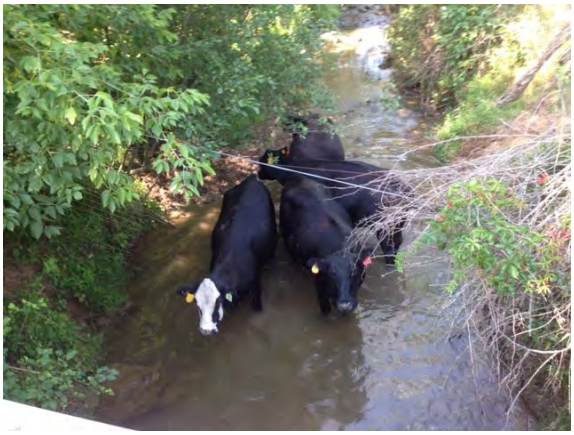


Ohio Environmental Protection Agency
Northeast District Office
2110 East Aurora Road
Twinsburg, Ohio 44087

Eastgate Council of Governments
100 E. Federal Street, Suite 1000
Youngstown, OH 44503

Watershed Assessment Units 050301030805 and 06
Mahoning and Columbiana Counties, Ohio

INTRODUCTION

Figure1. *Yellow Creek watershed study area*

Six stream sampling locations were evaluated in the Yellow Creek watershed in Mahoning and Columbiana Counties in 2016 (Table 1; Figures 1, 2, 3). Three sites on the main stem of Yellow Creek, an unnamed tributary to Yellow Creek, an unnamed tributary to Burgess Run and one location on Burgess Run, were sampled. There are currently two package plants discharging treated effluent into Yellow Creek, along Evan Lake. A Package Plant is a prefabricated, discharging treatment facility typically treating wastewater volumes less than 100,000 gpd. Besides the package plants, there are two additional National Pollutant Discharge Elimination System (NPDES) permit holders within the Yellow Creek Watershed. One is located on Burgess Lake, and the other on an unnamed tributary to Yellow Creek. Figure 4 illustrates the location of each permit holder.

Table 1. Location of bacteria and chemistry sampling sites within the Yellow Creek watershed study area.

Stream	River Mile (STATION ID)	Drain Area	Latitude	Longitude
Yellow Creek @ Heck Road	14.03[H] (301466)	3.7	40.895379	-80.631220
Yellow Creek @ SR 165	11.40[H] (301407)	10.11	40.944043	-80.641385
Yellow Creek @ E. Western Reserve Road	7.75[W] (301468)	20.52	40.987931	-80.615975
UT to Yellow Creek at E. Middleton Road (RM 8.85)	1.38[H] (303747)	0.81	40.9582081	-80.58933446
UT to Burgess Run at Arrel Road (RM 1.56)	0.9[H] (303749)	1.36	40.9941813	-80.5719967
Burgess Run (Burgess Lake) at SR 170	2.55[H] (303748)	1.36	40.9860840	-80.5792934

During 2016, Ohio EPA conducted a water resource assessment of 6 locations in the Yellow Creek watershed using standard Ohio EPA protocols. Included in this study were assessments of the surface water and recreation (bacterial) condition. A total of 6 water chemistry and bacterial stations were sampled in the Yellow Creek watershed. All of the chemical and bacteria results can be downloaded from the Ohio EPA GIS interactive maps at the following link:
http://www.epa.state.oh.us/dsw/gis/index.aspx.

Specific objectives of the evaluation were to:

- Monitor and assess *E. coli* at six sites within the Yellow Creek watershed (HUCs 050301030805 and 050301030806).
- Monitor and assess water quality (focusing on nutrients) at six sites within the Yellow Creek watershed (HUCs 050301030805 and 050301030806).
- Evaluate the appropriateness of existing recreational use designations;

- Determine any recreational use impacts from known potential sources, including point source dischargers and unsewered communities.

STUDY AREA DESCRIPTION

The Yellow Creek watershed is located in the Erie-Ontario Lake Plain (EOLP) ecoregion. All streams in the study are designated Warmwater Habitat (WWH), Primary Contact Recreation (PRC), Agricultural Water Supply (AWS), Industrial Water Supply (IWS). Burgess Run and portions of Yellow Creek are Public Water Supply (PWS) in the Ohio Water Quality Standards (WQS).

The Yellow Creek watershed begins in northeast Columbiana County and expands north into eastern Mahoning County (Figures 2 and 3). The center of the watershed is located at 40°58'12.00"N, 80°36'36.00"W. The Yellow Creek watershed is mainly rural, but transitions to a suburban and urban setting as it travels to its confluence with the Mahoning River in the City of Struthers (RM 15.38). Yellow Creek is the primary watercourse that supplies water to two drinking water sources. Beginning in Columbiana County, Yellow Creek flows through, in order of succession, Beaver Lake (Columbiana County), Pine Lake, Evans Lake, and Lake Hamilton. Pine Lake, Evans Lake, and Lake Hamilton are maintained and operated by Aqua Ohio, Inc., of which Evans Lake and Lake Hamilton are drinking water sources for residents in Mahoning County. It is a small size tributary (39.53 mi^2 drainage area) of the Mahoning River (Figure 2) and is broken down into two, 12-digit Hydrologic Unit Codes (HUC):

- Headwaters Yellow Creek
    - 12-digit HUC: 050301030805
    - Location: 40°55'48.00"N, 80°37'12.00"W.

- Burgess Run-Yellow Creek
    - 12-digit HUC: 050301030806
    - Location: 41° 0'36.00"N, 80°35'60.00"W

As a part of the greater Mahoning River Watershed, Yellow Creek incorporates several townships and municipalities (Figure 5):

- Columbiana County
    - Unity Township
    - Fairfield Township
    - City of Columbiana

- Mahoning County
    - *S*pringfield Township
    - Beaver Township
    - Poland Township
    - Boardman Township
    - Village of Poland
    - Village of New Middletown
    - City of Struthers

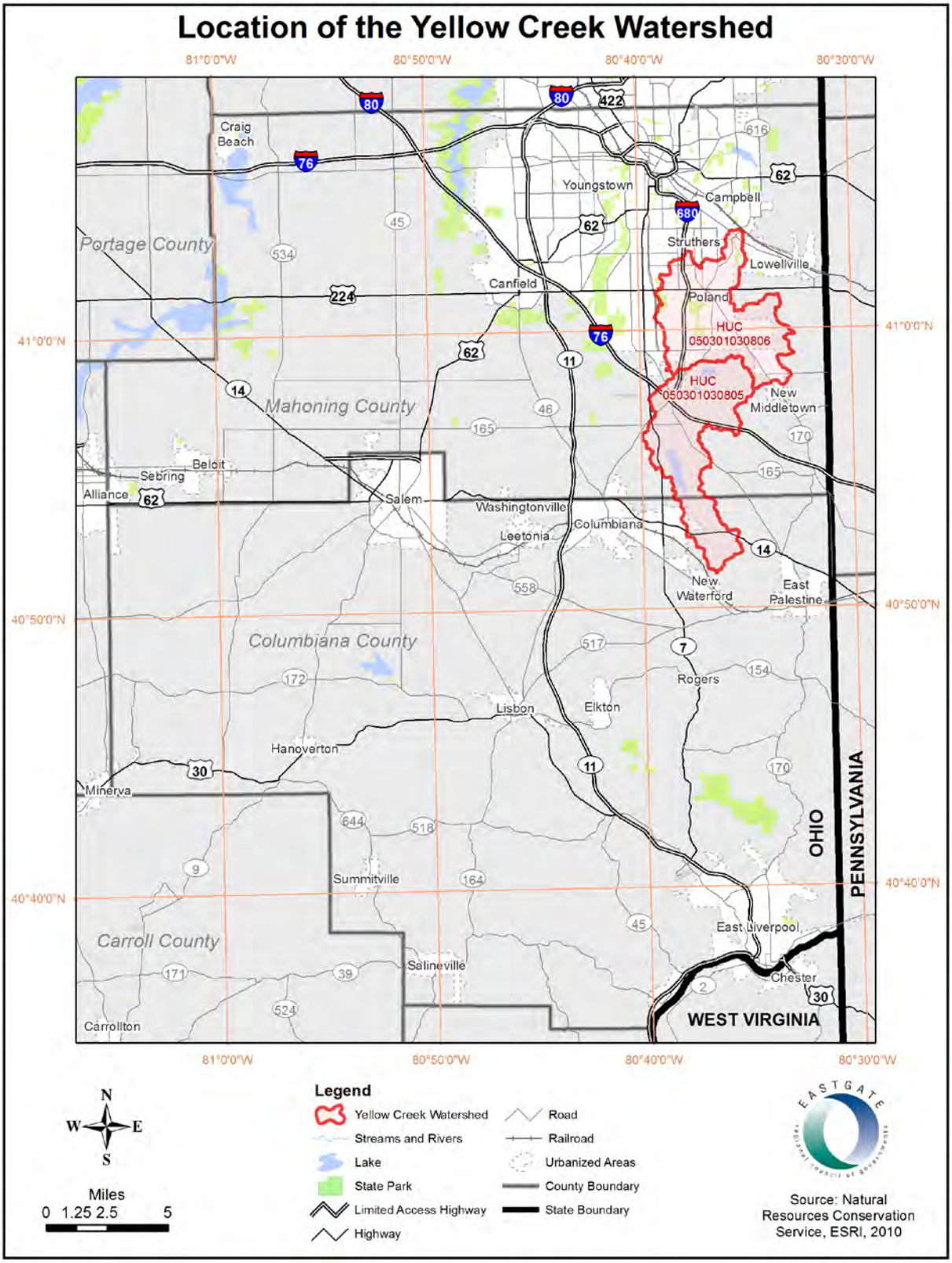


Figure 2. Location of the Yellow Creek watershed.

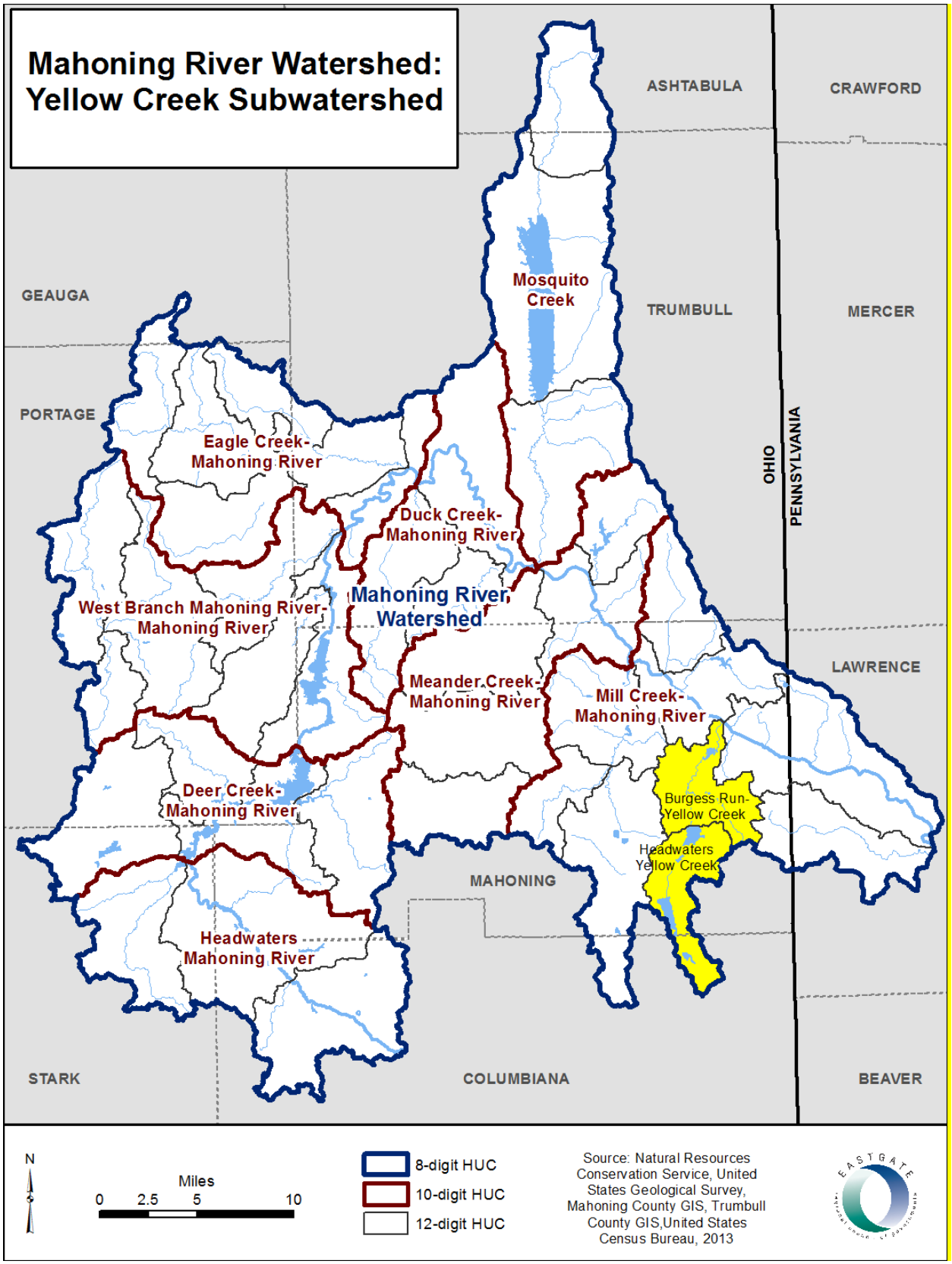


Figure 3. Location of Yellow Creek watershed within the Mahoning River watershed.

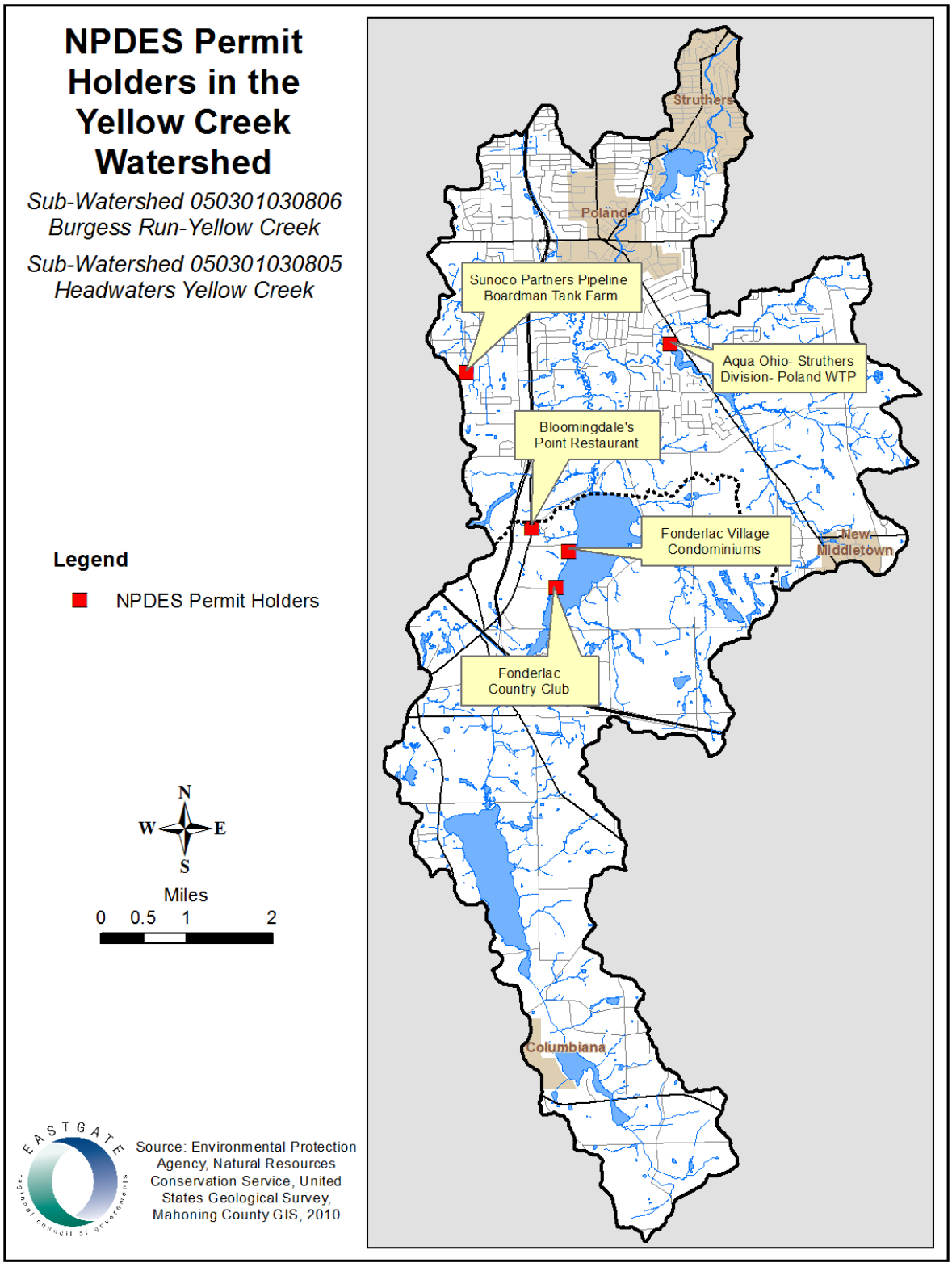
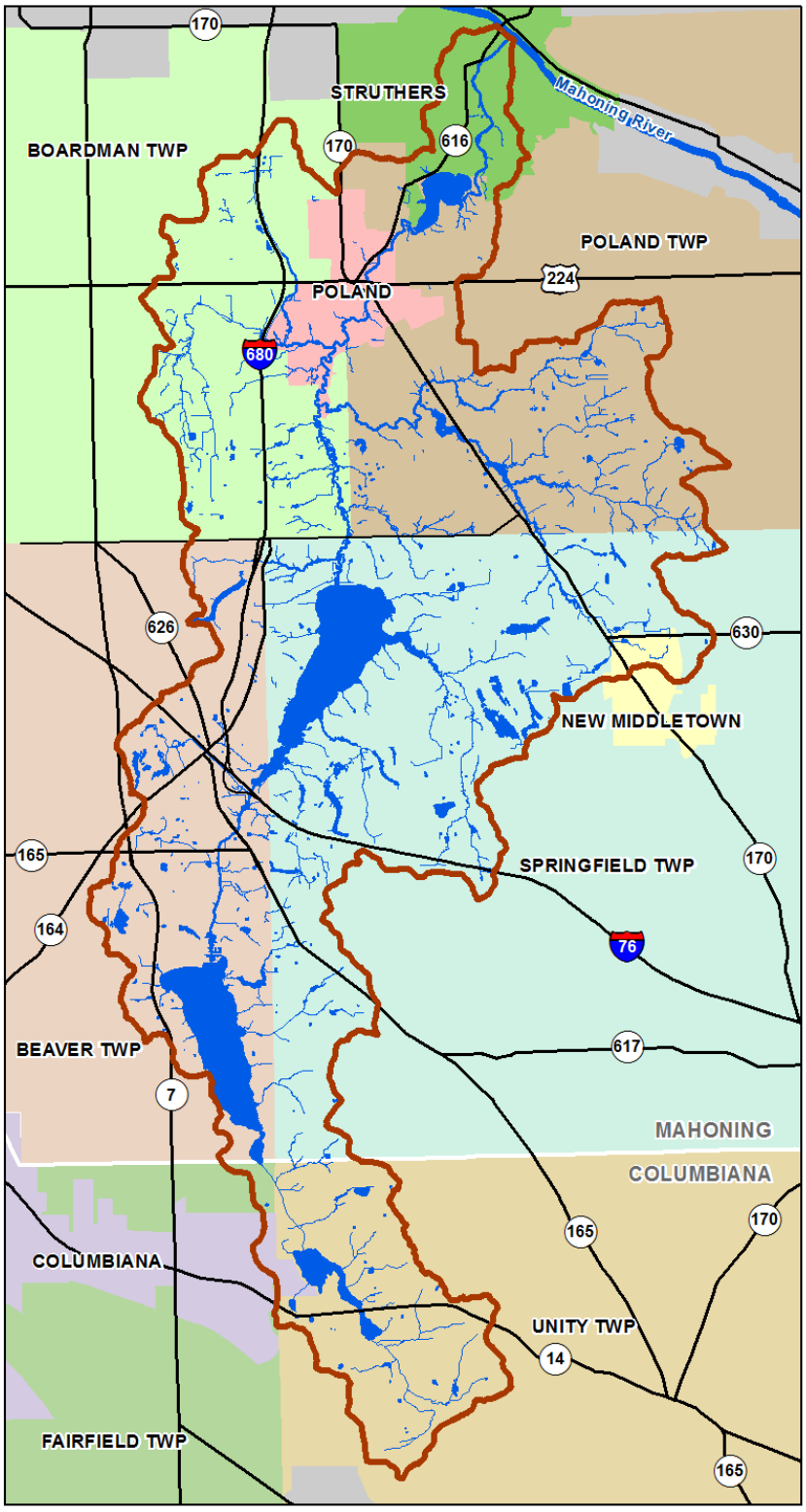


Figure 4. NPDES Permit Holders in the Yellow Creek watershed.

Communities of the Yellow Creek Watershed

Community	Square Miles of Watershed
Springfield Twp	12.16
Poland Twp	7.69
Beaver Twp	6.67
Boardman Twp	5.53
Unity Twp	3.98
Poland	1.62
Struthers	1.26
New Middletown	0.27
Columbiana	0.20
Fairfield Twp	0.14
Watershed Total	***39.52***



N
W E
S

Miles
0 0.5 1 2

Source:
Natural Resources Conservation Service,United States Geological Survey, Mahoning County GIS, United States Census Bureau 2010

Figure 5. Communities of the Yellow Creek watershed.

The Yellow Creek watershed contains a total of 149.39 miles of streams. The main stem of Yellow Creek is 22.11 miles (including headwaters) of the total calculation. Though the watershed has numerous streams, the Gazetteer of Ohio Streams only recognizes two: Yellow Creek and Burgess Run. Other streams locally recognized within the watershed include Drakes Run, McKay's Run, Beard Creek, East Branch Yellow Creek, Turnpike Tributary (Figure 6), Rummels Run, and Beaver Canal. Figure 7 illustrates the location of the aforementioned streams. Table 2 describes the tributary features of the Yellow Creek watershed. Figure 8 illustrates those features.

Table 2. Tributary Features of the Yellow Creek watershed.

Tributary	Length	Drainage Area
Burgess Run	6.56 mi	7.42 mi^2
Drakes Run	4.43 mi	3.77 mi^2
McKays Run	1.96 mi	1.13 mi^2
Beard Creek	0.94 mi	0.35 mi^2
East Branch Yellow Creek	2.74 mi	2.72 mi^2
Turnpike Tributary* (E of I-76)	0.76 mi	0.63 mi^2
Turnpike Tributary* (W of I-76)	1.41 mi	0.65 mi^2
Rummels Run	0.93 mi	0.33 mi^2

* Turnpike Tributary appears to have been split into two sections as result of Interstate 76. The section west of I-76 meanders naturally until it reaches I-76. It then turns sharply southwest into a roadside ditch leading to Yellow Creek. The section east of I-76 leads directly to Evans Lake. The USGS National Hydrography Dataset, used by the USGS StreamStats website, displays the original course of the stream across I-76 and not current conditions. Therefore, drainage areas for each section were approximated.

Figure 6. Turnpike Tributary.

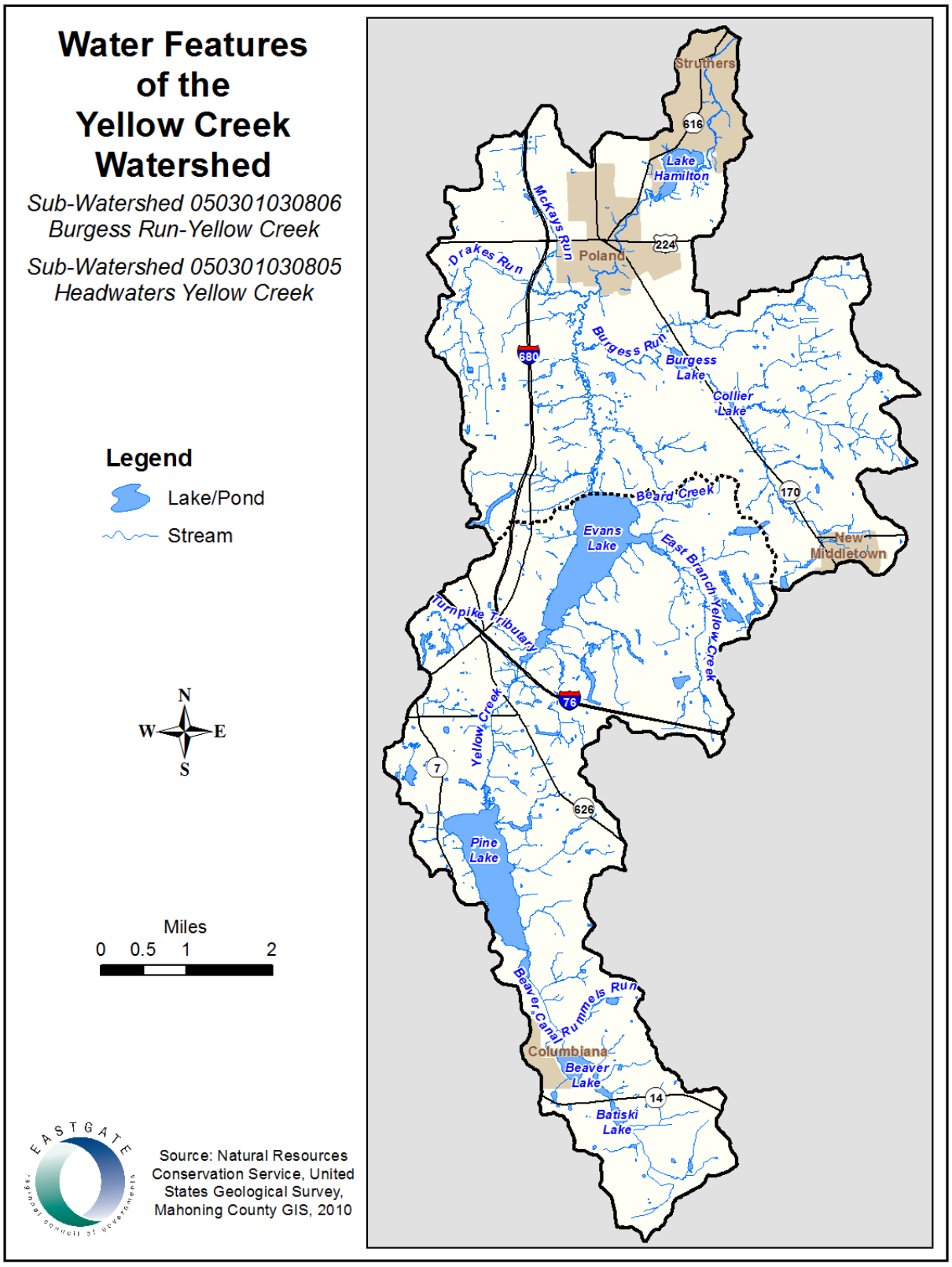


Figure 7. Water Features of the Yellow Creek watershed.

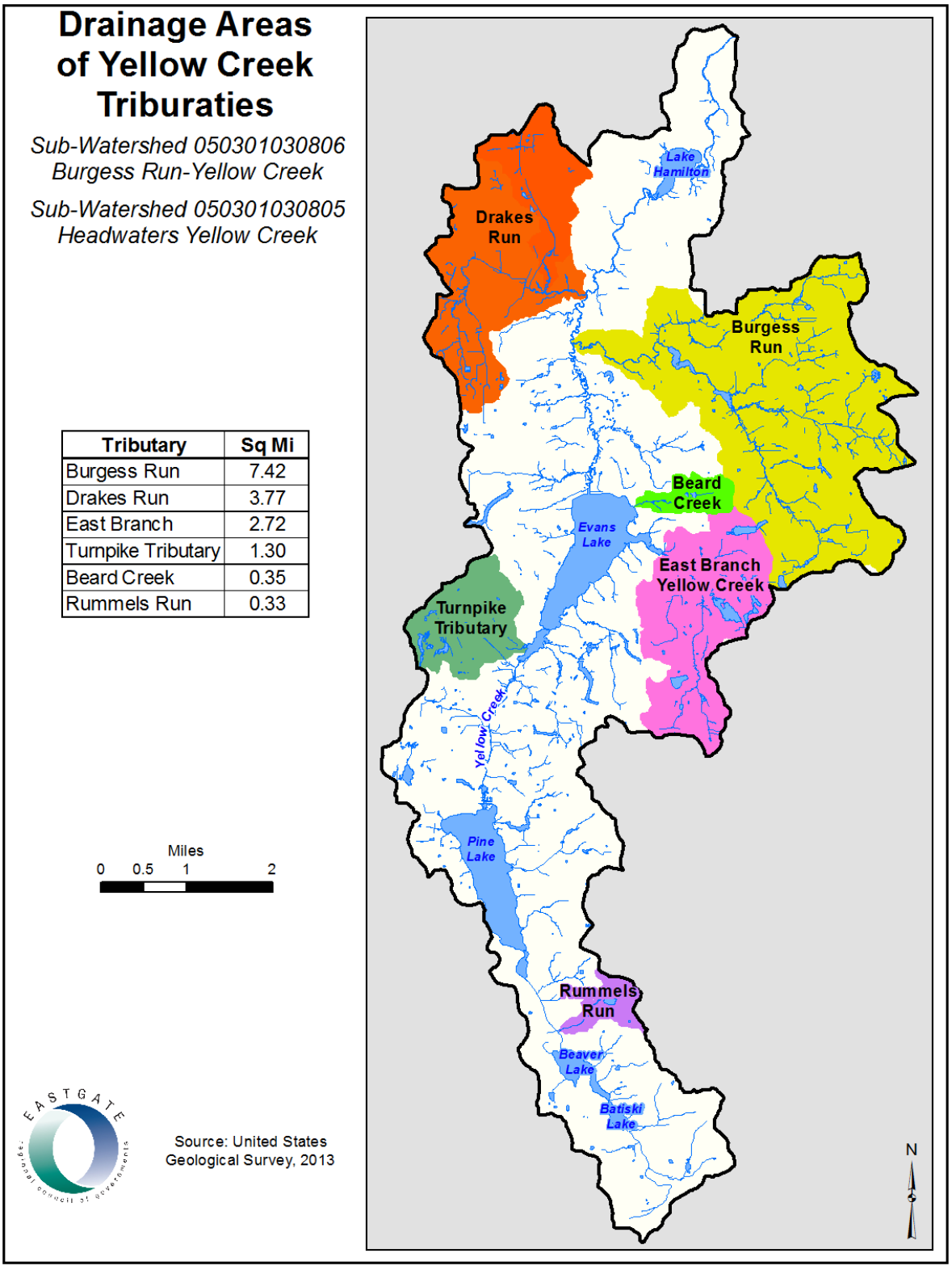


Figure 8. Tributaries of the Yellow Creek watershed's drainage areas.

Lakes and reservoirs (size, uses, watersheds, detention time).

In 1980, ODNR completed an inventory of lakes in Ohio. The Ohio Water Inventory Report No. 26, "Inventory of Ohio's Lakes, lists all known water impoundments, by county, that are 5 acres or greater in size. The report lists the following seven lakes (Table 3):

Table 3: Lakes and Reservoirs in the Yellow Creek watershed.

Lake	Useful Purpose	Surface Area (acreage)	Year Built
Batiski Lake	Recreation	5.4	1957
Beaver Lake	Water Supply	103	1916
Pine Lake	Water Supply, Recreation	474	1917
Collier Lake	Recreation	10	1958
Burgess Lake	N/A	20	1915
Lake Hamilton	Recreation	104	1905
Evans Lake	Water Supply, Recreation	566	1948

Land Use including land cover description

Land use in the Yellow Creek Watershed is composed of agricultural, residential and commercial (Table 4, Figure 9). The Headwaters Yellow Creek subwatershed is mainly agricultural, while the Burgess-Run Yellow Creek subwatershed contains more residential and commercial land uses. Overall, the watershed has a small amount of commercial, industrial, or vacant properties. The land designated as "Unclassified" is mostly road right-of-way which is not classified by the auditor.

Table 4: Land Use in the Yellow Creek watershed.

Land Use	Headwaters Yellow Creek 050301030805		Burgess Run-Yellow Creek 050301030806		Total	
Agricultural	7,000.14 *ac.*	56.54%	3,337.57 *ac.*	25.84%	10,337.71 *ac.*	40.87%
Residential- Single Family	1,893.86 *ac.*	15.30%	4,495.9 *ac.*	34.81%	6,389.76 *ac.*	25.26%
Vacant Land	1,534.97 *ac.*	12.40%	1,196.46 *ac.*	9.26%	2,731.43 *ac.*	10.80%
Commercial	695.08 *ac.*	5.61%	1,106.77 *ac.*	8.57%	1,801.85 *ac.*	7.12%
Unclassified	26.44 *ac.*	0.21%	1,058.58 *ac.*	8.20%	1,085.02 *ac.*	4.29%
Residential- Other	406.71 *ac.*	3.28%	520.57 *ac.*	4.03%	927.28 *ac.*	3.67%
Government or Public Owned	17.38 *ac.*	0.14%	733.8 *ac.*	5.68%	751.18 *ac.*	2.97%
Water	590.12 *ac.*	4.77%	146.55 *ac.*	1.13%	736.67 *ac.*	2.91%
Industrial	217.07 *ac.*	1.75%	221 *ac.*	1.71%	438.07 *ac.*	1.73%
Residential-Apartments	0 *ac.*	0%	96.66 *ac.*	0.75%	96.66 *ac.*	0.38%
Total	**12,381.77 *ac.***	**100.00%**	**12,913.86 *ac.***	**100.00%**	**25,295.63 *ac.***	**100.00%**

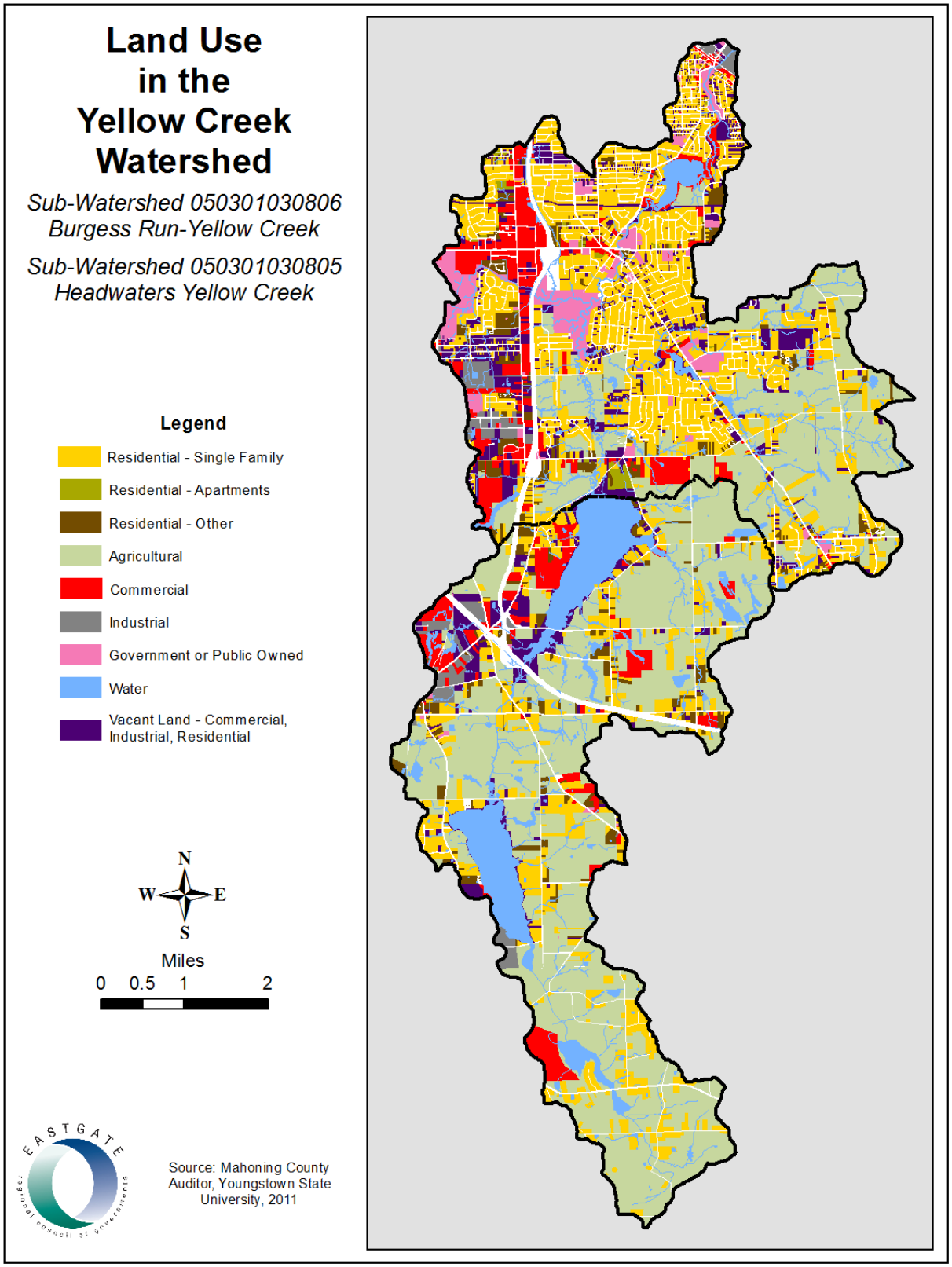


Figure 9. Land use of the Yellow Creek watershed.

According to Eastgate's 2011 Land Cover Data, the Yellow Creek Watershed contains 7 different land cover types: Agricultural/Open Urban, Barren Land, Non-Forested Wetland, Open Water, Shrub/Scrub, Urban, and Wooded (Table 5). Figure 10 displays the land cover in the watershed.

Table 5. Eastgate Land Cover Classification in the Yellow Creek watershed.

Landcover (aerial classification)	**Headwaters Yellow Creek 050301030805**		**Burgess Run-Yellow Creek 050301030806**		**Total**	
Forest	5,717.80 ac.	46.18%	7,105.39 ac.	55.02%	12,823.19 ac.	50.69%
Field (non-leafy crop, shrub/scrub, plowed)	3,422.63 ac.	27.64%	1,979.25 ac.	15.33%	5,401.88 ac.	21.35%
Grass/Field (leafy crop/vegetation)	985.64 ac.	7.96%	1,221.07 ac.	9.46%	2,206.71 ac.	8.72%
Urban	458.62 ac.	3.70%	1,606.77 ac.	12.44%	2,065.39 ac.	8.17%
Open water	1,402.61 ac.	11.33%	275.14 ac.	2.13%	1,677.75 ac.	6.63%
Forested Wetland	139.38 ac.	1.13%	622.28 ac.	4.82%	761.66 ac.	3.01%
Non-forested Wetland	255.09 ac.	2.06%	102.86 ac.	0.80%	357.95 ac.	1.42%
Barren	0.0 ac.	0.00%	1.10 ac.	0.01%	1.10 ac.	0.00%
Total	**12,381.77 *ac.***	**100.00%**	**12,913.86 *ac.***	**100.00%**	**25,295.63 *ac.***	**100.00%**

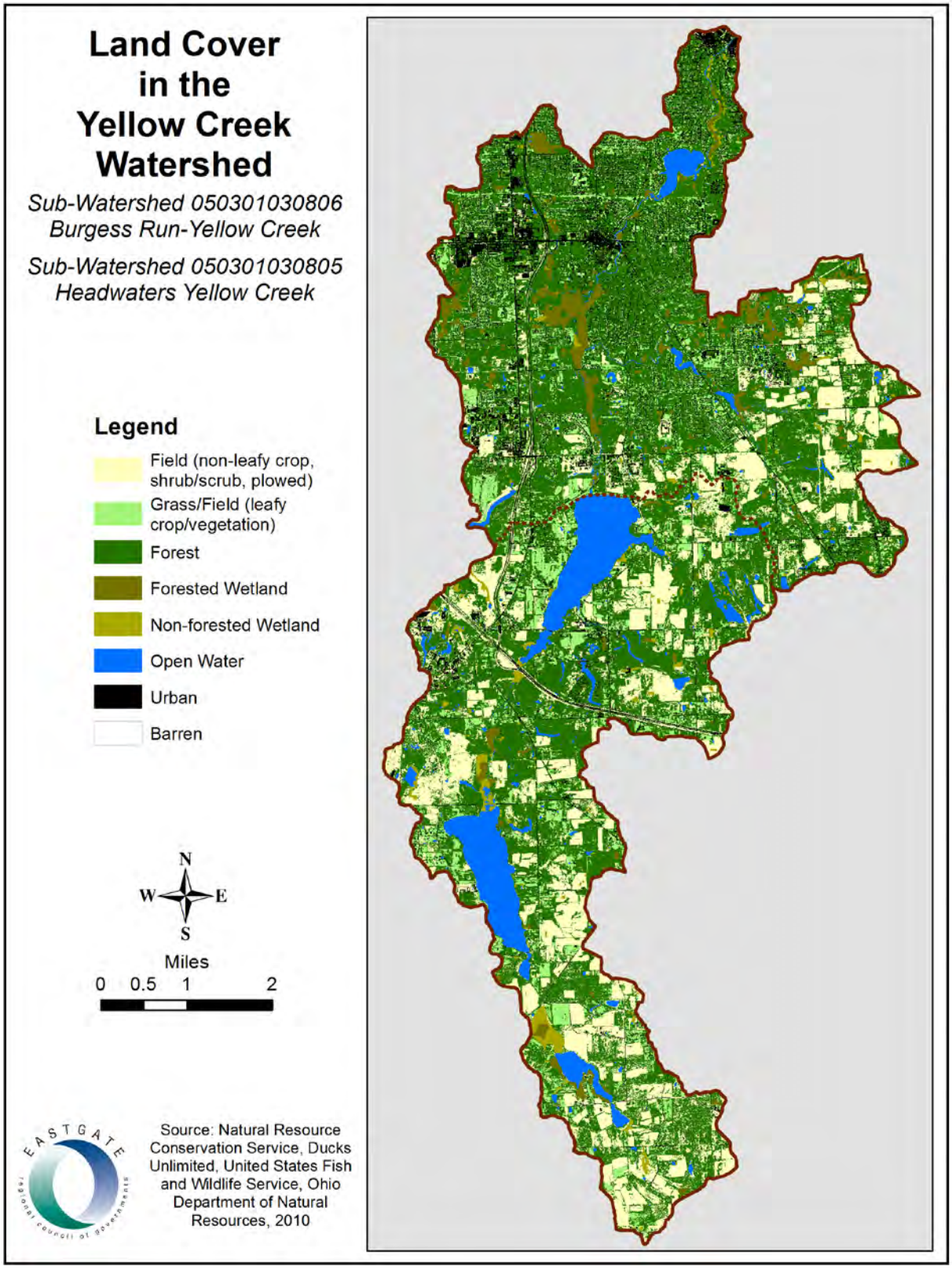


Figure 10. Land Cover of the Yellow Creek watershed.

The Yellow Creek watershed contains 1,716 HSTSs, of which 1,547 are recorded in Mahoning County. Located mainly within the headwaters subwatershed of Yellow Creek, there are neighborhoods within the Burgess Run subwatershed that rely on HSTSs for wastewater treatment. Figure 11 illustrates the areas reliant on HSTSs for wastewater treatment. No sanitary sewer overflows (SSO) or combined sewer overflows (CSO) exist within the watershed.

Numerous dams can be found within the watershed. Five major dams are present along the main stem of Yellow Creek and form Beaver Lake, Pine Lake, Evans Lake, Lake Hamilton; a sixth major dam sits outside the main stem, but along one of Yellow Creek's major tributaries forming Burgess Lake. According to Aqua Ohio's SWAP the construction of the earthen dam at Beaver Lake is unknown. Two earthen dams form Pine Lake, were constructed in 1912 and are located at the northern and southern embankment, respectively. The earthen dam forming Evans Lake was built in 1948. The dam at Lake Hamilton was constructed in 1905 and is comprised of cut stone and a concrete main structure. Though not located on the main stem of Yellow Creek, the dam at Burgess Lake was built in 1915. Numerous small dams exist within the watershed, many located on unnamed tributaries to Yellow Creek and Burgess Run. A list of dams within the watershed was compiled from ODNR and can be seen in Table 6. Figure 12 shows the locations of all dams and impoundments in the watershed. It was noted that the dam in Yellow Creek at E. Western Reserve Road (RM 7.75) was not included in ODNR's list.

The findings of this evaluation may factor into regulatory actions taken by the Ohio EPA (e.g. NPDES permits, Director's Orders, or the Ohio Water Quality Standards [OAC 3745-1], and may eventually be incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, Total Maximum Daily Loads (TMDLs) and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d] report).

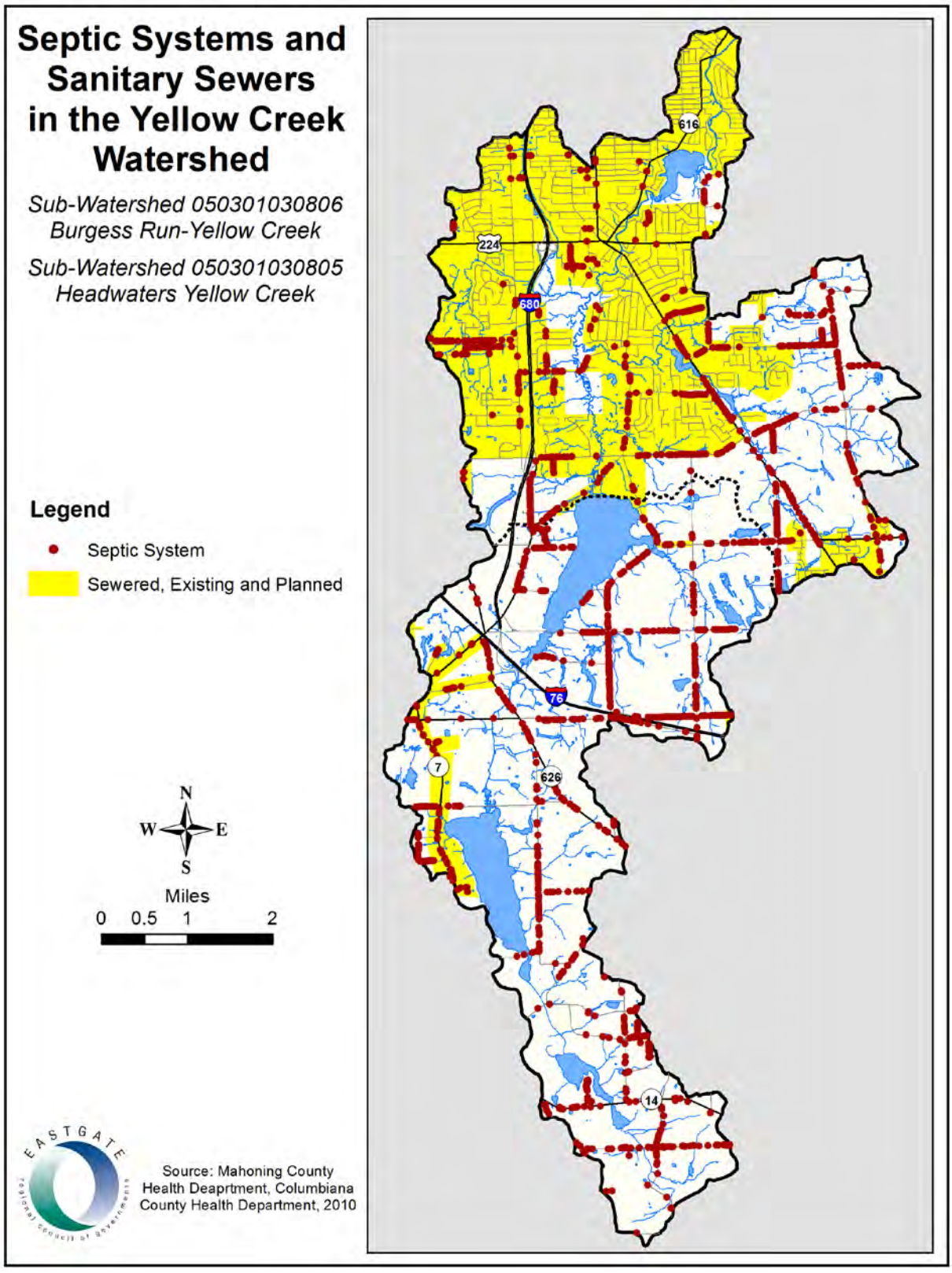


Figure 11. Septic Systems and Sanitary Sewers in the Yellow Creek watershed.

Table 6. Dams and impoundments in the Yellow Creek watershed.

ID	Name	Owner	Owner Type	Stream	Purpose	Type	Structure Type	Max Height
1	Keating Lake Dam		Private	Tributary to Yellow Creek	Recreation, Private	Dam and Spillway		10.0
2	Beaver Lake Dam	Meadowbrooke Development, Llc	Private	Bull Creek	Recreation, Private	Dam and Spillway	Earthfill	17.7
3	Moore Lake Dam	Robert R. & Laura Mehocic Moore	Private	Tributary to Yellow Creek	Recreation, Private	Dam and Spillway	Earthfill	9.2
4	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
5	Pine Lake Dam	Aqua Ohio, Inc.	Utility	Yellow Creek	Water Supply, Industrial; Recreation, Public	Dam and Spillway	Earthfill	16.0
6	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
7	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
8	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
9	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
10	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
11	Strip Mine Impoundment	D & R Elser	Private		Surface Mining	Dugout		
12	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
13	Strip Mine Impoundment	Ray Heindel	Private		Surface Mining	Dugout		
14	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
15	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
16	Unknown			Tributary to Yellow Creek (Evans Lake)		Dam and Spillway	Earthfill	18.0
17	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
18	Unknown			Burgess Run		Dam and Spillway	Earthfill	10.0

ID	Name	Owner	Owner Type	Stream	Purpose	Type	Structure Type	Max Height
19	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
20	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
21	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
22	Strip Mine Impoundment		Unknown		Surface Mining	Dugout		
23	Evans Lake Dam	Aqua Ohio, Inc.	Utility	Yellow Creek	Water Supply, Industrial; Recreation, Public	Dam and Spillway	Earthfill	49.0
24	Mike Lake Dam	M Charlotte Mike.	Private	Burgess Run	Recreation, Private	Dam and Spillway	Earthfill	11.3
25	Burgess Lake Dam	Aqua Ohio, Inc.	Utility	Burgess Run	Water Supply, Industrial	Dam and Spillway	Earthfill	26.5
26	Roybuck Lake Dam	D.H. Roybuck	Private	Tributary to Burgess Run	Recreation, Private	Dam and Spillway	Earthfill	10.0
27	Boardman Park Detention Basin Dam	Boardman Township		Unnamed Tributary to Yellow Creek				
28	Lake Hamilton Dam	Aqua Ohio, Inc.	Utility	Yellow Creek	Recreation, Public; Water Supply, Industrial	Dam and Spillway	Concrete; Masonry	70.1

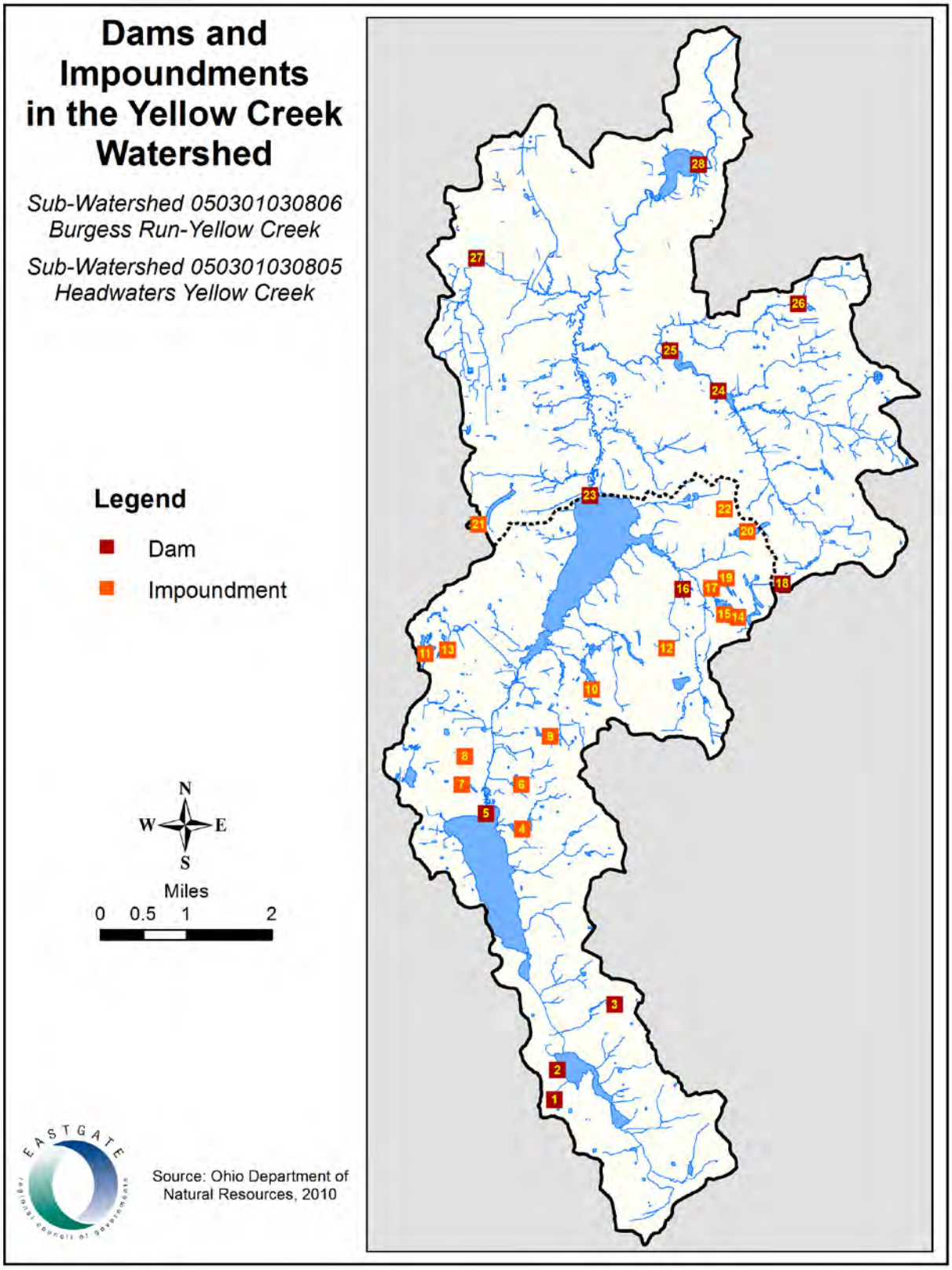


Figure 12. Dams and Impoundments in the Yellow Creek watershed.

RESULTS

Water Chemistry

Surface water chemistry samples were collected from the Yellow Creek watershed study area from August through October 2016 at six locations (Table 1). Stations were established in free-flowing sections of the stream and were primarily collected from bridge crossings. Surface water samples were collected directly into appropriate containers, preserved and delivered to Ohio EPA's Environmental Services laboratory. Collected water was preserved using appropriate methods, as outlined in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 2015). Interactive maps of surface water chemical data, downloadable to excel files, are available at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx .

The Yellow Creek watershed area did not have United States Geological Survey (USGS) gage stations with current data at the time of the study, therefore, the USGS gage data from the Mahoning River near Youngstown, Ohio was used to show flow trends in the watershed area in 2011 (Figure 13). Dates when water samples and bacteria samples were collected in the study area are noted on the graph. Flow conditions during the summer/fall field season were typically lower than the historic median. Low flow conditions were recorded from August through November with some rain events elevating flow above the historic median. Water samples captured a variety of flow conditions in the study area during the field season. Bacteria was collected during the recreation use season (May 1 through October 31) and was typically collected during low flows.

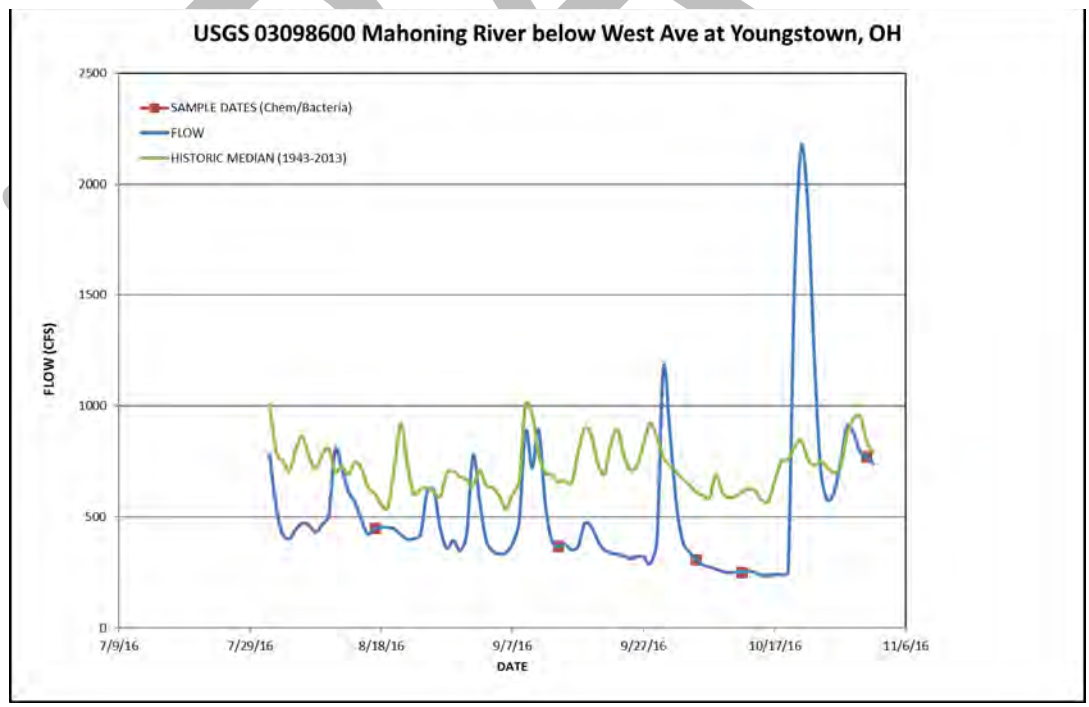


Figure 13. Water column chemistry and bacteria sampling plotted along flow trends for the 2010 sampling season. Flow trend data taken from the nearest USGS gaging station located in Youngstown, Ohio on the Mahoning River.

Surface water samples were analyzed for metals, nutrients, bacteria, pH, temperature, conductivity, dissolved oxygen (D.O.), percent D.O. saturation, and suspended and dissolved solids, however the purpose of this report is to discuss water quality based on nutrient and bacteria analysis. Parameters which were in exceedance of the Ohio EPA Nutrient Target Levels are reported in Table 7. Bacteriological samples results are reported and discussed in the Recreation Use Section.

The low gradient and channelization of Yellow Creek/Evans Lake headwaters at RMs 14.03 and 11.4 resulted in a monotonous and motionless stream and allowed for general low D.O. with values below the WWH criterion of 4.0 mg/L. These reached of the stream were generally sluggish and therefore provided little turbulence that would allow for higher instream D.O. Conversely, in the upper reach of Yellow Creek (RMs 7.75), and the other streams in the study, the gradient was slightly higher, allowing for movement to the stream. Thus, D.O. levels were maintained above the WWH standard.

Chemical water quality in Yellow Creek, especially the headwater reaches, was heavily influenced by nutrients in the watershed. The D.O. and nutrient values are the result of nutrient inputs from agricultural activities or from areas with failing home sewage treatment systems (HSTS). In Yellow Creek (RM 14.03), elevated mean concentrations of total phosphorus could be attributed to poor treatment of sanitary waste from HSTS. Agricultural runoff and poorly treated sewage may be responsible for elevated concentrations of ammonia and TKN in Burgess Run (RM 2.55). Algae were abundant in Yellow Creek's headwater reaches which indicates nutrient enrichment from the surrounding agricultural landscape. A lack of riparian corridor in these areas exacerbates the algal growth.

Table 7. Summary statistics for selected nutrient water quality parameters sampled in the Yellow Creek watershed 2016. Highlighted values are above the statewide nutrient targets for nitrate+nitrite-N and total phosphorus.

Location			Nitrate+Nitrite-N mg/L	Phosphorus-T mg/L
Stream	**River Mile**	**Drain Area**	**Geometric Mean**	**Geometric Mean**
Yellow Creek @ Heck Road	14.03[H] (301466)	3.7	0.15	0.27
Yellow Creek @ SR 165	11.40[H] (301407)	10.11	0.31	0.04
Yellow Creek @ E. Western Reserve Road	7.75[W] (301468)	20.52	0.21	0.03
UT to Yellow Creek at E. Middleton Road (RM 8.85)	1.38[H] (303747)	1.38	0.17	0.03
UT to Burgess Run at Arrel Road (RM 1.56)	0.9[H] (303749)	1.36	0.47	0.03
Burgess Run (Burgess Lake) at SR 170	2.55[H] (303748)	1.36	0.3	0.08

Statewide Nutrient Targets	**Headwater**			**Wadeable**			**Small River**			**Large River**		
	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH	WWH	EWH	MWH
Nitrate+Nitrite-N (mg/L)	1.0	0.5	1.0	1.0	0.5	1.6	1.5	1.0	2.2	2.0	1.5	2.4
Phosphorus-T (mg/L)	0.08	0.05	0.34	0.10	0.05	0.28	0.17	0.10	0.25	0.30	0.15	0.32

*Use designations (aquatic life)

MWH – modified warmwater

WWH – warmwater habitat

EWH – exceptional warmwater habitat

Recreation Use

Water quality criteria for determining attainment of recreation uses are established in the Ohio Water Quality Standards (Table 7-13 in OAC 3745-1-07) based upon the presence or absence of bacteria indicators (*Escherichia coli*) in the water column.

Escherichia coli (*E. coli*) bacteria are microscopic organisms that are present in large numbers in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour, 1977), but there is currently no simple way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis are becoming more practicable. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes, or may enter water bodies along with runoff from soils where these wastes have been deposited.

Pathogenic (disease causing) organisms are typically present in the environment in such small amounts that it is impractical to monitor them directly. Fecal indicator bacteria by themselves, including *E. coli*, are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, capable of causing serious illness. Although not necessarily agents of disease, fecal indicator bacteria such as *E. coli* may indicate the potential presence of pathogenic organisms that enter the environment through the same pathways. When *E. coli* are present in high numbers in a water sample, it invariably means that the water has received fecal matter from one source or another. Swimming or other recreational-based contact with water having a high fecal coliform or *E. coli* count may result in ear, nose, and throat infections, as well as stomach upsets, skin rashes, and diarrhea. Young children, the elderly, and those with depressed immune systems are most susceptible to infection.

The streams of the Yellow Creek watershed are designated as a Primary Contact Recreation (PCR) use in OAC Rule 3745-1-24. Water bodies with a designated recreational use of PCR "…are waters that, during the recreation season, are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking and SCUBA diving" [OAC 3745-1-07 (B)(4)(b)]. There are three classes of PCR use to reflect differences in the potential frequency and intensity of use. Streams designated PCR Class A typically have identified public access points and support primary contact recreation. Streams designated PCR Class B support, or potentially support, occasional primary contact recreation activities. Streams designated as PCR class C support, or potentially support, infrequent primary contact recreation activities. Streams designated as Secondary Contact Water (SCR) use are rarely used for water-based recreation. The Yellow Creek study area is all designated Class B PCR wasters. The *E. coli* criteria that apply to PCR Class A and B streams include a geometric mean of 126 and 161 cfu/100 ml. The geometric mean is based on two or more samples and is used as the basis for determining attainment status when more than one sample is collected.

Bacteria

Elevated bacteria counts were found throughout the watershed. Failing home sewage treatment systems inadequate manure management and unrestricted livestock access to streams are the most likely sources of bacteria.

Summarized bacteria results are listed in Table 8. Downloadable bacteria results are also available from the Ohio EPA GIS interactive maps at the following link: http://www.epa.ohio.gov/dsw/gis/index.aspx . Six locations in the Yellow Creek study area were samples for *E. coli* four times, from August 17 to October 31, 2016. Evaluation of *E. coli* results revealed that all six locations sampled failed to attain the applicable geometric mean criterion indicating an impairment of the recreation use at these locations. The locations not attaining the recreational use were most likely due to unsanitary conditions from failing HSTS and/or agricultural activities such as pasture land runoff, livestock with free access to the stream and manure land application.

Because of the rural nature of much of the study area, centralized sewer systems are rare and therefore most homes located outside of the major populated centers treat their sanitary waste via HSTS. Therefore, HSTS are suspected as a source of *E. coli* in much of the Yellow Creek watershed.

The large percentage of land dedicated to row crop agriculture and livestock pasturage may also contribute to the excessive levels of bacteria in the watershed. As indicated in Figure 12, agriculture and livestock pasturage accounts for roughly 41% Yellow Creek and Burgess Run watershed's land use. As a result of these activities, manure-laden runoff from farm fields or pasture, animal feedlots, and/or unrestricted livestock access to stream channels could also contribute *E. coli* bacteria to many areas of Yellow Creek and Burgess Run that are within or downstream from agricultural operations.

In addition to failing HSTS and agriculture, poorly treated sanitary waste from NPDES-regulated facilities may also be sources of bacteria to areas of Yellow Creek in which they discharge. Shadeland Apartments package plant, south of E. Western Reserve Road (RM 7.75) has had compliance issues in the past. This area is also downstream of Fonderlac Village Condo Association's and the Lake Club package plants. There is a farm with livestock that have unrestricted access to Yellow Creek in that area. The Mahoning County Health Department has indicated that this area has several failing HSTS, and there is a small private low-head dam in the area, that restricts flow in the creek. All of the factors may be the cause of why this location had the highest geometric mean of *E. coli* in the survey.

Finally, urban runoff is also a likely source of bacteria in the lower Yellow Creek and Burgess Run. These stream reaches are within the municipal limits of Poland, Struthers, and New Middletown, and are susceptible to contaminated runoff during precipitation events.

Table 8. A summary of E. coli *data for locations sampled in the Yellow Creek watershed, August 17 to October 31, 2016. Recreation use attainment is based on comparing the geometric mean to the Primary Contact Recreation (PCR) Classes A or B geometric mean water quality criterion of 126 or 161 cfu/100 ml (Ohio Administrative Code 3745-1-07). All values are expressed in colony forming units (cfu) per 100 ml of water. Gray shaded values exceed the applicable PCR Class A or B geometric mean criterion.*

Location	River Mile	Recreation Use	Number of Samples	Geometric Mean	Maximum Value	Recreational Attainment Status	Probable Source(s) of Bacteria
HUC 050301030805 – Headwaters to Yellow Creek/Evans Lake							
Yellow Creek @ Heck Road	14.03	PCR Class B	4	72.4	230	**FULL**	
Yellow Creek @ State Rt. 165	11.4	PCR Class B	4	405	830	**NON**	Agriculture; natural
HUC 050301030806 – Burgess Run – Yellow Creek							
Yellow Creek @ E. Western Reserve Road	7.75	PCR Class B	4	263	570	**NON**	Failing HSTS; failing package plant; livestock; agriculture; dam pool; natural; urban runoff
UT to Yellow Creek at E. Middleton Road (RM 8.85)	1.38	PCR Class B	4	301	860	**NON**	Failing home sewage treatment systems (HSTS); agriculture; natural
UT to Burgess Run at Arrel Road (RM 1.56)	0.9	PCR Class B	4	225	410	**NON**	Failing home sewage treatment systems (HSTS); agriculture; drainage tile discharge; natural
Burgess Run at SR 170	2.55	PCR Class B	4	104	300	**FULL**	

Point Sources (by subwatershed or stream segment)

Point source pollution is a direct discharge into a river, stream, lake or wetland from a known source such as a wastewater treatment plant or industrial facility. Any such direct discharge into a water body is required, by the laws set forth in the Clean Water Act, to obtain an NPDES permit. The NPDES permit creates a means of operating, monitoring, reporting, and sets numerical limitations on the amount of specified pollutants authorized for discharge. There are currently four package plants and two facilities discharging treated effluent into Yellow Creek and are located along Evans Lake. A Package Plant is a prefabricated, discharging treatment facility typically treating wastewater volumes less than 100,000 gpd. Besides the package plants, the Ohio EPA lists three (3) additional NPDES permit holders within the Yellow Creek Watershed. Figure 4 illustrates the location of each permit holder. Visit the Ohio EPA's Division of Surface Water Individual NPDES Permits for more information on Ohio's Individual NPDES permits, http://www.epa.ohio.gov/dsw/permits/individuals.

Too numerous to mention are the HSTS off lot discharges covered under Ohio House Bill (HB) 110. House Bill 110 provides an NPDES permit for off lot discharging HSTS systems that fall under the jurisdiction of local health departments. Adding another level of permitting, Ohio HB 231 requires the Ohio EPA to create a general permit for all residential systems discharging to Waters of the State. On February 17, 2006, the Ohio EPA introduced a draft General NPDES Permit (No. OHK000001) to issue for new and replacement discharging sewage treatment systems. The general permit received final approval in December of 2006. On January 1, 2007 the Ohio EPA adopted the general permit, authorizing wastewater discharges for selected new and replacement HSTS's under the NPDES program. Both county health departments signed memorandums of understanding (MOU) with the Ohio EPA to administer the General NPDES permit program. According to the Ohio EPA, the general permit is issued to those dischargers that will have a minimal impact on the environment and covers a one, two, or three family or residential dwelling. In order to ensure compliance with the discharge standards of each permit and proper system operation, the Ohio EPA is requiring each permit holder annual sampling and testing of discharge from the system. The sampling results are to be submitted to the jurisdictional local health department and made available at the request of the Ohio EPA. A second General NPDES permit, OHL000001 was created to cover existing discharging HSTSs in counties that have not signed an MOU with the Ohio EPA and therefore, would be under the Ohio EPA's HSTS program. Due to the number of NPDES permits for such systems, a list was not created.

Non Point Sources

Inventory of Home Sewage Treatment Systems/Projected Number of Failing Systems

Regardless of age, numerous problems and failures with individual HSTS systems have been documented across Ohio. Specifically, in the Yellow Creek Watershed soil suitability, the age of the system, and the establishment of subdivision and environmental regulations are leading causes of system failure.

Soil suitability is a prevalent failure factor in watershed. If effluent cannot percolate efficiently, then it remains in the leachfield and can cause a system backup or discharge. Effluent percolates faster in soil composed of sand and gravel than in clay-like soil. The elevation of a site's water table will also have a direct effect on the percolation of effluent. Other factors that can prohibit the proper HSTS function include:

- Shallow depth to bedrock;

- Slope that shall not exceed 15 percent in both county regulations;

- Frequency of flooding- both counties state that an HSTS shall not be placed in a one hundred (100) year flood plain (delineated using FEMA maps);
- Improper installation and lack of maintenance (i.e. switching leachfield distribution baffle);
- Excessive water use in the home;
- Change in property drainage i.e. position of down spouts or rain gutters, or the installation of paved areas that drain to excess water to yard area of the septic system; and
- Failure to pump the septic tank.

Failing septic systems were identified as one of many sources causing nonattainment status for all but one sampling site within the watershed. According to Mahoning County District Board of Health (Board of Health), septic system inspections occur, either prior to the sale of a house, land re-plats, home additions, owner repair request, or if a nuisance report was filed. According to the Board of Health, systems with minor problems are allowed to function under the condition the problem is fixed through maintenance, servicing, or alternative system permit. Systems brought back into compliance require documentation of such to be submitted to the appropriate board of health. Figure 14 shows how many septic systems in the watershed had complaints issued or were designated as failing, unsafe, or malfunctioning in each year, through the end of 2012.

Biosolids

Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge. Biosolids are recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth. There are different classes of biosolids which determine regulation levels.

Class A biosolids contain no detectible levels of pathogens and do not need Ohio EPA authorization to be land applied. Information on where Class A biosolids are used is not available because use is not monitored.

Class B biosolids are treated but still contain detectible levels of pathogens. There are buffer requirements, public access, and crop harvesting restrictions for virtually all forms of Class B biosolids. Fields which have authorization to land apply Class B biosolids are shown in Table 9 and Figure 15. Because a fields is approved for the application of Class B biosolids does not mean biosolids have ever been applied to the field.

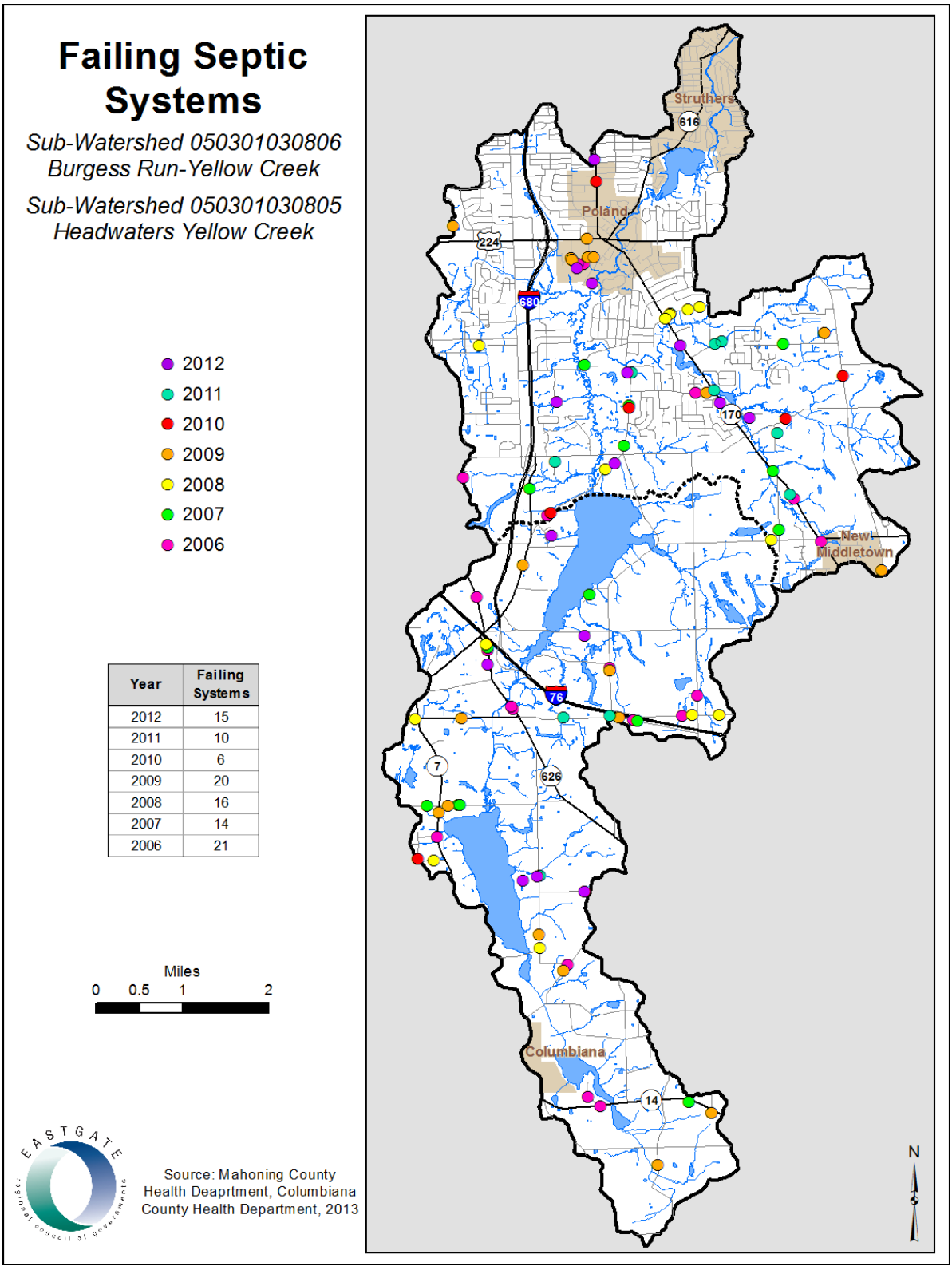


Figure 14. Failing Septic Systems within the Yellow Creek watershed.

Table 9. Fields approved for application of Class B Biosolids in the Yellow Creek watershed.

Sub-Watershed	Acres within Watershed	OEPA Site #	NPDES #	Biosolids Generator	Owner
Burgess Run-Yellow Creek	1.01	50-00058	3PD00026*JD	Struthers WWTP	Stacey Hugh
Burgess Run-Yellow Creek	8.88	50-00054	3PD00026*JD	Struthers WWTP	Stacey Hugh
Burgess Run-Yellow Creek	1.6	50-00059	3PD00026*JD	Struthers WWTP	Stacey Hugh
Headwaters Yellow Creek	8.96	50-00101	3PD00026*JD	Struthers WWTP	Kohler
Headwaters Yellow Creek	3.02	50-00104	3PD00026*JD	Struthers WWTP	Kohler
Headwaters Yellow Creek	18.06	50-00100	3PD00026*JD	Struthers WWTP	Kohler
Headwaters Yellow Creek	5.09	50-00102	3PD00026*JD	Struthers WWTP	Kohler
Headwaters Yellow Creek	6.64	50-00103	3PD00026*JD	Struthers WWTP	Kohler
Headwaters Yellow Creek	9.84	50-00105	3PD00026*JD	Struthers WWTP	Kohler
Headwaters Yellow Creek	2.81	15-00158	3PD00027*ID	Salem STP	Kenneth Robb
Headwaters Yellow Creek	7.47	15-00159	3PD00027*ID	Salem STP	Kenneth Robb
Headwaters Yellow Creek	40.54	15-00160	3PD00027*ID	Salem STP	Kenneth Robb
Headwaters Yellow Creek	30.74	15-00161	3PD00027*ID	Salem STP	Kenneth Robb
Headwaters Yellow Creek	26.38	50-00106	3PD00027*ID	Salem STP	Ronald Rapp
Headwaters Yellow Creek	1.05	50-00116	3PD00041*FD	Columbiana WWTP	David Bair
Headwaters Yellow Creek	12.01	50-00115	3PD00041*FD	Columbiana WWTP	Glacier Hills Corp-Raymond Wiery

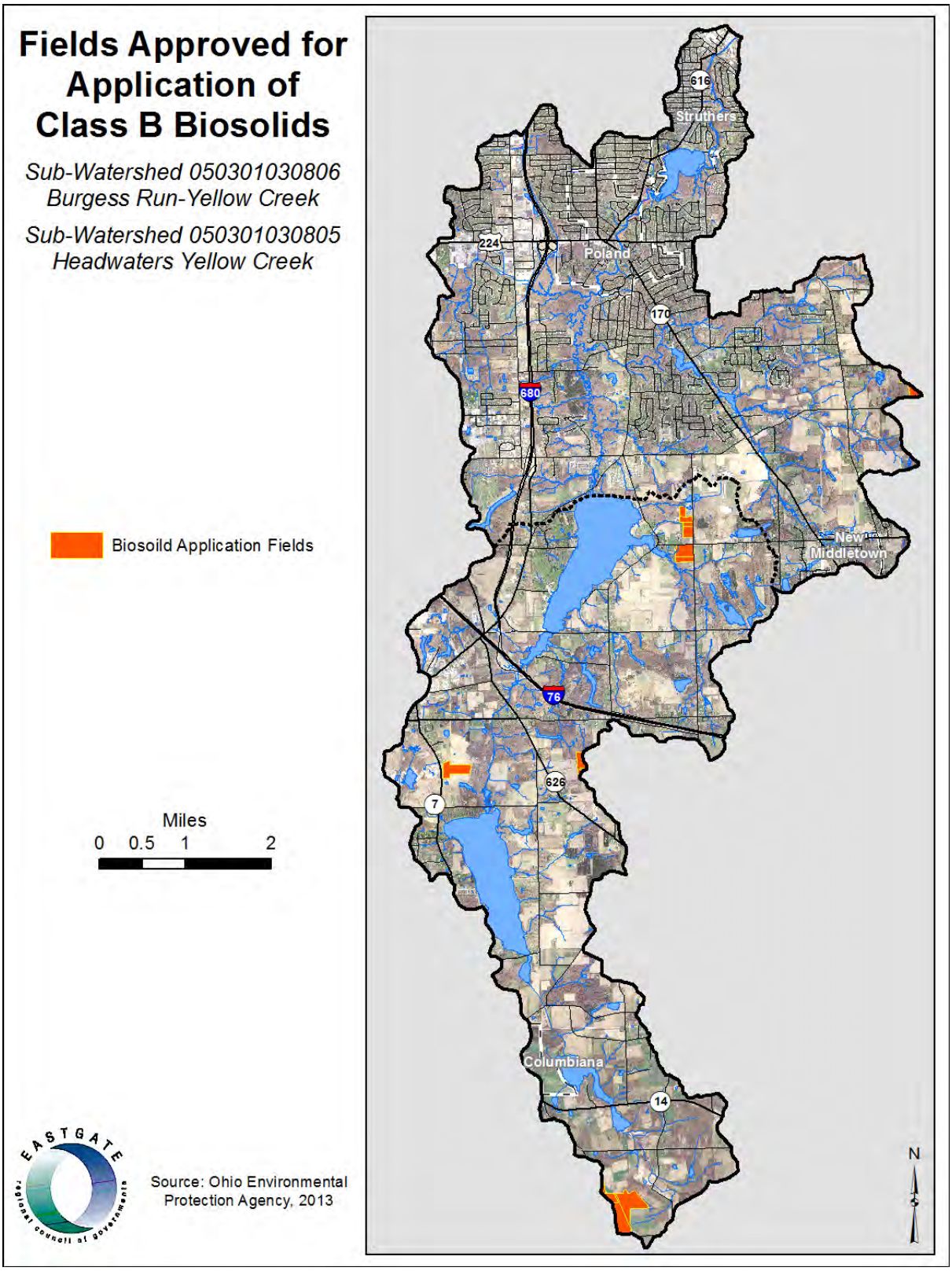


Figure 15. Fields approved for the application of Class B Biosolids within the Yellow Creek watershed.

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