Karst of Springfield, Ohio

by
Douglas J. Aden

with
GIS and cartography by Dean R. Martin

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Cover image: At the top of the photo is the massive and unfractured Cedarville Dolomite. Below, a spring flows from the blocky and highly fractured Springfield Dolomite.

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Introduction

Karst terrain forms by dissolution of carbonate rocks, such as limestone or dolomite, or evaporites, such as gypsum or salt, and is characterized by features including sinkholes, disappearing streams, caves, and springs. *Sinkholes* are enclosed depressions that do not usually hold water; they often have a "throat" or opening at the bottom where they drain to the subsurface. When a stream flows into a sinkhole, it is known as a *disappearing stream* or *losing stream*. Water flowing into the ground can cause solution enlargement of natural fractures in the rock and these fractures eventually can grow into caves. In Ohio, a *cave* is defined as "…a naturally occurring void, cavity, recess, or system of interconnecting passages beneath the surface of the earth or within a cliff or ledge…" (State of Ohio, 1989).

The many passageways formed in karst terrain allow for high connectivity between the land surface and the water table. These passageways permit water to bypass soil and rock layers that filter out contaminants. Consequently, when compounds such as fertilizers, pesticides, and waste enter sinkholes, they are rapidly transported to the water table and quickly pollute water wells, streams, and rivers. When water exits these solutional features, a *spring* is formed. Such springs enable release of these contaminants at the surface. These different features may pose infrastructure complications: roads, utilities, houses, and other facilities built in karst areas are at risk of subsidence, collapse, or other damage.

In order to provide a reference for future planning on both the local and regional scale, this map book identifying the known and suspected karst areas of Springfield, Ohio, has been produced.

Previous Work

Karst areas have been studied in Ohio for many years. In the 1980s and 1990s, karst was researched for the proposed Superconducting Super Collider and mapped statewide to determine areas suitable for storage of low-level nuclear byproducts. Ohio's preliminary map of karst features (Pavey and others, 1999) was completed in 1997 and released in 1999; it since has been updated with new data in 2002, 2004, and 2007 and soon will be updated again. In the spring of 2008, severe karst-related flooding occurred in Bellevue and initiated increased concern regarding Ohio's geohazards (Raab and others, 2009). In 2011, karst was mapped in the rapidly developing Delaware County region (Aden and others, 2011). Finally, from late 2011 to 2012 karst areas were mapped in the Springfield and Donnelsville 7.5-minute quadrangles using methods that were refined in the Delaware County region, and new features were added to those provided by an Ohio Environmental Protection Agency study (Raymond and McGinnis, 2007).

Methodology

To locate sinkholes, a digital elevation map (DEM) generated from LiDAR (Light Detection and Ranging) data was used to create a map layer that identified low, enclosed areas. To locate potential sinkholes, these low spots were cross referenced with known karst points, bedrock geology, aerial photography of multiple sources and ages, soil maps, drift thickness maps, and water well logs. Suspect locations were then visited in the field, evaluated, and photographed. Through this process many of the LiDAR returns were found not to be sinkholes; features such as building foundations, broken field tiles, steep-walled streams, and road culverts often produced enclosed areas similar in shape to sinkholes. Many of these misleading features were eliminated remotely using both 6-inches-per-pixel aerial photography and experience from past field verification. However, many points remained that could not be distinguished remotely and these were visited in the field.

Results

The resulting karst feature set was overlain on four different geologic data sets to show how the features are related to the local geology. The first of these is the land surface map (p. 4), which shows the 96 two-km^2 tiles that form the project area overlain on the DEM of the land surface. This map shows that in Springfield karst features often occur near a break in slope.

Tiles outlined in red contain the karst features identified throughout the project area. No karst was identified in black-outlined tiles. In total there are 112 karst features, including 32 springs, in 22 tiles. On the top left of each aerial imagery page (p. 8–28) is a Tile Number that references the corresponding numbered tile on the four overlay maps.

There are four types of karst features identified on each map:

- Red circles indicate field-verified features, i.e., those that have been visited in the field and confirmed as karst.
- Orange circles indicate sites that were field visited but could not be verified at the time; for example a suspicious depression that is flooded or that lacks an active sink throat and cannot be clearly classified.
- Yellow circles represent areas with suspect characteristics, such as a distinct LiDAR depression, but where access to the property could not be gained.
- Blue squares represent springs where water was found flowing from the subsurface.

The next overlay map is the Bedrock Geology map (p. 5). This map shows that the karst features are restricted primarily to the dolomites, one of the main rock types that forms solutional cavities. Eighty of the 112 points are within the Silurian-age Cedarville, Springfield, & Euphemia Dolomites (**Scse** on the bedrock map) with the majority of the rest in the Brassfield Limestone (within the **Sm-b**). These formations and the others on the Bedrock Geology map are buried in many places by surficial glacial materials. The depth of the bedrock below the surficial materials is called Bedrock Topography and is shown on page 6. The bedrock elevations were subtracted from the DEM (p. 4) to create the Drift Thickness map (p. 7). Drift Thickness is useful because where the drift is shallow—about 25 ft or less in this region—sinkholes are commonly expressed. Other sinkholes may exist but were either buried beneath the glacial drift or prevented from forming by the thick drift. The Drift Thickness map clearly shows that the karst features are concentrated along areas of thin glacial drift.

Conclusions

Of the 112 mapped karst features, 79 have photos, and 38 show up on LiDAR. Of the springs, five have a LiDAR response while 26 do not. Springs do not typically show up as depressions unless a catch basin was built and subsequently failed. The large number of sinks and springs found without LiDAR attests to the need for spending time in the field near known karst areas, looking for new features and talking to the public. Farmers and other land holders are still one of the best sources of local information; particularly for historical features, such as drained ponds, old mill races, and even sinkholes that have been periodically filled in.

In addition to this map book, a CD containing the GIS data, metadata, LiDAR depressions, and photographs of many of the features is available. The GIS data contains details such as the location of each point and a brief description of what was found there. The metadata provides information on the sources and quality of the data used in this project. The LiDAR depressions layer records the depth and area for many of the sinkholes. In addition, the collection of photographs captured for many of these features can be used to monitor the growth of preexisting sinkholes and development of new karst features, as well as assisting in identification. Identification is important because karst regions are highly susceptible to pollution and structures built near them may subside. These maps will allow areas of land development near karst features to be better planned and maintained.

Acknowledgments

Both the Delaware County Region project and the Springfield project were funded by the Great Lakes Geologic Mapping Coalition surficial mapping grant program.

References Cited

Aden, D.J., Powers, D.M., Pavey, R.R., Jones, D.M., Martin, D.R., Shrake, D.L., and Angle, M.P., 2011, Karst of the western Delaware County, Ohio, region: Ohio Department of Natural Resources, Division of Geological Survey Open-File Report 2011-4, 2 p., 35 maps, accessible at <http://www.dnr.state.oh.us/Portals/10/pdf/OpenFileReports/OFR_2011-4.pdf>.

State of Ohio, 1989, Ohio Revised Code 1517.21 Cave definitions, in chap. 1517 of Title 15 Conservation of Natural Resources: State of Ohio, Ohio Revised Code, accessible at <http://codes.ohio.gov/orc/1517.21>.

Pavey, R.R., Hull, D.N., Brockman, C.S., Schumacher, G.A., Stith, D.A., Swinford, E.M., Sole, T.L., Vorbau, K.E., Kallini, K.D., Evans, E.E., Slucher, E.R., and Van Horn, R.G., with GIS and cartography by Powers, D.M., and Vogt, K.L., 1999, Known and probable karst in Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map EG-1, scale 1:500,000. [Revised 2002, 2004, 2007.]

Raab, James, Haiker, Bill, Jones, Wayne, Angle, Michael, Pavey, Rick, Swinford, Mac, and Powers, Donovan, 2009, Ground water induced flooding in the Bellevue Ohio area, spring and summer 2008: Ohio Department of Natural Resources, Division of Water Technical Report of Investigation 2009-1, 19 p., accessible at <http://www.dnr.state.oh.us/Portals/7/pubs/reports/Bellevue_Final_Report.pdf>.

Raymond, Heather, and McGinnis, John, 2007, Clark County karst investigation: Ohio Environmental Protection Agency, 27 p.

Further Reading

The following resources provide additional information on karst and its effects in Ohio and beyond.

Ohio Department of Natural Resources

"Revised Ohio Karst Map Helps Homeowners, Developers and Land-use Planners Define Areas of Possible Groundwater Pollution and Unstable Terrain," press release dated October 30, 2007, accessible at <http://ohiodnr.com/home_page/NewsReleases/tabid/18276/EntryId/204/10-29-07-Revised-Ohio-Karst-Map.aspx>.

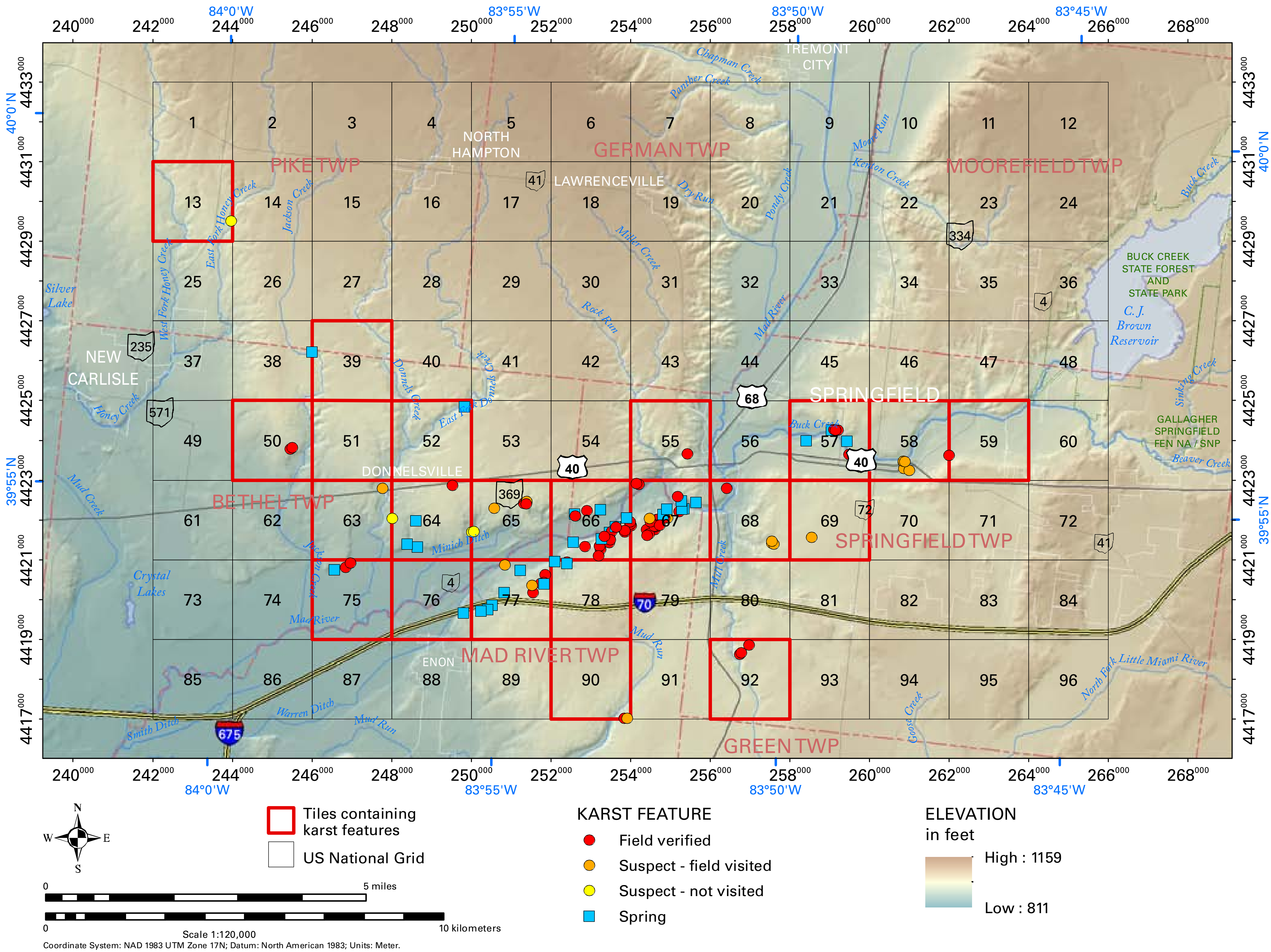
Karst Flooding in Bellevue, Ohio, and Vicinity—2008, ODNR Division of Geological Survey, Map EG-5, 2012, accessible at <http://ohiodnr.com/?TabId=24066>.

American Geological Institute

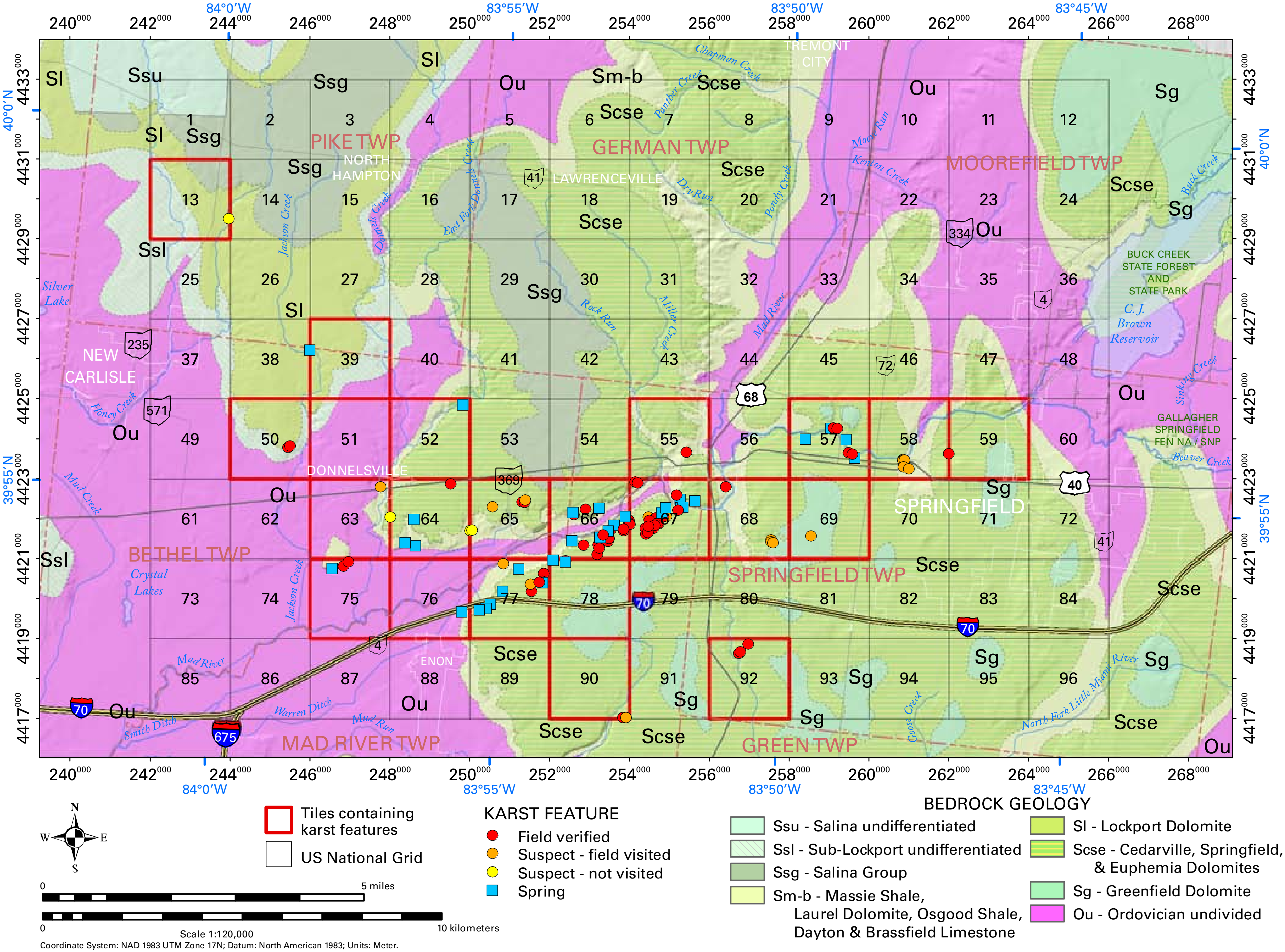
Living With Karst—A Fragile Foundation, AGI Environmental Awareness Series, no. 4, accessible at <http://www.agiweb.org/environment/publications/karst.pdf>.

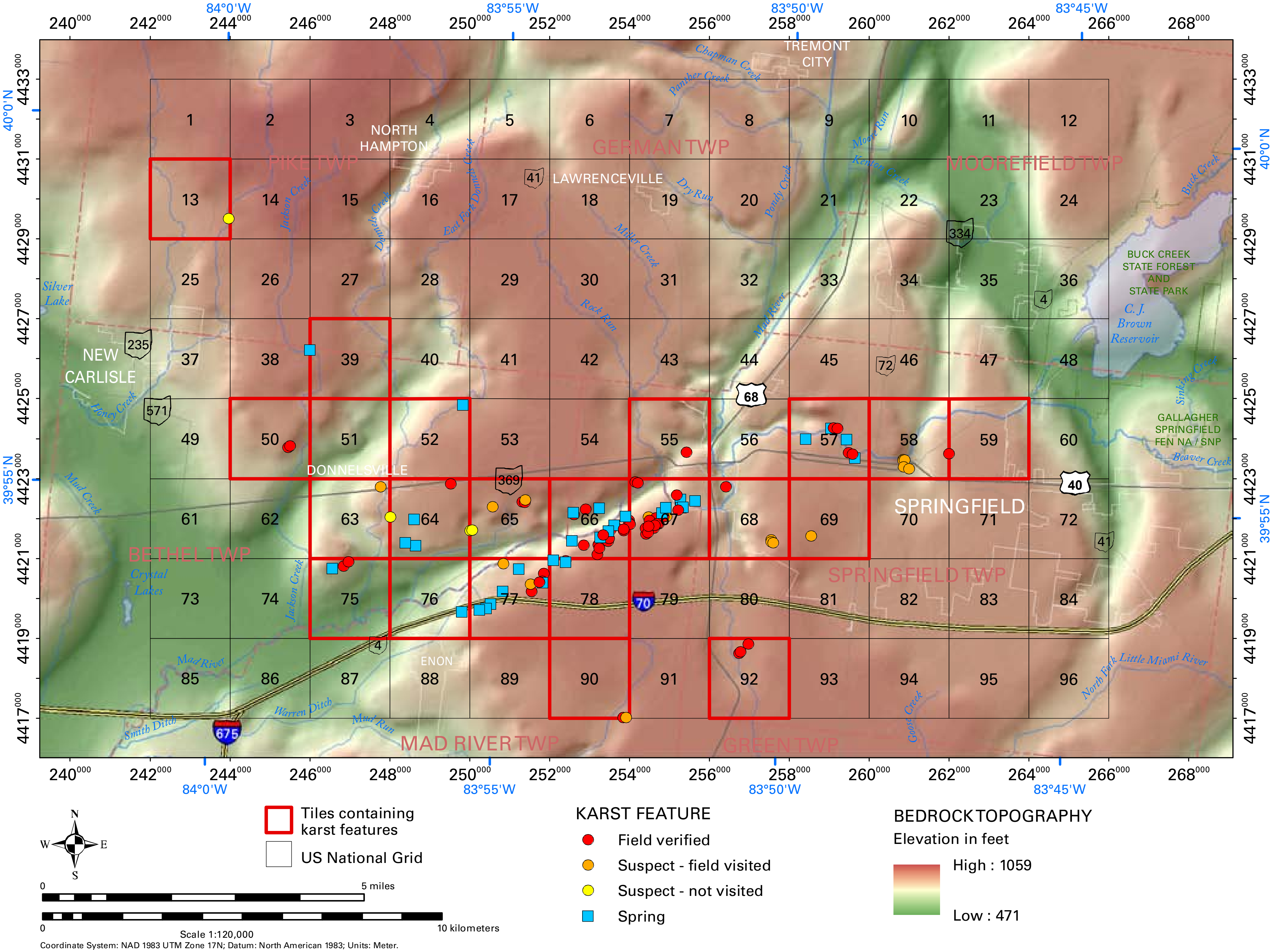
U.S. Geological Survey

USGS Groundwater Information, Karst and the USGS, accessible at <http://water.usgs.gov/ogw/karst/>.



TREMONT CITY
NORTH HAMPTON
LAWRENCEVILLE
PIKE TWP
GERMAN TWP
MOOREFIELD TWP
NEW CARLISLE
SPRINGFIELD
DONNELSVILLE
BETHEL TWP
SPRINGFIELD TWP
MAD RIVER TWP
ENON
GREEN TWP
BUCK CREEK STATE FOREST AND STATE PARK
C. J. Brown Reservoir
GALLAGHER SPRINGFIELD FEN NA / SNP
Silver Lake
Crystal Lakes
Chapman Creek
Panther Creek
Moore Run
Kenton Creek
Dry Run
Pondy Creek
Miller Creek
Rock Run
Mad River
Buck Creek
Beaver Creek
Sinking Creek
Honey Creek
East Fork Honey Creek
West Fork Honey Creek
Jackson Creek
Donnels Creek
East Fork Donnels Creek
Minich Ditch
Jackson Creek
Mill Creek
Mud Creek
Mud Run
Warren Ditch
Smith Ditch
North Fork Little Miami River
Goose Creek
84°0'W
83°55'W
83°50'W
83°45'W
40°0'N
39°55'N
Tiles containing karst features
US National Grid
KARST FEATURE
Field verified
Suspect - field visited
Suspect - not visited
Spring
ELEVATION in feet
High : 1159
Low : 811
0
5 miles
10 kilometers
Scale 1:120,000
Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.


PIKE TWP
GERMAN TWP
MOOREFIELD TWP
BETHEL TWP
SPRINGFIELD TWP
MAD RIVER TWP
GREEN TWP
NORTH HAMPTON
LAWRENCEVILLE
TREMONT CITY
NEW CARLISLE
DONNELSVILLE
ENON
SPRINGFIELD
BUCK CREEK STATE FOREST AND STATE PARK
GALLAGHER SPRINGFIELD FEN NA / SNP
C. J. Brown Reservoir
Silver Lake
Crystal Lakes
Chapman Creek
Panther Creek
Moore Run
Kenton Creek
Dry Run
Pondy Creek
Buck Creek
Jackson Creek
Donnels Creek
East Fork Donnels Creek
Rock Run
Miller Creek
Mad River
Sinking Creek
Beaver Creek
Honey Creek
Mud Creek
Warren Ditch
Smith Ditch
Mud Run
Goose Creek
North Fork Little Miami River
84°0′W
83°55′W
83°50′W
83°45′W
40°0′N
39°55′N
Tiles containing karst features
US National Grid
KARST FEATURE
Field verified
Suspect - field visited
Suspect - not visited
Spring
BEDROCK GEOLOGY
Ssu - Salina undifferentiated
Ssl - Sub-Lockport undifferentiated
Ssg - Salina Group
Sm-b - Massie Shale, Laurel Dolomite, Osgood Shale, Dayton & Brassfield Limestone
Sl - Lockport Dolomite
Scse - Cedarville, Springfield, & Euphemia Dolomites
Sg - Greenfield Dolomite
Ou - Ordovician undivided
0
5 miles
10 kilometers
Scale 1:120,000
Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.



84°0'W
83°55'W
83°50'W
83°45'W
40°0'N
39°55'N
240000
242000
244000
246000
248000
250000
252000
254000
256000
258000
260000
262000
264000
266000
268000
4433000
4431000
4429000
4427000
4425000
4423000
4421000
4419000
4417000
TREMONT CITY
NORTH HAMPTON
LAWRENCEVILLE
NEW CARLISLE
DONNELSVILLE
SPRINGFIELD
ENON
PIKE TWP
GERMAN TWP
MOOREFIELD TWP
BETHEL TWP
SPRINGFIELD TWP
MAD RIVER TWP
GREEN TWP
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C. J. Brown Reservoir
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Silver Lake
Crystal Lakes
Chapman Creek
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Buck Creek
Dry Run
Pondy Creek
Miller Creek
Rock Run
Mad River
Jackson Creek
Donnels Creek
East Fork Donnels Creek
Honey Creek
Mud Creek
Sinking Creek
Beaver Creek
Little Miami River
North Fork
Goose Creek
Warren Ditch
Mud Run
Smith Ditch
41
334
4
235
571
72
68
369
40
70
675
1
2
3
4
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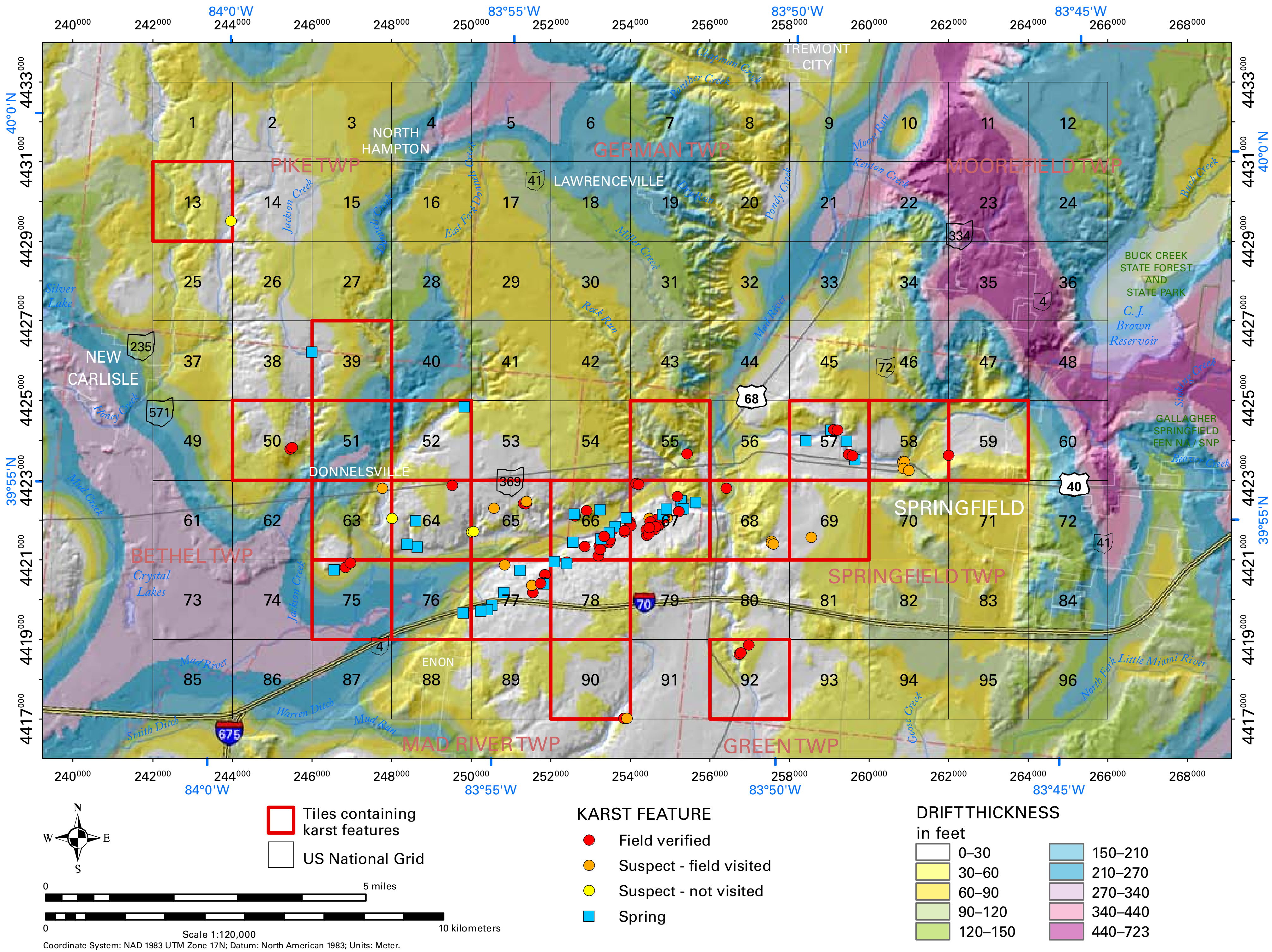
92
93
94
95
96
N
W
E
S
0
5 miles
0
10 kilometers
Scale 1:120,000
Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.
Tiles containing karst features
US National Grid
KARST FEATURE
Field verified
Suspect - field visited
Suspect - not visited
Spring
BEDROCK TOPOGRAPHY
Elevation in feet
High : 1059
Low : 471



84°0'W
83°55'W
83°50'W
83°45'W
40°0'N
39°55'N
240000
242000
244000
246000
248000
250000
252000
254000
256000
258000
260000
262000
264000
266000
268000
4433000
4431000
4429000
4427000
4425000
4423000
4421000
4419000
4417000
TREMONT CITY
NORTH HAMPTON
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PIKE TWP
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Kenton Creek
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Dugan Creek
East Fork Donnels Creek
Donnels Creek
Miller Creek
Dry Run
Rock Run
Mad River
Honey Creek
Mad Creek
Beaver Creek
Little Miami River
North Fork Little Miami River
Goose Creek
Warren Ditch
Smith Ditch
Mud Run
41
235
571
369
68
334
4
72
40
70
675
Tiles containing karst features
US National Grid
KARST FEATURE
Field verified
Suspect - field visited
Suspect - not visited
Spring
DRIFT THICKNESS in feet
0–30
30–60
60–90
90–120
120–150
150–210
210–270
270–340
340–440
440–723
0
5 miles
10 kilometers
Scale 1:120,000
Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 13

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	**17S**

N W E S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 39

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	17S

N W E S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 50

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	17S

N W E S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 52

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 55

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

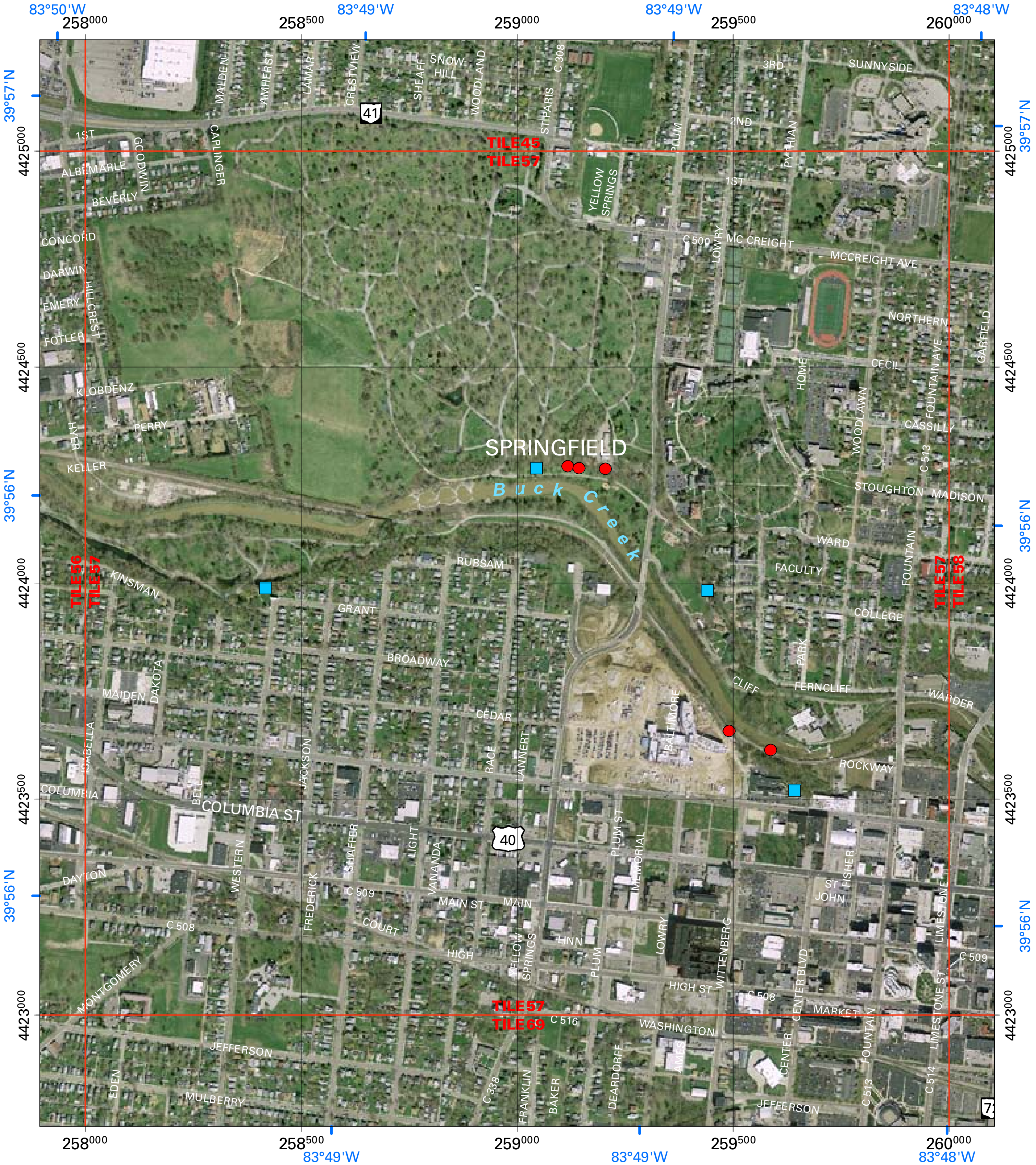
0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 57



US National Grid

100,000-m Square ID	Grid Zone Designation
KE	17S

KARST FEATURE

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- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 58

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 59

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 63

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**

N W E S

0 0.5 miles

0 Scale 1:12,000 1 kilometers

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 64

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	17S

N W E S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

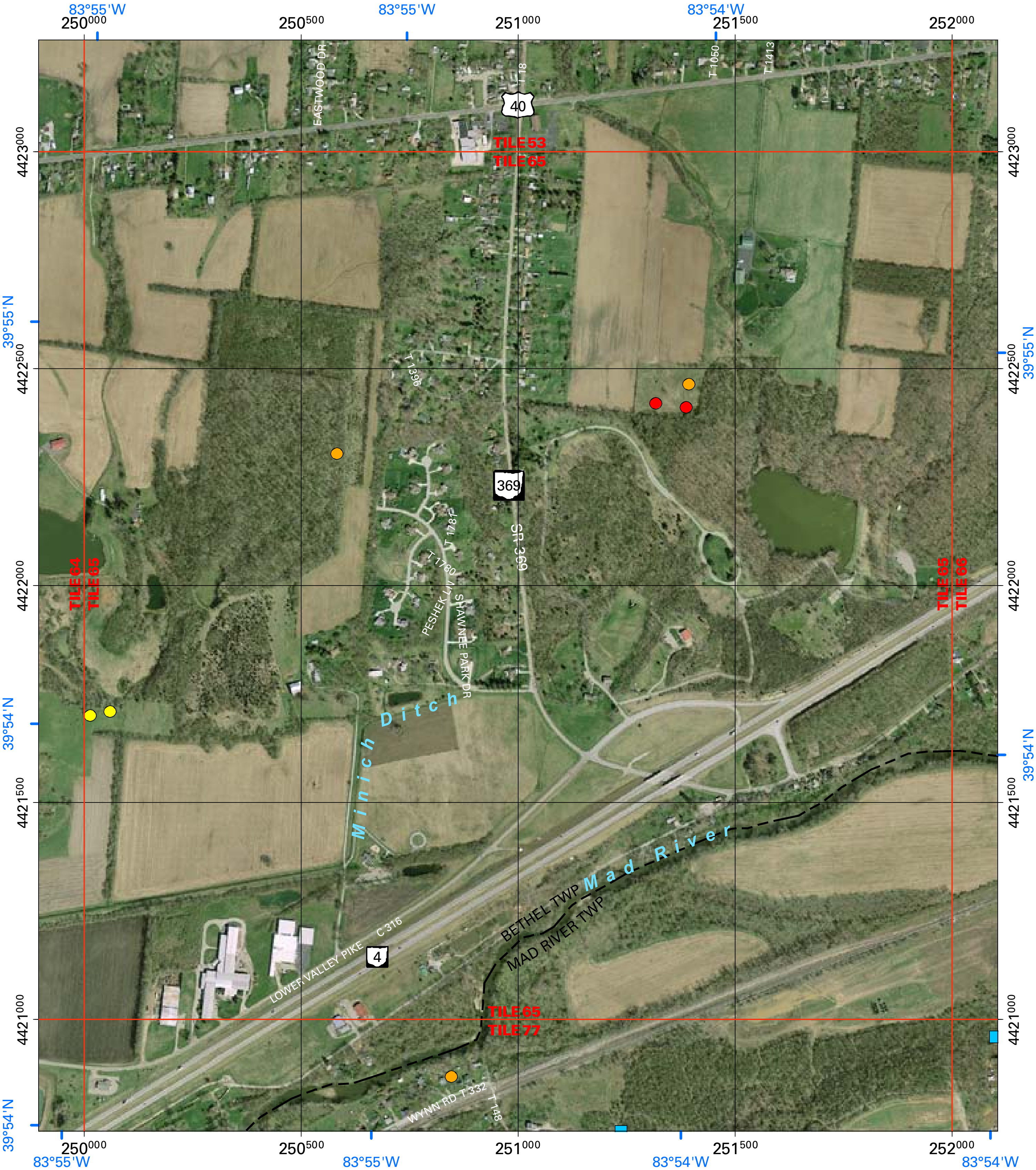
0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 65



US National Grid

100,000-m Square ID	Grid Zone Designation
KE	17S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

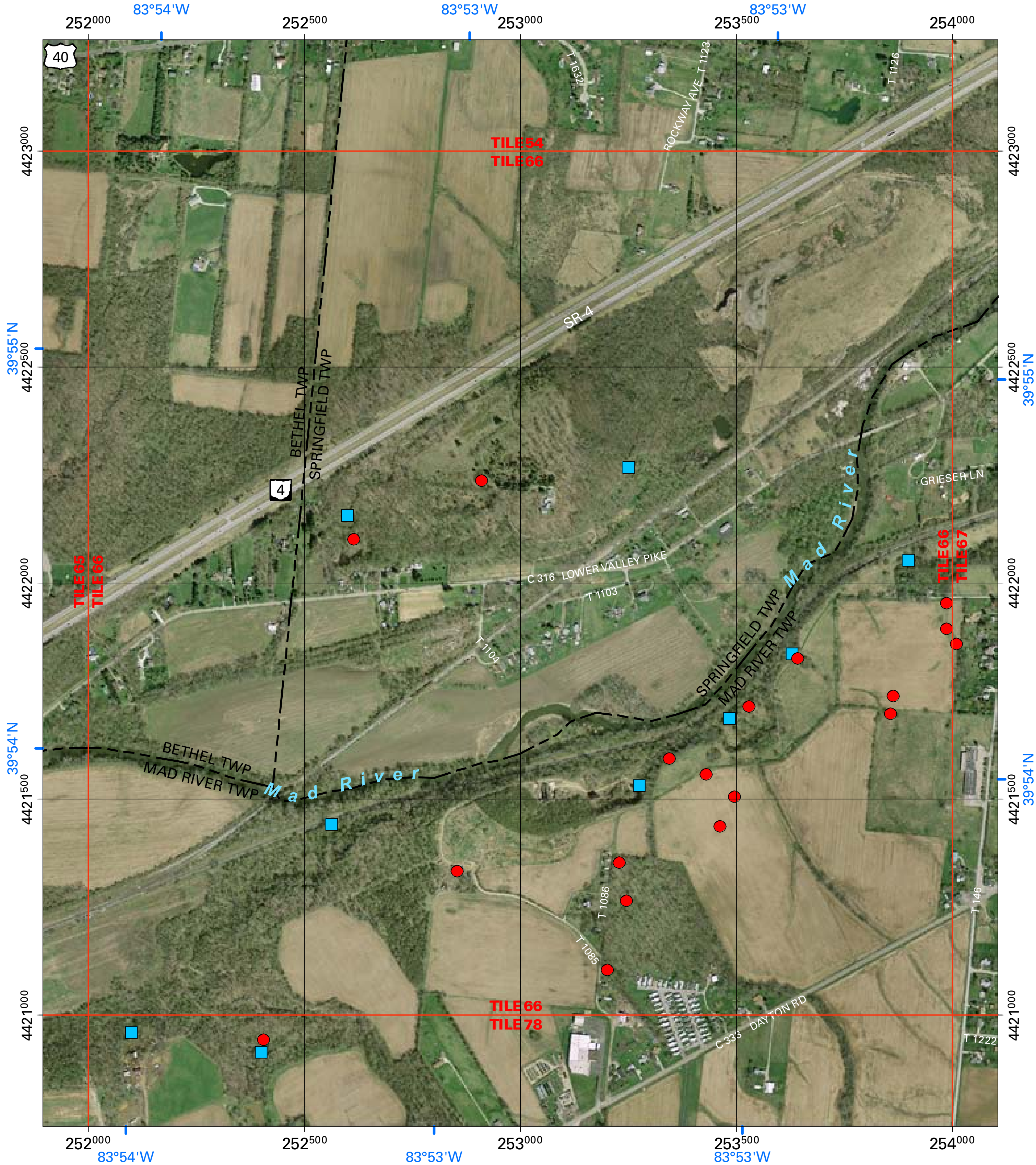
0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 66



US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

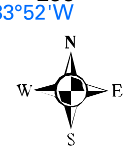
Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 67

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**



KARST FEATURE
- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 68

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	17S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 69

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	17S

N
W E
S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

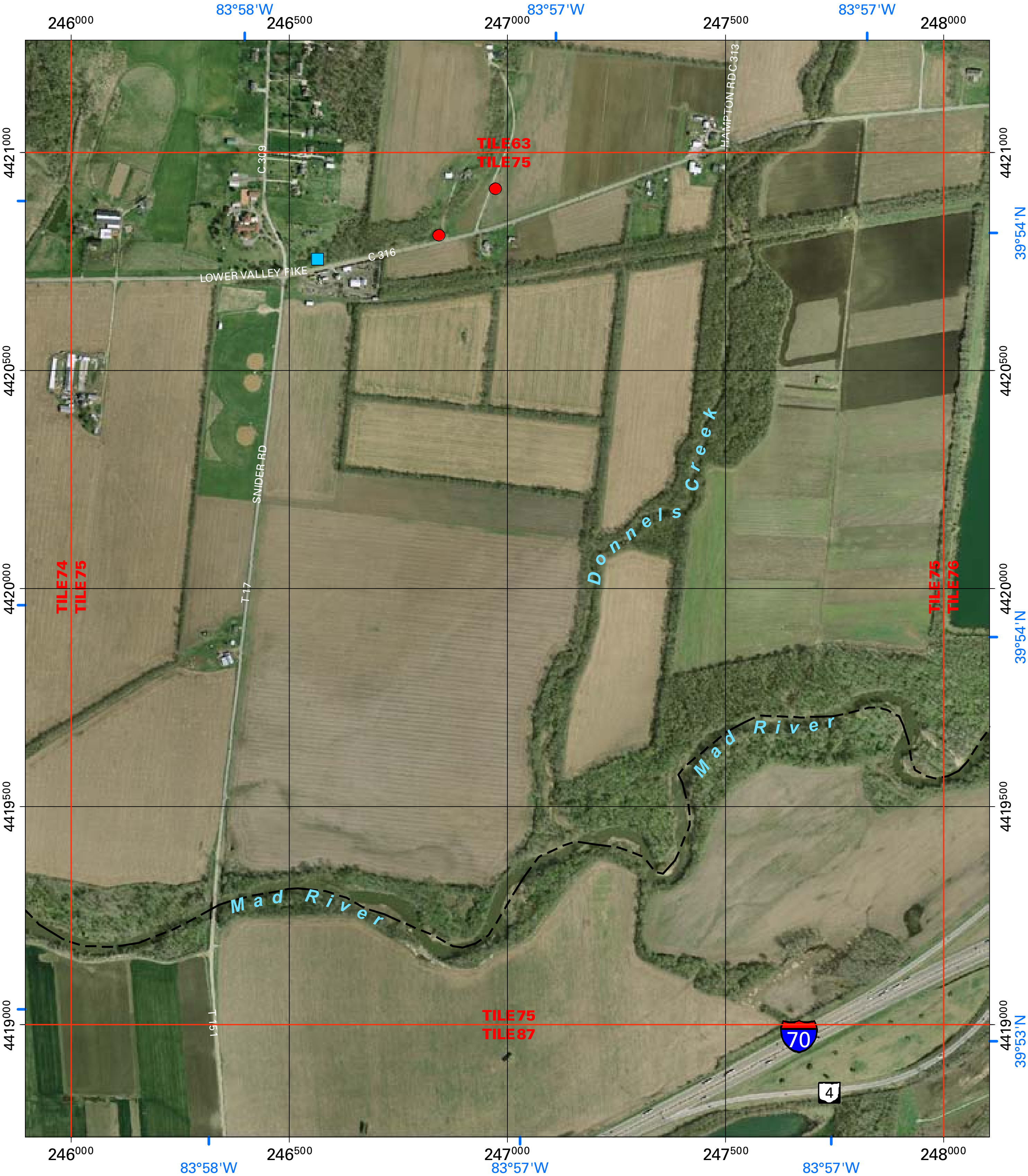
0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 75



US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 76

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	17S

N W E S

0 0.5 miles

0 1 kilometers

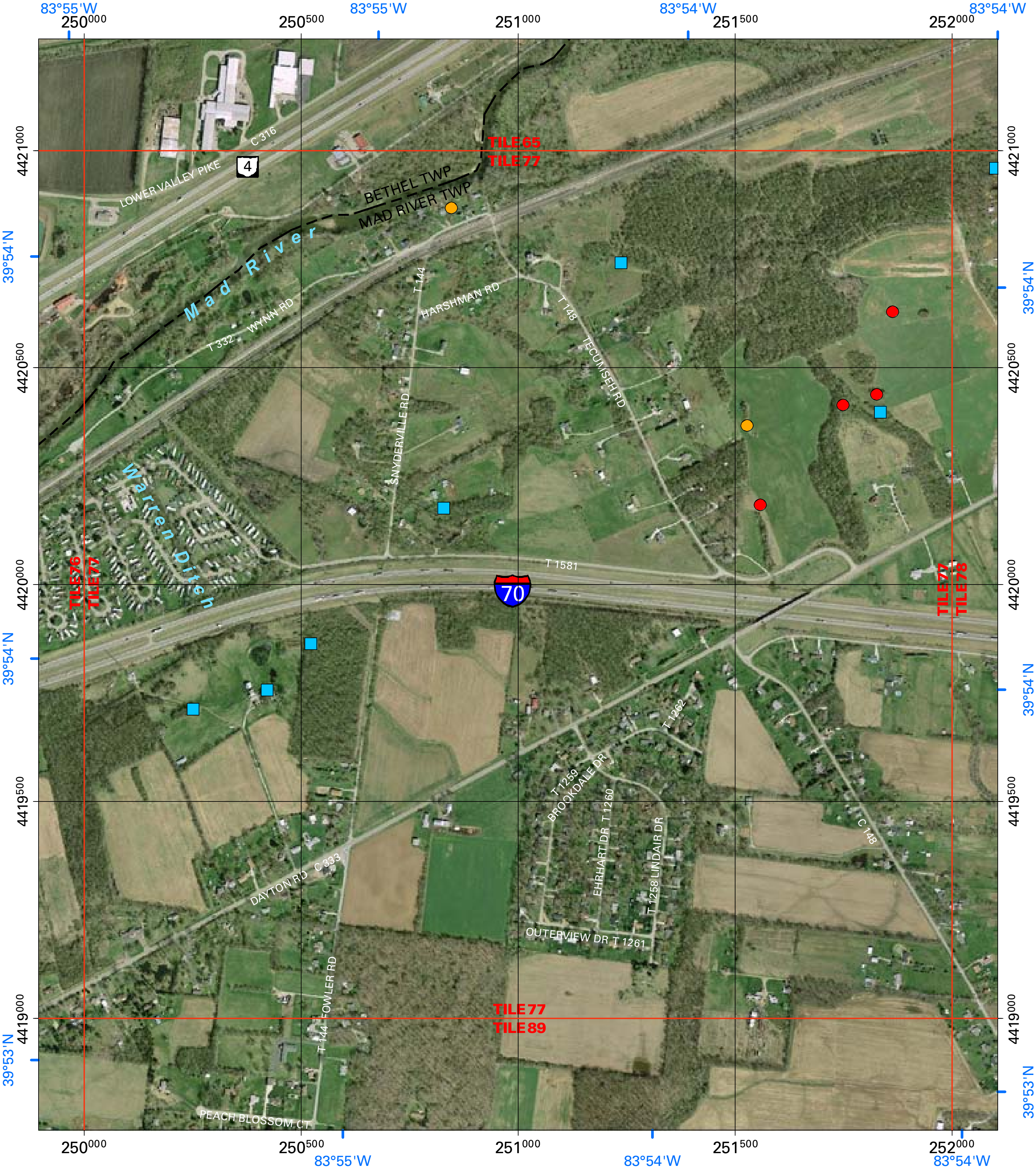
Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

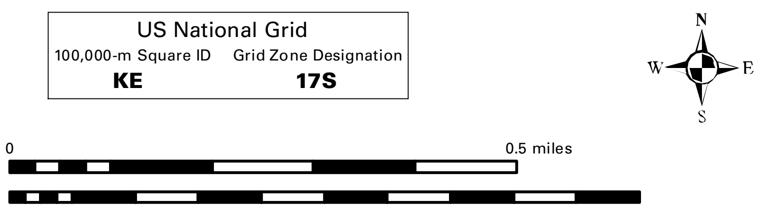
- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 77



US National Grid

100,000-m Square ID	Grid Zone Designation
KE	17S



Scale 1:12,000

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

Tile Number: 78

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 90

US National Grid

100,000-m Square ID	Grid Zone Designation
KE	**17S**

N
W E
S

0 0.5 miles

0 1 kilometers

Scale 1:12,000

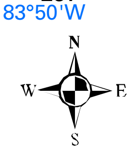
Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.

KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

Tile Number: 92

US National Grid	
100,000-m Square ID	Grid Zone Designation
KE	**17S**



KARST FEATURE

- Field verified
- Suspect - field visited
- Suspect - not visited
- Spring

0 0.5 miles

0 1 kilometers

Scale 1:12,000

Coordinate System: NAD 1983 UTM Zone 17N; Datum: North American 1983; Units: Meter.