

# Development of an Assessment Tool for Agricultural Best Management Practice Implementation in the Great Lakes Restoration Initiative Priority Watersheds—Eagle Creek, Tributary to Maumee River, Ohio

## Introduction

The Great Lakes face a number of serious challenges that cause damage to water quality, habitat, ecology, and coastal health. Excess nutrients from point and nonpoint sources have a history of causing harmful algal blooms (HABs); since the late 1990s, a resurgence of HABs have forced beach closures and resulted in water quality impairments across the Great Lakes. Studies increasingly point to phosphorus (P) runoff from agricultural lands as the cause of these HABs. In 2010, the Great Lakes Restoration Initiative (GLRI) was launched to revitalize the Great Lakes. The GLRI aims to address the challenges facing the Great Lakes and provide a framework for restoration and protection. As part of this effort, the Priority Watersheds Work Group (PWWG), cochaired by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Agriculture-Natural Resources Conservation Service (USDA–NRCS), is targeting Priority Watersheds (PWs) to reduce the amount of P reaching the Great Lakes. Within the PWs, USDA–NRCS identifies small-scale subbasins with high concentrations of agriculture for coordinated nutrient reduction efforts and enhanced monitoring and modeling. The USDA–NRCS supplies financial and/or technical assistance to producers to install or implement best management practices (BMPs) to lessen the negative effects of agriculture to water quality; additional funding is provided by the GLRI through USDA–NRCS to saturate the small-scale subbasins with BMPs. The watershed modeling component, introduced in this fact sheet, assesses the effectiveness of USDA–NRCS funded BMPs, and nutrient reductions because of GLRI or other funding programs are differentiated. Modeling scenarios consider BMPs that have already been applied and those planned to be implemented across the small-scale subbasins.

## Eagle Creek Description

The Maumee River watershed is in northwestern Ohio, northeastern Indiana, and southern Michigan. As a part of the Western Lake Erie Basin, this area has been receiving extra attention since 2014 after the toxin microcystin was found in the municipal water supply of the city of Toledo, Ohio. The focus of this BMP assessment is the Upper and Lower Eagle Creek subbasins (hereinafter referred to as the Eagle Creek subbasin) within the Maumee River Watershed. The Eagle Creek subbasin is a 50.3–square-mile (mi<sup>2</sup>) subwatershed of the Maumee River Watershed, Ohio (fig. 1). The Eagle Creek subbasin is mostly in Hancock County with some tributary headwaters extending southward into Hardin County in Northwestern Ohio (fig. 2). The Eagle Creek subbasin is south of the city of Findlay, Ohio, and north of Kenton, Ohio. The Eagle Creek subbasin is a heavily agricultural area with over 80 percent of its land use dedicated to agricultural production (table 1; fig. 3). Primary crops grown are corn and soybeans. The Eagle Creek subbasin has somewhat poorly to poorly drained soils (Soil Survey Staff, 2014) and has been subject to frequent flooding. A majority of the Eagle Creek subbasin, upwards of 90 percent, is expected to have tile drainage to increase field drainage and improve crop yields during the growing season.



Base map from U.S. National Park Service (NPS) Natural Earth physical map.

**Figure 1.** Priority watersheds (purple) and study subbasins of interest (red), the Great Lakes area.

**Table 1.** Land use for the Eagle Creek subbasin, Ohio (from U.S. Department of Agriculture, National Agricultural Statistics Service, 2013).

Land use	Percent
Soybeans	40
Corn	29
Deciduous forest	10
Developed/open space	7
Grass/pasture	7
Winter wheat	5
Developed/low intensity	1
Alfalfa	1
Other	<1

## Best Management Practices

Producers within Eagle Creek subbasin have received extensive funding through GLRI and existing authorities provided to USDA–NRCS by the Farm Bill to implement BMPs to improve the water quality of agricultural runoff. Funding of BMPs in the Eagle Creek subbasin has increased immensely since 2010 due to GLRI. Common BMPs are listed in table 2. A typical agricultural rotation is a 2-year cycle of corn-soybeans. A growing number of producers, 15 percent of the Eagle Creek subbasin (U.S. Department of Agriculture-Natural Resources Conservation Service, oral commun., 2014), are on a 5-year corn-soybeans-corn-soybeans-winter wheat rotation; winter wheat is used as a cover crop. Widespread adoption of conservation tillage has already taken place within the Eagle Creek subbasin; as of 2014, about 85 percent of the soybean crop is planted no-till (U.S. Department of Agriculture-Natural Resources Conservation Service, oral commun., 2014). Fertilizer is not generally applied prior to the soybean crop as the fertilizer applied to the corn crop is generally sufficient for the 2-year corn-soybean rotation.

## Monitoring Data

The U.S. Geological Survey (USGS) installed one edge-of-field (EOF) site (0405051083391201) within the Eagle Creek subbasin for monitoring nutrient loads in surface runoff (fig. 2). Collocated with this site, a subsurface-tile drain flow (0405051083391001) is also monitored. Daily and annual nutrient loadings are computed with the Graphical Constituent Loading Analysis System (GCLAS; Koltun and others, 2006). The monitored field is targeted for the implementation of two BMPs: cover crops and no-till.

## Assessment Tool Development

The Soil and Water Assessment Tool (SWAT) model is under development for simulating the effects of GLRI-funded BMPs on nutrient loadings at the small subbasin scale in the Eagle Creek subbasin. This model is to help demonstrate the potential benefits BMPs have to reducing nutrient loading from agricultural fields. The SWAT model is an empirically based model that simulates hydrology and water quality on a daily basis (Neitsch and others, 2011). The model is being built and downscaled from an existing, calibrated Maumee River

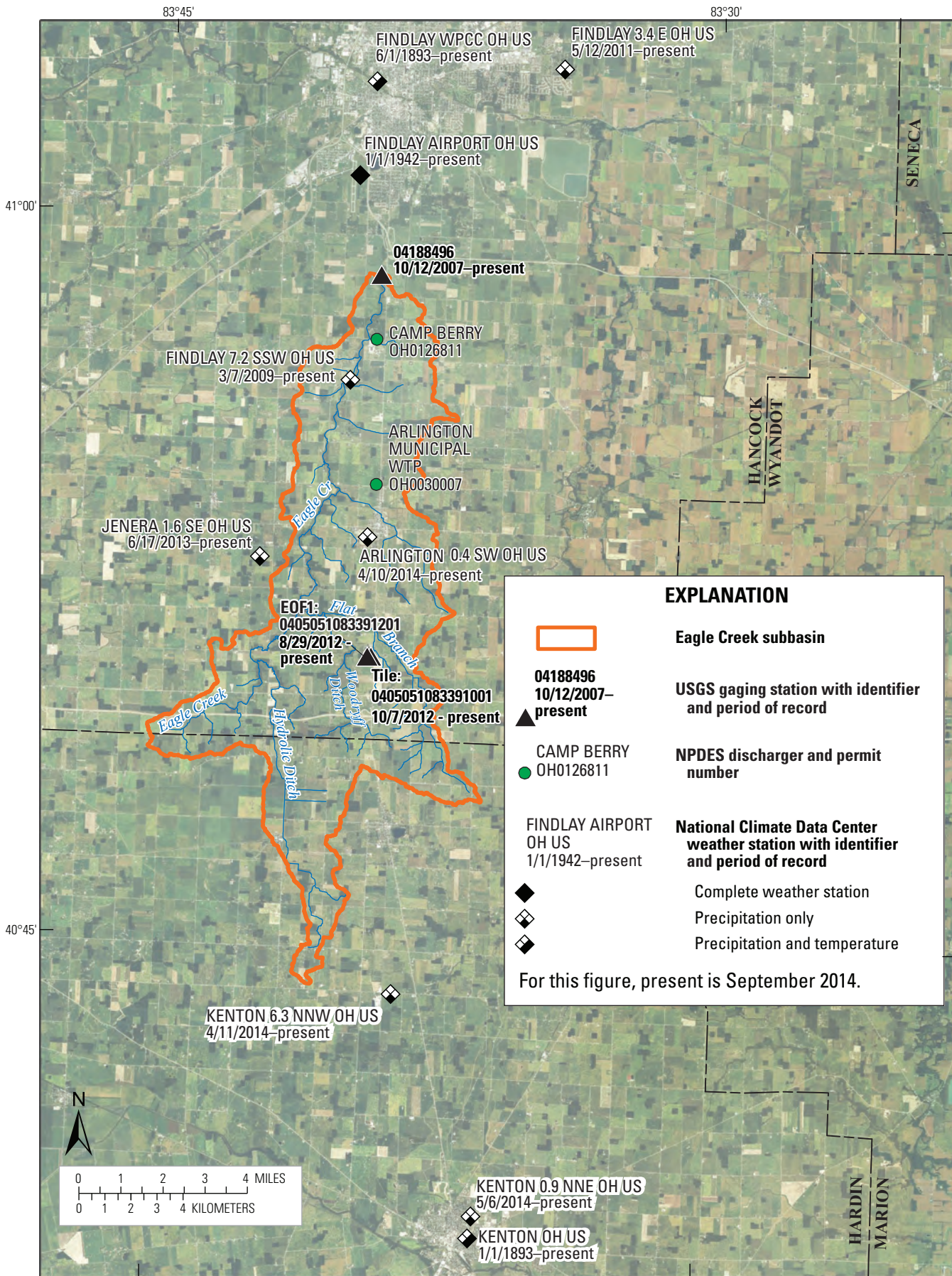
**Table 2.** Most contracted best management practices through U.S. Department of Agriculture-Natural Resources Conservation Service Farm Bill conservation programs in the Eagle Creek subbasin, Ohio (in alphabetical order from the National Conservation Planning Database, David Butler, U.S. Department of Agriculture-Natural Resources Conservation Service, written commun., 2015).

Best management practice
Conservation cover.
Conservation crop rotation.
Cover crop.
Early successional habitat development.
Filter strip.
Grassed waterway.
Nutrient management.
Prescribed burning.
Prescribed grazing.
Residue management, mulch till.
Residue management, no-till/strip till.
Residue management, reduced till.
Residue management, no-till.
Upland wildlife habitat management.

Watershed SWAT model in cooperation with Texas A&M University. Site-specific BMP information has been received from the USDA–NRCS National Conservation Practice Database from applied practices 2004 to 2014, and planned practices from present (2015) until 2018 through a Memorandum of Understanding and coordination between USDA–NRCS. The USDA–NRCS field-level staff are supplying additional information on best management practices, such as: timing of operations, type and amounts of fertilizer or manure applied, and harvest dates and yields. These data are for setup and calibration of the model. Fertilizer application rates for the model are based on conversations with local USDA–NRCS staff and recommendations found in Vitosh and others (1995). Spatial tile drainage distribution is being estimated based on land use, soil type, and land slope. Modeling inputs are detailed in table 3.

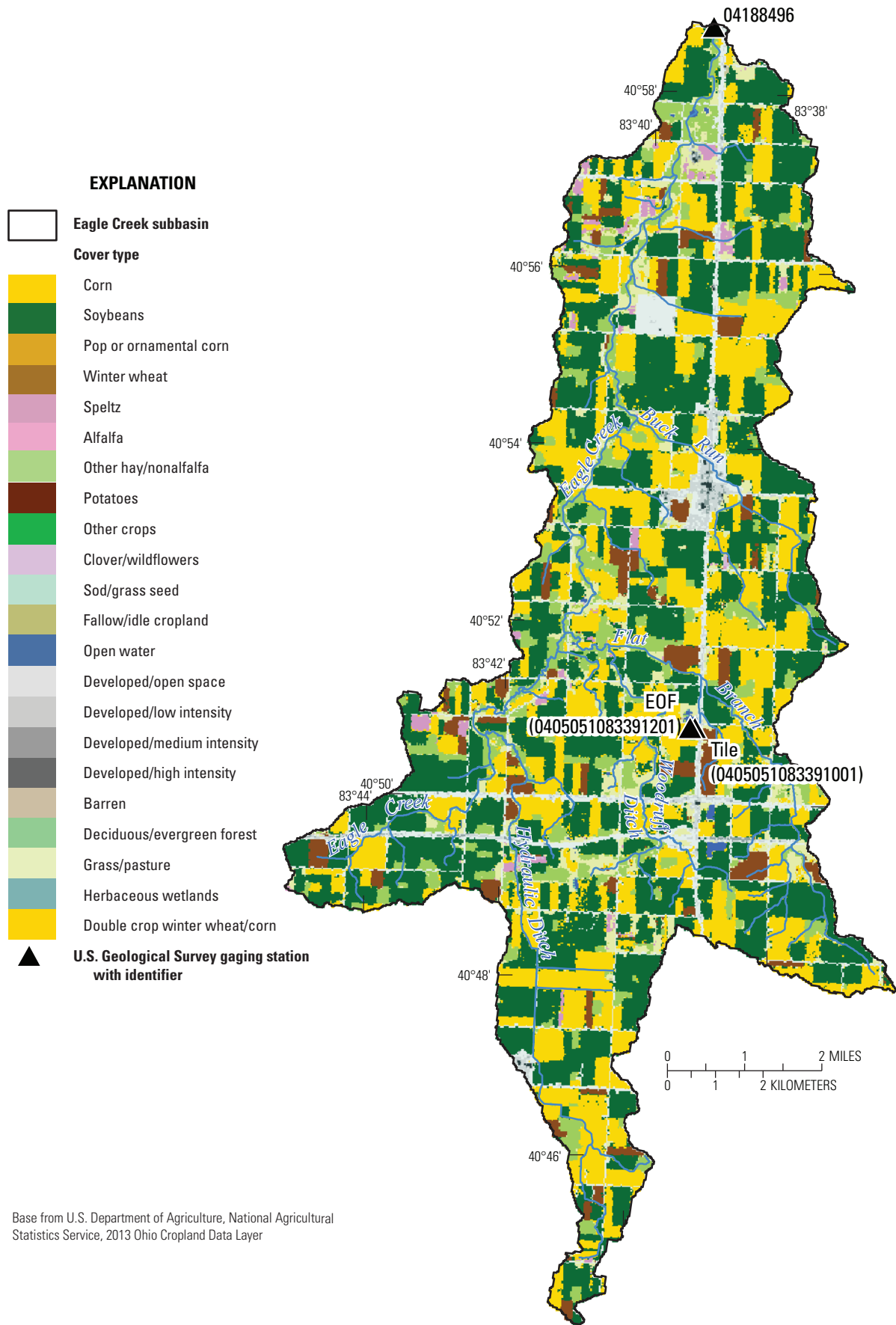


Photo by Carrie Huitger, USGS.



Base image from U.S. Department of Agriculture National Agriculture Imagery Program (NAIP), Ohio, 2013.

**Figure 2.** Locations of U.S. Geological Survey (USGS) gaging stations, National Pollutant Discharge Elimination System (NPDES) sites, and National Climatic Data Center (NCDC) weather stations in the Eagle Creek subbasin, Ohio.



**Figure 3.** U.S. Geological Survey gaging station and land use in the Eagle Creek subbasin, Ohio.

**Table 3.** Soil and Water Assessment Tool Modeling Parameters for the Eagle Creek subbasin, Ohio.

[HUC, hydrologic unit code; ID, identification; mi<sup>2</sup>, square mile; SWAT, soil and water assessment tool; CAFO, confined animal feeding operation; NPDES, National Pollutant Discharge Elimination System]

Parameter	Item/data source
HUC 12 IDs	041000080301 Upper Eagle Creek subbasin.
	041000080302 Lower Eagle Creek subbasin.
Eagle Creek priority area	50.3 mi <sup>2</sup> (32,207 acres).
Landuse	Constructed from site-specific management data provided U.S. Department of Agriculture-Natural Resources Conservation Service combined with common land unit field boundaries and the U.S. Department of Agriculture, National Agricultural Statistics Service (2013). ( <a href="http://nassgeodata.gmu.edu/CropScape/">http://nassgeodata.gmu.edu/CropScape/</a> ).
Soils	Soil Survey Geographic (SSURGO) database (Soil Survey Staff, Natural Resources Conservation Service, U.S. Department of Agriculture, 2014). ( <a href="http://datagateway.nrcs.usda.gov/">http://datagateway.nrcs.usda.gov/</a> ).
Weather	National Climatic Data Center for precipitation and temperature ( <a href="http://www.ncdc.noaa.gov">http://www.ncdc.noaa.gov</a> ). All other weather data were simulated by the Soil and Water Assessment Tool built-in weather generator from averages from the nearby station at the Findlay Airport including the following: wind speed, solar radiation, and relative humidity.
Gage used for hydrology validation and period of record available	U.S. Geological Survey water data ( <a href="http://waterdata.usgs.gov/nwis">http://waterdata.usgs.gov/nwis</a> ). Eagle Creek above Findlay, OH (04188496), October 2009–present (2015) (calibration period), October 2007–September 2009 (validation period).
Gage used for water quality calibration and period of record available	Eagle Creek above Findley, OH (04188496), daily samples, August 2012–present (2015).
Number of CAFOs	There are no permitted CAFOs within Eagle Creek (Ohio Environmental Protection Agency, written commun., 2014).
NPDES discharge	U.S. Environmental Protection Agency Enforcement and Compliance History Online (ECHO), 2014. ( <a href="http://echo.epa.gov/">http://echo.epa.gov/</a> ). There are two permitted dischargers (fig. 3).

The SWAT model calibration for hydrology, sediment, nitrogen, and phosphorus loads is to the gaging station on Eagle Creek at the Eagle Creek HUC 12 outlet (04188496). The period of record at this site is approximately 7 years (table 3). Model calibration is being performed with the later 5 years (October 2009 through September 2014) of data from 04188496; validation also is being performed at the 04188496 site with the first 2 years of data (October 2007 through September 2009). Additional model calibration and validation details for other sites are listed in table 3.

A field-scale Agricultural Policy/Environmental eXtender (APEX) model (<http://apex.tamu.edu/>) is under development by Heidelberg University to simulate implemented BMPs and resulting nutrient loadings at the EOF site, and serve as input to the larger scale SWAT model. Site-specific management practices, including time of operations, type and amounts of fertilizer or manure applied, and harvest dates and amounts, were documented for the EOF site by the producer with assistance from USDA–NRCS staff. These data were needed for setup and calibration of the model. At the EOF site, APEX models are to be calibrated to water quality loads.

These models are assessment tools to determine the effect agricultural BMPs have on reducing nutrient loads at the field and small watershed scale in the Eagle Creek subbasin. Initial model runs simulate current practices and differentiate between

GLRI and nonGLRI funded practices. Additional model scenarios target specific BMPs, determined with input from local and state NRCS agents, at different implementation levels. Candidate BMPs for modeling in the Eagle Creek subbasin include those listed in table 2. Nutrient management, cover cropping, conservation tillage, and crop rotation are an initial focus of the modeling work. Subbasin-specific information about the BMPs, including timing and quantity of fertilizer application, species of cover crops, typical crop rotation, etc., for the Eagle Creek subbasin is being collected at this time (2015) and to help determine how to incorporate these BMPs into the SWAT model.



Eagle Creek at Hancock County, Ohio CR45 crossing. Photo by Katherine Merriman, USGS.



Automated field camera at USGS gage 0405051083391001, June 19, 2013.

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