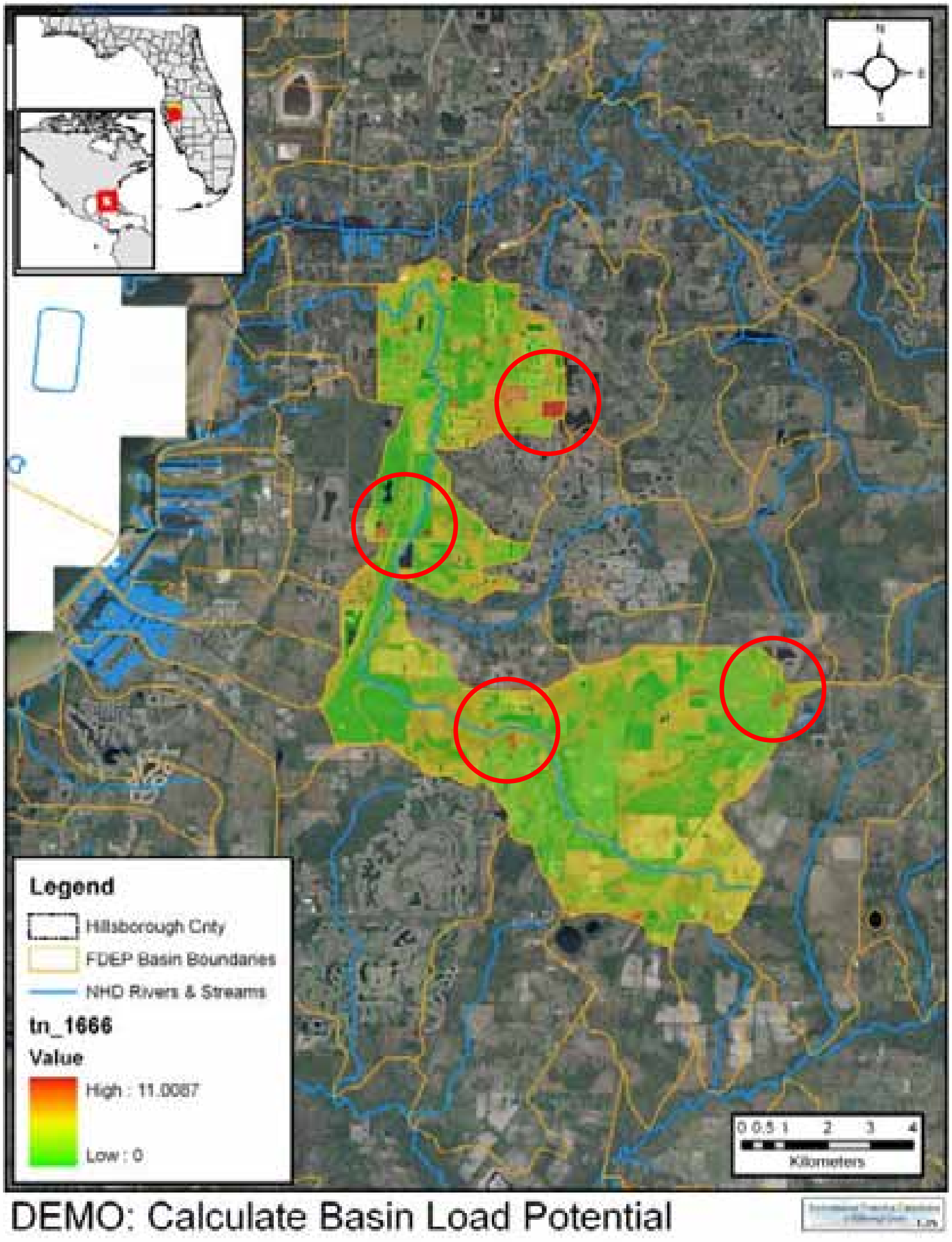

Figure 7. Resulting 10-m raster calculated from the ArcMap ModelBuilder Tool for the water body segment of interest. Areas where high concentrations of total nitrogen have a greater potential for runoff are depicted by the orange to red gradient (in red circles).

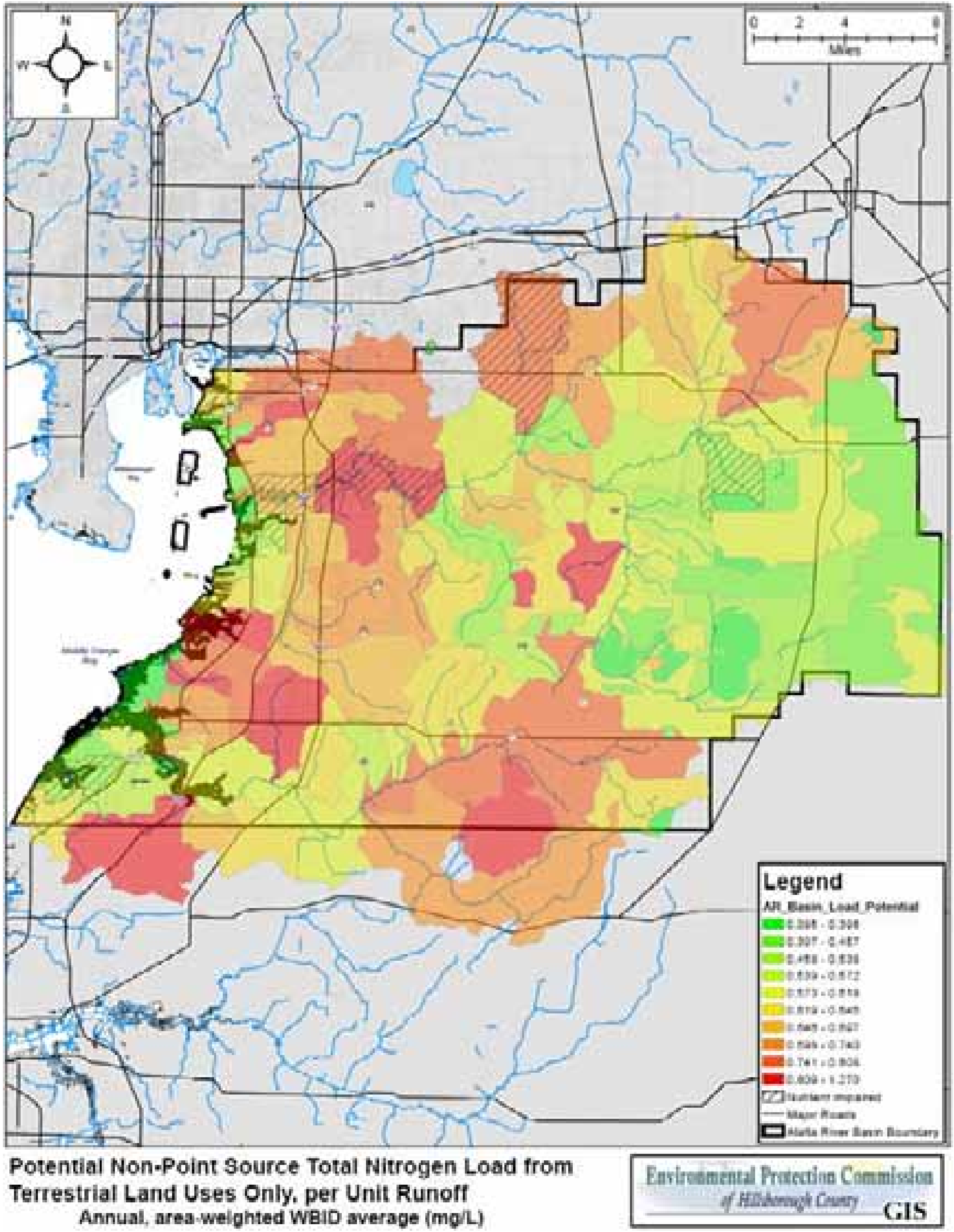

Figure 8. Application of the ArcMap ModelBuilder Tool at the BMAP project area scale. Area-weighted averages of the water body segments show the basins that have the greatest total nitrogen land surface load potential.

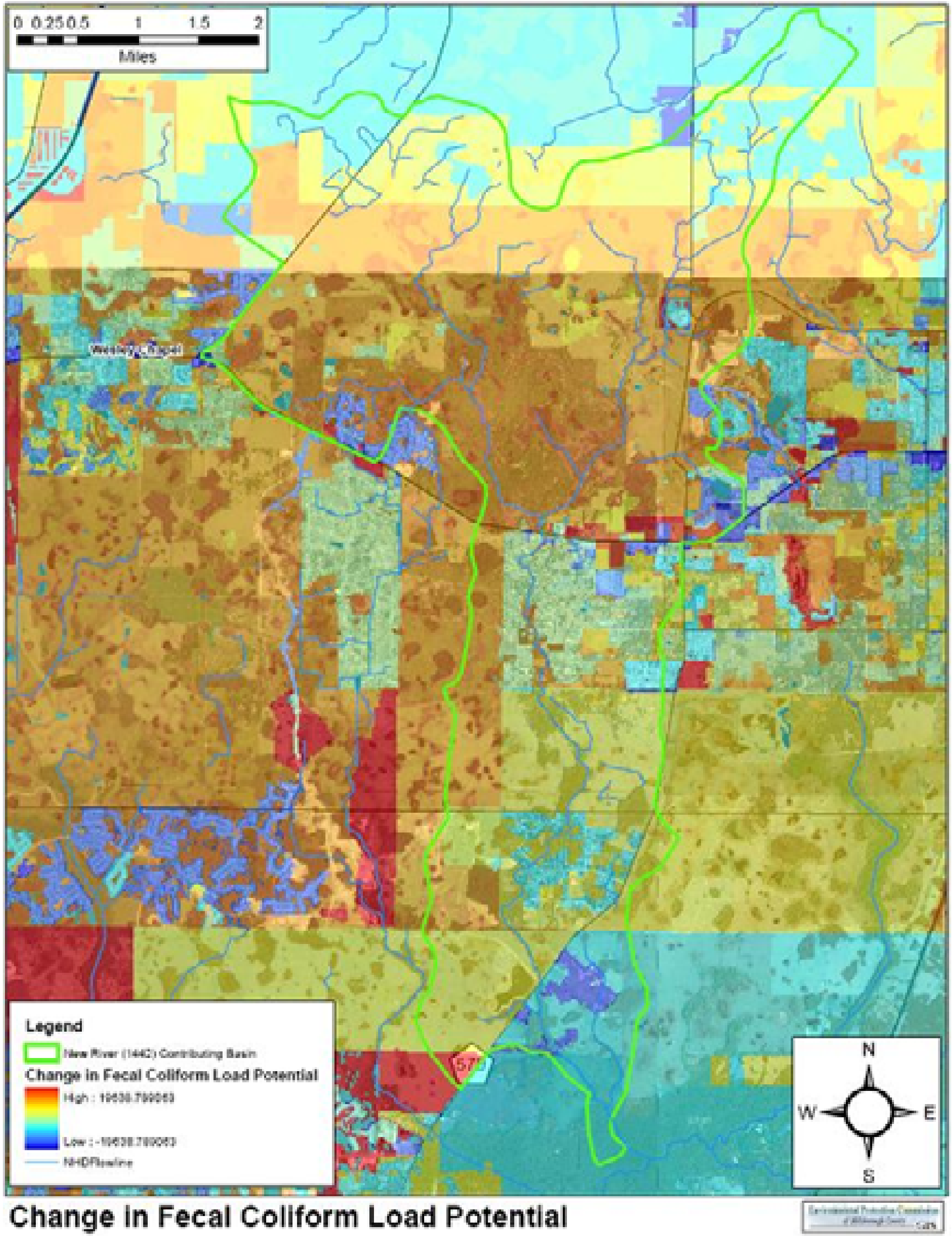

Figure 9. Example product map showing the relative change in fecal coliform land surface load potential for the impaired water body segment of New River, Florida (WBID 1442). Areas in the yellow-red gradient indicate moderate to large changes in load potential. Data Sources: FDEP, SWFWMD.