MAUMEE RIVER BASIN

The Maumee River drains 6,608 square miles including 4,862 in Ohio, 1,283 in Indiana, and 463 in Michigan. The Maumee forms at the confluence of the St. Joseph River and the St. Marys River and flows about 150 stream miles to its mouth in Maumee Bay. The map in figure 6 shows the outline of the basin and flow paths of the main watercourses. The St. Joseph River and the St. Marys River are both ice front streams that flow along the outer edge of the Fort Wayne Moraine. These rivers discharged to the west before retreat of the glacial ice allowed flow along the present day Maumee. Each river is about 100 miles long. Drainage area of the St. Joseph River at Fort Wayne is 1,085 square miles while that of the St. Marys is 839 square miles.

East Branch and West Branch of the St. Joseph River gather headwaters in the morainal hills of southern Michigan and flow into Ohio joining north of Montpelier. All of the larger tributaries to the St. Joseph lie northwest of the river and gather headwaters in the Wabash Moraine. The largest of these tributaries are Fish Creek with a drainage area of 109 square miles and Cedar Creek with a drainage area of 273 square miles. Headwaters of the St. Marys River gather along the St. Johns Moraine and flow northward through the Wabash Moraine to the Fort Wayne Moraine. Numerous small tributaries gather along the Wabash Moraine and join the St. Marys as it flows toward Fort Wayne. The largest of these tributaries are Black Creek with a drainage area of 54 square miles and Blue Creek with a drainage area of 82 square miles.

The drainage area of the Maumee River increases from 1,924 square miles at Fort Wayne to 2,315 square miles at Defiance through addition of relatively small drainages along its course, the largest being Gordon Creek with 44 square miles of drainage area. At Defiance, the drainage area of the Maumee and the size of the river channel increase dramatically with the addition of the Tiffin River drainage of 777 square miles and the Auglaize River drainage of 2,435 square miles.

The Tiffin River originates in the morainal hills northwest of Morenci, Michigan in the same general area as the East Branch of the St. Joseph River. Bean Creek, as the Tiffin River is known in Michigan, enters Ohio near Powers in Fulton County and flows southwestward to its confluence with the Maumee River at Defiance. The larger tributaries to the Tiffin in downstream order are Beaver Creek, Brush Creek, Lick Creek, and Mud Creek with drainage areas of 45, 66, 106, and 59 square miles, respectively. The Auglaize River originates along the St. Johns Moraine and flows westward along the distal side of the Wabash Moraine to Wapakoneta where it turns abruptly northward. The river crosses the Fort Wayne Moraine as it enters Allen County and is joined by Jennings Creek with a drainage area of 69 square miles just north of Delphos. In Putnam County the Ottawa River with a drainage area of 365 square miles joins the Auglaize doubling its drainage area to 703 square miles. Not far downstream, the Blanchard River with a drainage area of 771 square miles joins the Auglaize, doubling its drainage area to 1,496 square miles. Major tributaries to the Auglaize between the Blanchard and the Maumee in downstream order include Little Auglaize River, Blue Creek, Flatrock Creek, and Powell Creek with drainage areas of 405, 108, 195, and 98 square miles, respectively.

From the confluence with the Auglaize River, drainage area of the Maumee River increases from 5,528 square miles to 6,608 square miles at Maumee Bay. The largest tributaries contributing to the increase in downstream order are South Turkeyfoot Creek, North Turkeyfoot Creek, Bad Creek, Beaver Creek, and Swan Creek with drainage areas of 149, 75, 65, 186, and 204 square miles, respectively.
The Ottawa River (Ten Mile Creek) lies north of the Maumee River and drains 172 square miles directly to Lake Erie. Some of the land west of the Ottawa River drainage in northern Fulton County drains to the River Raisin in Michigan.

Physiography
The central portion of the Maumee River Basin is in the Huron-Erie Lake Plains while peripheral areas are in the Till Plains. The Ottawa River and bordering tributaries to the River Raisin are in the Lake Plains.

Headwaters of the St. Joseph River and its western tributaries gather along the Wabash Moraine in the Steuben Till Plain, a hummocky terrain of moderately low relief with rolling hills, interspersed flats and closed depressions, wetlands, and deranged drainage. The main stem of the river flows in the Central Ohio Clayey Till Plain along a highly sinuous course at average gradient of about 1.5 feet per mile. Headwaters of the St. Marys River gather along the St. Johns Moraine in the Central Ohio Clayey Till Plain. The St. Marys flows across the Central Ohio Clayey Till Plain at an average gradient of about 2.5 feet per mile and joins the St. Joseph River at the western edge of the Maumee Lake Plain. The moraine along the southern boundary of the basin is gently rolling and more subdued than the hummocky moraine along the boundary in the Steuben Till Plain. The Maumee River between Fort Wayne and Defiance meanders along a winding course with a very low gradient of about 1.2 feet per mile. The river flows onto the Paulding Clay Bottom not far inside Ohio and joins the Tiffin and Auglaize River at the eastern edge of the Paulding Plain in Defiance.

Headwaters of the Tiffin River gather in the hummocky terrain of the Steuben Till Plain and flow across the Central Ohio Clayey Till Plain onto the Maumee Lake Plain. The Tiffin flows across the Maumee Sand Plains in Fulton County as does Brush Creek, its major eastern tributary. Along its lower reaches, the Tiffin flows across the Paulding Clay Bottom.

Headwaters of the Auglaize River gather along the St. Johns Moraine in the Central Ohio Clayey Till Plain. The river flows along a winding course at average fall of about 3.2 feet per mile northward to its confluence with the Maumee. The Auglaize crosses from till plain to the lake plain in northern Allen County and enters the Paulding Clay Bottom in Putnam County. The largest tributary to the Auglaize, the Blanchard, originates in Hardin County on the Central Ohio Clayey Till Plain and flows north to the Findlay Embayment, a lacustrine plain with relatively coarse sediments. The Blanchard flows at average fall of about 1 foot per mile along the Findlay Embayment and Defiance Moraine onto the Paulding Clay Bottom in western Hancock County. Streams in the Auglaize River Basin have cut through thin till to bedrock in many locations. Channel bottoms of bedrock with shifting alluvial sediments are common along lower reaches of the

Blanchard River.

The Maumee River between Defiance and Maumee Bay flows in a much more linear pattern than the reach between Fort Wayne and Defiance. Gradient of the river is very low averaging about 1.2 feet per mile, but the gradient varies considerably. Between Waterville and Maumee, the river flows on bedrock at gradient of about 5 feet per mile. North Turkeyfoot Creek, South Turkeyfoot Creek, and Beaver Creek are mainly confined to the Lake Plains while Bad Creek and Swan Creek flow across areas of the Sand Plains before joining the Maumee. Waters of the Ottawa River gather on the Lake Plains and flow across the Sand Plains to the lake.

Geology

The Maumee River Basin lies along the western flank of the Findlay Arch where Silurian, Devonian, and Mississippian-age rocks occur at or near the surface. Rocks in the eastern part of the basin along the axis of the arch are the oldest with successively younger rocks surfacing toward the northwestern part of the basin. The bedrock in the basin is relatively dense with limited ground water storage in rock fractures. Although rock exposures along streams in the basin are common, the effect of ground water discharge from the rock on base flows is not great.

Surficial deposits in the Lake Plains portion of the basin consist of wave-planed glacial till and lacustrine deposits of fine sand, silt, and clay. These deposits are of low permeability in most areas, but deep deposits of relatively permeable sand exist mainly in the sand plains. Beach ridges in the Lake Plains generally consist of shallow permeable sand with limited ground-water storage that is typically perched on top of low permeability till or lake clays.

Surficial deposits in the Till Plains portion of the basin consist of glacial drift and lacustrine deposits. The glacial drift is in the form of ground moraine with a series of end moraines superimposed as morainal belts. Thickness of the ground moraine atop the bedrock varies greatly within the basin and is generally of low permeability. Lens of permeable sand and gravel are common in much of the thicker ground moraine. Some lacustrine areas of relatively impermeable silt and clay exist amid the ground moraine in the southern portion of the basin.

Four morainal belts cross the southern portion of the basin including the Defiance, Fort Wayne, Wabash, and St. Johns. Portions of the St. Johns Moraine along the southern boundary of the basin contain permeable sands and gravel in the form of kames and eskers. The other moraines contain limited amounts of permeable deposits. The Fort Wayne and Wabash Moraines extend northward from Fort Wayne across extreme northwestern Ohio into southern Michigan. Deep permeable sands and gravel along these moraines store considerable ground water to sustain stream flows.

Soils

The Lake Plains in the central portion of the Maumee River Basin are dominated by Hoytville-Nappanee-Paulding-Toledo soils of Soil Region 1. The Till Plain portions of

the basin are dominated by Blount-Pewamo-Glywood soils of Soil Region 3.
Slowly permeable Hoytville clay loam is the most wide spread soil in the Maumee Lake Plains. Toledo clay soils dominant the Paulding Clay Plain and lake plain areas in and around Toledo. The Sand Plains and beach ridges contain areas of moderate to rapidly permeable soils including Ottokee, Tedrow, and Oakville sandy loams and sands.
The extensive areas of slowly permeable soils and limited ground water storage that exist in most of the basin results in low volumes of ground water discharge to sustain base flows of streams. Streams that gather headwaters in the morainal hills along the northwestern part of the basin, however, receive substantial ground water discharge to sustain base flows.

Land Use
The Maumee River Basin is in parts of two Land Resource Regions. The central part of the basin is in the Erie-Huron Lake Plain Resource Area of the Lake States Fruit, Truck and Dairy Region while peripheral areas are in the Indiana and Ohio Till Plain Resource Area of the Central Feed Grains and Livestock Region.

Although the Maumee River Basin includes some major urban centers, the majority of the land in the basin is used for farming. Cash grain crops and specialty crops such as tomatoes and sugar beets dominate farming operations in the Lake Plains area. Feed grains and livestock are prevalent in the Till Plains, and cash grain farming is an important part of these operations. Toledo is a major grain export terminal supplying world markets.

Removal of forest cover in the Maumee River Basin for agriculture has been so extensive that only about 3 to 5 percent of the land remains wooded. Scattered woodlots and river corridors account for most of the woodland. The largest contiguous woodlands are on the Sand Plains in the Oak Openings Metro Park and Maumee State Forest.

Surface and subsurface drainage works completed to eliminate the Black Swamp and facilitate farming operations in the Maumee River Basin are some of the most extensive works of this type that exist anywhere. Most of the headwater channels and tributaries of the major streams in the southern part of the basin are channelized. Extensive surface drainage modifications were completed before systematic stream flow measurements began in the 1920s. Historic observations of flow conditions before major drainage work in the basin are sparse.

Water Development
The relatively flat topography of the Maumee River Basin presents few good sites for development of on-stream reservoirs, and not many large ones have been constructed. Cedarville Reservoir on the St. Joseph River is an important on-stream reservoir that supplies Fort Wayne. At Defiance, there is a relatively large hydroelectric power dam on the Auglaize River. Grand Lake straddles the Lake Erie-Ohio River divide capturing water from tributaries of the Wabash River and St. Marys River for the Ohio-Erie Canal. There are three large low head dams of canal era vintage on the Maumee River at Independence and Grand Rapids.

Off-stream reservoirs are well suited for storage of water supply in the Maumee River Basin and are common. These reservoirs are created by enclosing land with earth embankments. Water is pumped from nearby streams during high flow periods to fill the impoundment. Communities in the basin with off-stream storage reservoirs include: Lima, Van Wert, Paulding, Findlay, Ottawa, Archbold, Wauseon, Delta, Swanton, and Metamora.

Many of the smaller communities in the Maumee Basin obtain adequate source of supply from bedrock aquifers, but development of large quantities of supply from these aquifers is generally restrained by dewatering conflicts and highly mineralized water at greater depths.

Abundant sand and gravel deposits in deep till in extreme northwestern Ohio and neighboring areas of Michigan and Indiana yield ground water for communities in the area. Auburn, located along Cedar Creek in Indiana, has the largest ground water supply system in the Maumee Basin. Wapakoneta with the second largest is situated over a sizeable outwash area along the Wabash Moraine.

Many industries in the Maumee Basin obtain part or all of their supply from ground water sources. Return flows from independent industrial supplies significantly augment stream flows at Fort Wayne and Lima.

Most communities located along the Maumee River downstream from Fort Wayne obtain supply from the river. Bowling Green, although not located along the river, obtains its supply from the river and discharges wastewater to the Portage River Basin. Toledo and Oregon obtain large quantities of water supply directly from Lake Erie. Toledo distributes water as far west as eastern Fulton County.

Flow Characteristics

The Maumee River Basin includes streams with some of the lowest mean annual flows in the state. Mean annual runoff of the Maumee River at Waterville equates to 10.7 inches, ranking at the low end of the range for Ohio streams. Mean annual precipitation is relatively low and fairly evenly distributed across the basin such that mean annual runoff of streams deviates little from that at Waterville.

Mean annual runoff is slightly higher in the northwestern part of the basin than elsewhere. Mean annual runoff of the St. Joseph River and Tiffin River each equate to about 11 inches. The Maumee River at Antwerp has mean annual flow of 10.9 inches, an amount that is representative of runoff from both the St. Marys River and St. Joseph River. Mean annual runoff of streams in the southern portion of the basin is generally lower than those in the northwestern part of the basin. Mean annual flow of the Auglaize River near Defiance is 10.4 inches. The relatively high mean annual runoff in table 1 for the Auglaize River near Fort Jennings includes a wetter than normal period of record and canal diversions from Grand Lake. Municipal and industrial water supply operations at Lima result in relatively high mean annual flow of 11.1 inches in the Ottawa River at Allentown. The Blanchard River at Findlay with 10.1 inches of runoff is the lowest

registered in the basin. Mean annual runoff of the Ottawa River at Toledo and Swan Creek are probably at least as low as the Blanchard because of lower mean annual precipitation near the lake.

Base-flow characteristics of streams in the Maumee River Basin are much more variable than mean annual flow characteristics. Mean base-flow indices indicate that ground water may contribute as little as 25 percent of mean annual flow of streams in the southern till plains area of the basin while streams in the northwestern part may derive as much as 65 percent of mean annual flow from ground water discharge. Streams in the latter category include the St. Joseph River and Tiffin River that originate in the morainal hills of southern Michigan and receive ground-water contributions from abundant sand and gravel deposits. The relatively low mean base-flow index of Unnamed Tributary to Lost Creek at Farmer of 25.6 is noteworthy because it is indicative of the minimal ground water that tributaries to the lower Tiffin River receive from the inner flank of the Fort Wayne Moraine. Streams representative of the relatively low base-flow indices in the southern portion of the basin include Town Creek near Van Wert that originates on the inner flank of the Fort Wayne Moraine and Eagle Creek at Findlay that originates on the ground moraine south of Findlay. Swan Creek with a relatively high mean base-flow index of 50 apparently receives substantial ground-water contribution from the extensive deep sand deposits of the Maumee Sand Plains.

Fifty percent duration flows of streams in the Maumee River Basin vary in similar manner as the base-flow indices. The median flows for streams in the upper basin are moderate at about 0.3 cfs per square mile indicating moderate amounts of ground-water storage to sustain base flows. Fifty percent flows of streams in the southern till plain areas of the basin are relatively low, averaging about 0.2 cfs per square mile indicating minimal amounts of ground-water storage to sustain flows. The 50-percent duration flow of the Maumee River at Waterville of 0.27 cfs per square mile indicates moderate amounts of ground-water storage exist in the basin to sustain base flows. The unusually high 50-percent duration flow of 0.37 cfs per square mile given in Table 1 for the Maumee River near Defiance is for a relatively short and wetter period of record. The lowest 50-percent duration flows occur in the Blanchard River Basin. Eagle Creek with 50-percent duration flow of 0.11 cfs per square mile is very low.

Streams in the western and northwestern parts of the Maumee River Basin have higher 90-percent duration flows than those in other parts of the basin. Bean Creek at Powers with 90-percent duration flow of 0.08 cfs per square mile is highest in the basin. Tributaries downstream of Powers like Beaver Creek near Stryker with 90-percent duration flow of 0.03 cfs per square mile contribute relatively less ground water to sustain stream flow resulting in 90-percent duration flow for Tiffin River at Stryker of 0.06 cfs per square mile. East Branch of St. Joseph River near Pioneer with 90-percent duration flow of 0.06 cfs per square mile is representative of the St. Joseph Basin. The 90-percent duration flow of 0.07 cfs per square mile of the Maumee River at Antwerp reflects augmentation at Fort Wayne as the relative base flow in the St. Marys River is less than in the St. Joseph River.

The 90-percent duration flows of streams in the Auglaize River Basin are low compared to those in the upper part of the Maumee Basin. The 90-percent duration flow of the Auglaize River near Defiance of 0.017 cfs per square mile is representative of base-flow conditions in the basin. The Auglaize River at Uniopolis gathers along the St. Johns Moraine where it receives limited ground-water contribution to sustain 90-percent duration flow of 0.013 cfs per square mile. The 90-percent duration flow of the Auglaize River at Buckland reported in Bulletin 40 is 0.025 cfs per square mile. Ground-water contributions from outwash deposits at Wapakoneta and wastewater discharge add to base flow at the Buckland station. The 90-percent duration flow of the Auglaize River near Fort Jennings is relatively high at 0.05 cfs per square mile reflecting further contribution to base flow from Grand Lake canal diversions and wastewater discharge at Delphos. The 90-percent duration flow for Ottawa River at Allentown of 0.119 cfs per square mile is exceptionally high for the Maumee Basin and due primarily to wastewater discharge at Lima and return flows from independent industrial supplies. Smaller streams such as the Blanchard River at Mount Blanchard and Eagle Creek near Findlay have 90-percent duration flows of zero or near zero. The 90-percent duration flow of the Blanchard River at Findlay of 0.025 cfs per square mile is relatively low despite the gage location directly downstream of the wastewater outfall for Findlay. The relatively low 90-percent duration flow of 0.008 cfs per square mile for North Turkeyfoot Creek near Liberty Center is typical of tributary streams in clayey areas of the Maumee Lake Plain.

The relatively high 90-percent duration flow of the Ottawa River at Toledo of 0.06 cfs per square mile is for a period of record that includes substantial upstream wastewater discharge at Sylvania. Bulletin 40 gives 90-percent duration flow of 0.008 cfs per square mile based on period of record before relatively large amounts of wastewater where discharged.

The 10-percent duration flows of streams in the Maumee River Basin are relatively low averaging about 2.2 cfs per square mile. Peak discharges for 2-year recurrence interval floods are also relatively low averaging about 8 cfs per square mile for the larger streams and proportionately more for smaller streams. Low permeability of soils in much of the basin favors direct surface runoff, but the flat topography tends to attenuate flood peaks. Areas of hummocky terrain in the northwestern parts of the basin contain large amounts of natural storage that attenuates flood peaks. Floods in the Maumee Basin are characterized by slowly rising flood stages of prolonged duration. Extensive channelization in the basin has resulted in many enlarged channels.

Figure 62: Maumee River Watershed

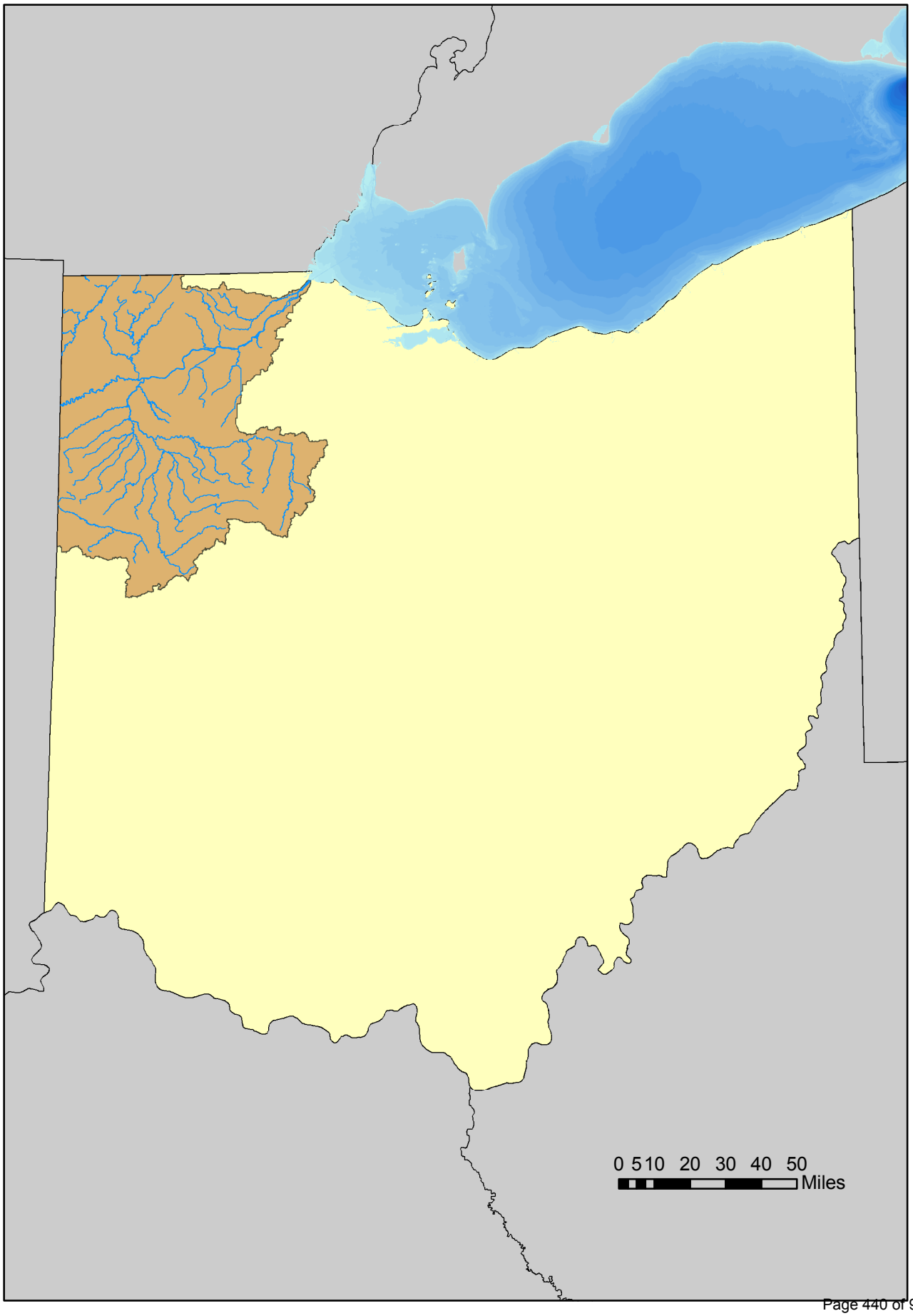

Figure 63: Maumee River Watershed Land Cover

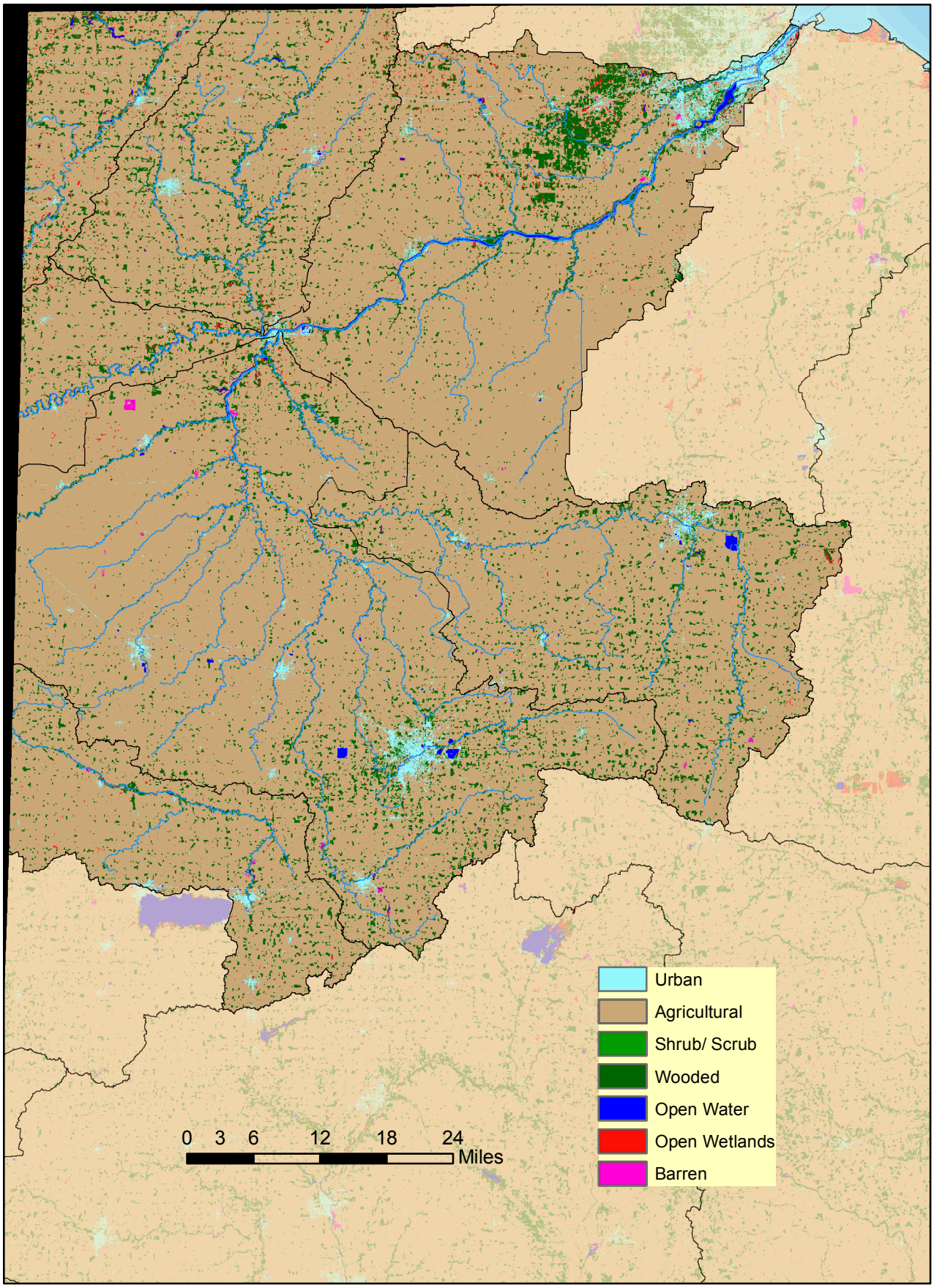
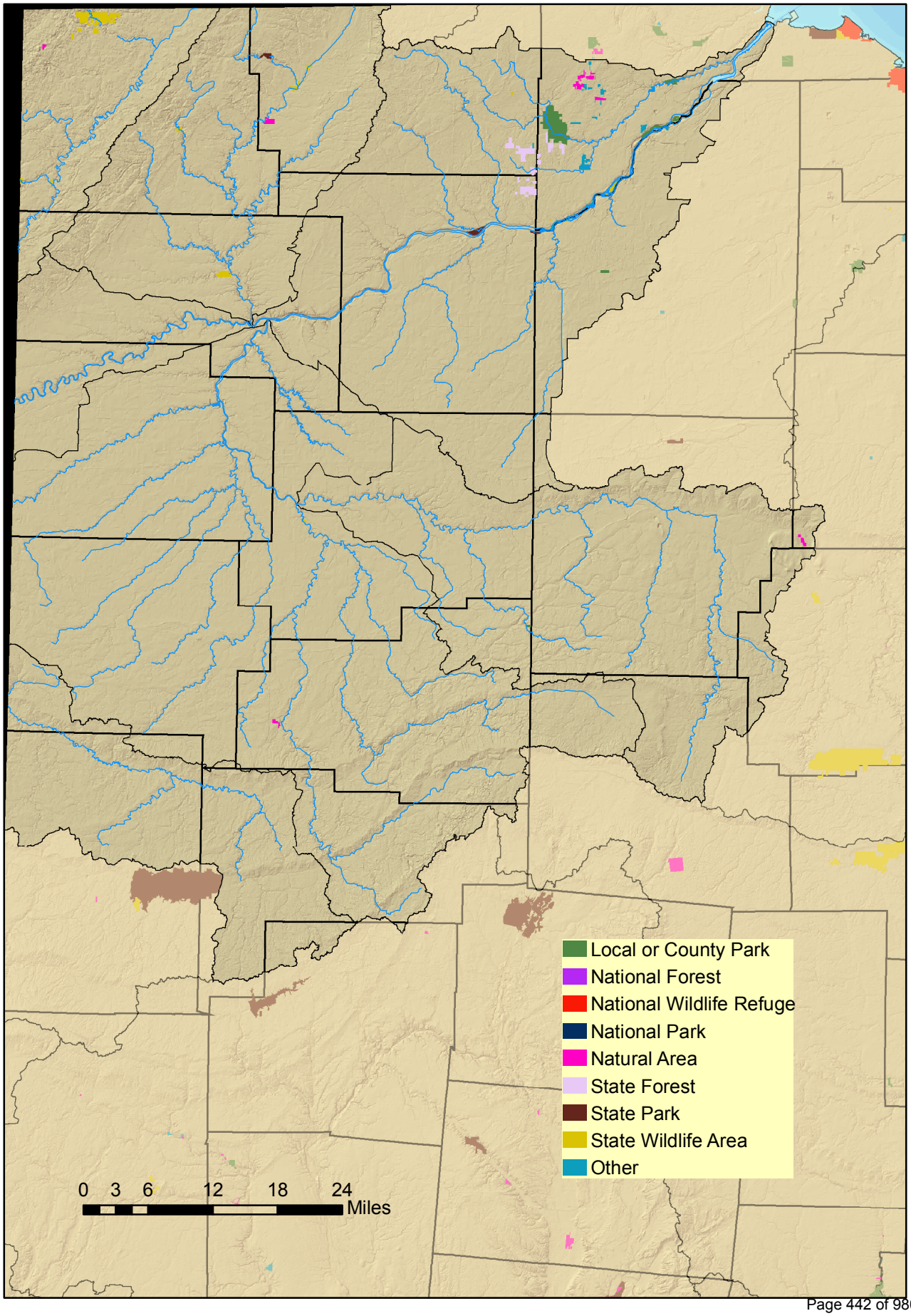
Figure 64: Maumee River Watershed Protected Lands