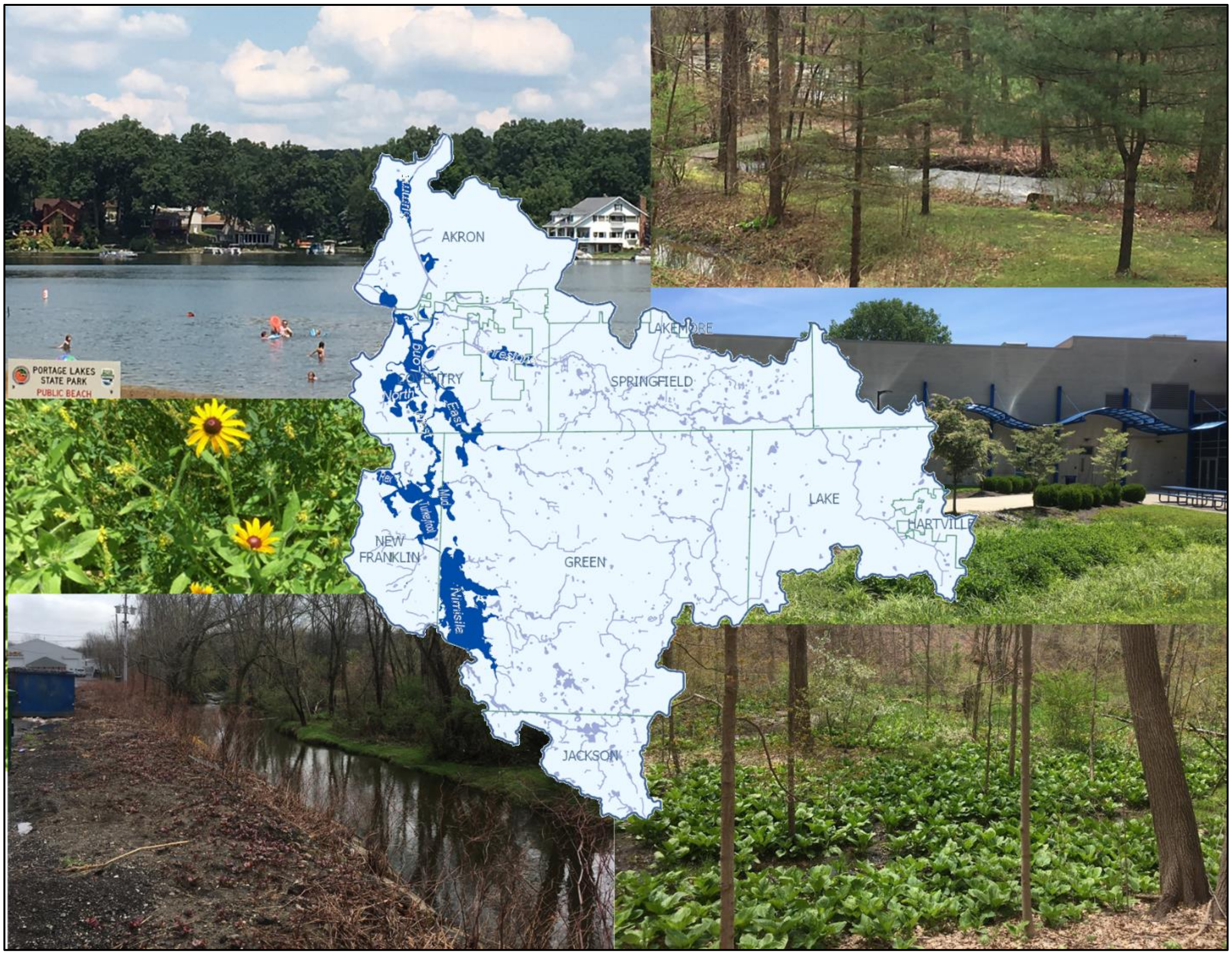
Chapter 6 – Overview
Water Quality and Watershed

Chapter Organization

The water quality of the Portage Lakes depends on what goes on in the watershed. Landscape features and activities can help protect or impair water quality and flood management. Natural features such as woods, wetlands, floodplains, and riparian vegetation protect water quality, reduce nutrient loading, increase resilience of stream channels, and reduce problem flooding and erosion. Developed landscapes are products of people living in the watershed, but they can increase runoff, stream damage, and contamination from activities. The external nutrient loading entering the lakes comes with runoff, as do floods, erosion, sedimentation, harmful chemicals, and pathogens. Any or all of these can harm the lakes and threaten their uses. Balancing the human use of the watershed with water quality protection and flood management requires protecting and restoring important landscape features and reducing runoff and contamination. This chapter presents an overview of many key watershed characteristics and suggests ways to reduce impacts from the developed landscape and sustain healthy lakes and streams.



6. Portage Lakes Water Quality and Watershed

The water of the Portage Lakes flows in across the landscape of the watershed. The landscape and land uses affect the water quality in the streams the Portage Lakes. Certain landscapes, such as wooded stream corridors, floodplains, and wetlands, help protect water quality, absorbing or storing rainwater and taking up nutrients and other contaminants. In developed and agricultural land, stormwater runoff increases and carries with its nutrients, chemicals, bacteria, and sediment from the altered landscape.

In the Portage Lakes, contaminants of greatest concern include:

- Nutrients, especially phosphorus, which fuels eutrophication, aquatic plants, and HABs
- Harmful bacteria
- Sediment

High levels may harm the water quality or uses of the lakes.

This chapter

- Describes the link between watershed landscape and water quality,
- Addresses the water quality of the watershed in light of the watershed characteristics, and
- Identifies practices can help protect and improve water quality of the streams and lakes.

Portage Lakes Watershed Setting - Ecoregion

Ecoregions are ways to characterize the landscape, areas of similar ecosystems and natural resources. They are determined by identifying living and non-living landscape characteristics. The Portage Lakes area is in a glaciated landscape, and shows many features of moving and melting ice. It is a portion of the Erie/Ontario Drift and Lake Plain, known as the Summit Interlobate area.[1] This area formed between lobes of ice, and is characterized by gently rolling hills of glacial drift and fine-grained lake deposits. It has abundant lakes, wetlands, bogs, sluggish streams, glacial kames (sandy hills that formed near ice) and kettles (isolated lakes from stranded ice blocks). The substrate is often sandy outwash from glacial meltwater, and till, a mixture of materials, from silt to boulders, left by the ice. Well-drained uplands once supported mixed oak forests but are largely developed.

The Portage Lakes began as kettle lakes in this landscape. Some still retain those characteristics, small, steep-sided, deep lakes with small watersheds. The area has some substantial wetlands, low-gradient streams, and bogs.

This area around Singer Lake has the kettle lakes, bogs, and other wetlands (darker land) of the ecoregion, as well as the developed uplands.

The Ohio EPA and Water Quality

When the Clean Water Act[2] was established, rivers, lakes, and areas of the oceans were so full of oil and other toxic chemicals, bacteria, and nutrients that many waters were toxic, unusable, dead zones, some caught fire, and many of transmitted diseases.

The goal of the Clean Water Act is to restore the chemical, physical, and biological integrity of the nation's waters. The Ohio EPA carries out the requirements of the Clean Water Act. Their role includes:

- Designating "beneficial uses" for waters in categories of water supply, recreation, and habitat. All waters are designated as high quality uses unless prohibit such uses, e.g., industrial discharge precludes use as a public water supply, canals are assigned different aquatic uses than streams.
- Developing and enforcing water quality standards,
- Permitting discharges within acceptable limits and activities that do not degrade water quality
- Monitoring the chemical, physical, and biological integrity of water for attainment of standards
- Listing water bodies not attaining water quality standards (i.e., impaired)
- Identifying causes, sources, and remedies of impairment
- Providing funding for water quality improvements
- Research, technical support, and outreach

Watershed Features Affect Water Quality

The Ohio EPA monitors the chemical and physical conditions of the water itself, pathogens, and the biological communities. The condition of the habitat and animals that the water can support reflect the long-term overall health of a water course and its watershed. Water courses that support a diverse community of pollution-sensitive species tend to be well-functioning and healthy – for people as well as animals. Ones that only support a few pollution-tolerant species tend to be so impaired that they cause problems for people as well.

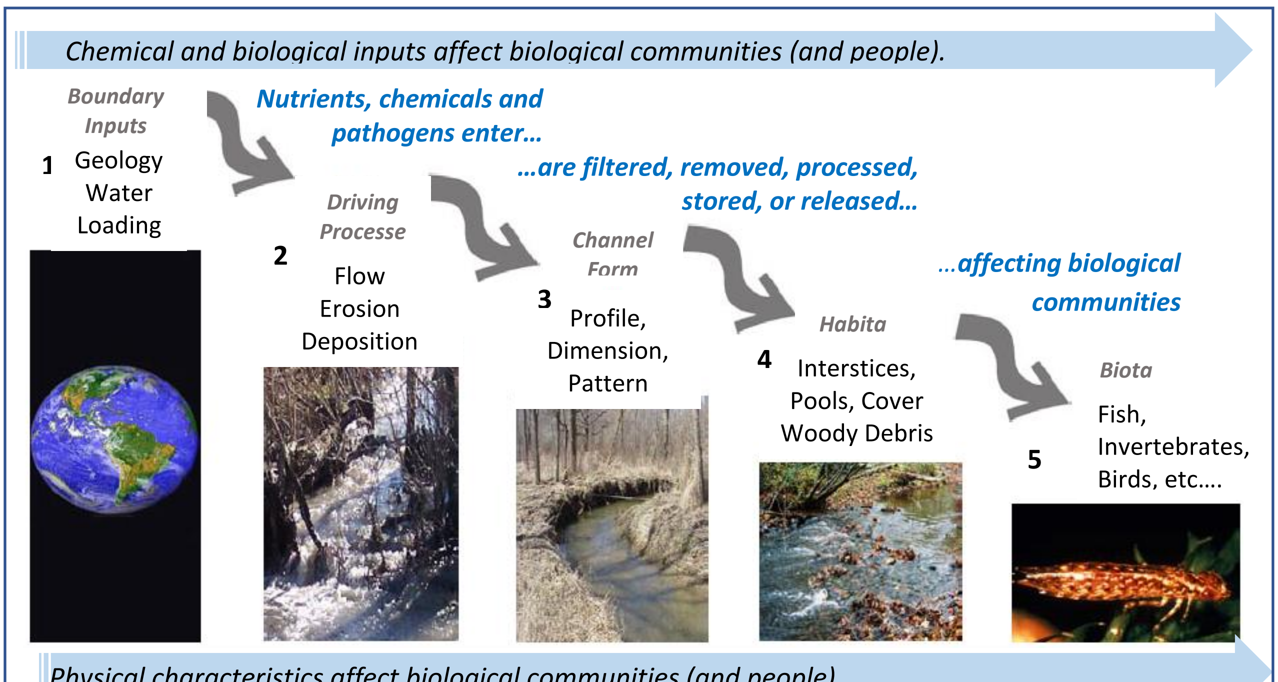
This chapter presents the known water quality indicators in the context of the contributing watershed. Figure 6.1 illustrates that:[3]

- Watershed characteristics affect the processes, inputs and forms, which influence
- Streams, contaminants, flooding, channel characteristics, habitat, and then,
- The biological organisms.

People affect and are affected by the system at all levels.

1. **Watershed conditions** affect loading of water, sediment, and contaminants into a stream
2. **The slope and load** affect flow, erosion, deposition,
3. **Flow, erosion and deposition** affect channel form, contaminants, and flood management
4. **Channel form** affects the habitat, oxygenation, channel stability (tendency to erode down or silt in), the connections to floodplain, and the sediment within the stream and channel
5. **The characteristics of the system**, from the watershed to the stream segment, affect the type of life that the stream will support.

Figure 6.1 Landscape Effects on Stream and Biota



Modified from Ohio EPA, 2006.

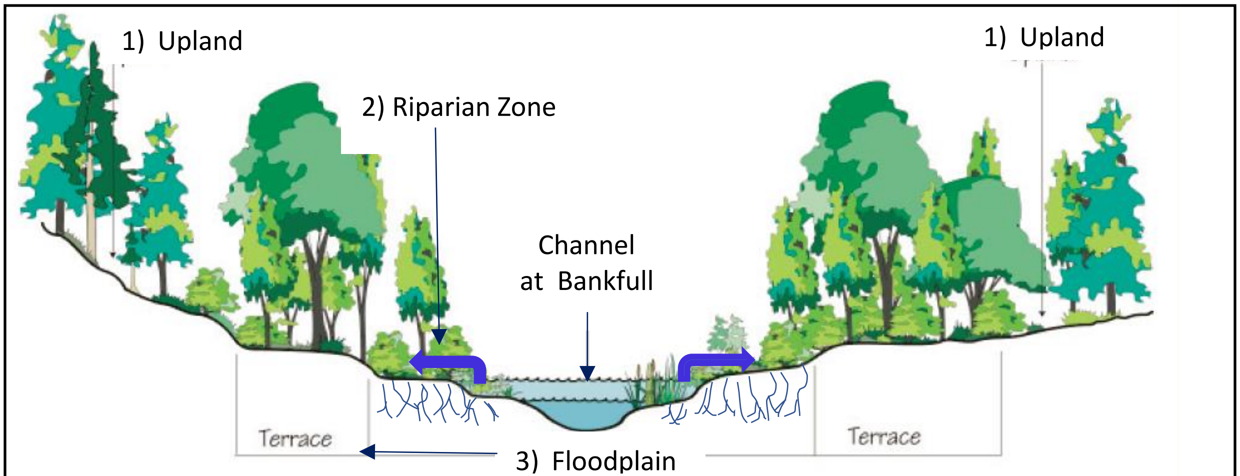
Ohio EPA monitors the biological communities at the receiving end, because they reflect the contributing factors from the watershed. Changes in the "upstream" end of system have effects all the way "downstream." When Ohio EPA identifies impaired waters, they look upstream to determine the causes and sources.

This chapter focuses on the watershed conditions that influence water quality.

Intact Natural Landscapes Help Streams, Lakes, and People

In an undisturbed landscape, the natural features perform important functions that contribute to a well-functioning stream (or lake) and diverse biological community. (Fig. 6.2)[4]

Figure 6.2 Riparian Ecosystem Cross Section



Modified from: USDA Forest Service, 2004.

1. Upland woods and fields intercept and allow rain to infiltrate into the ground.
2. Wetlands, floodplains, and deep-rooted plants in the riparian (streamside) corridor slow and absorb storm water, take up nutrients, stabilize stream banks, and provide shade, cover, and important habitat. Riparian vegetation is water loving – the roots extend to where the groundwater flows into the stream, taking up nutrients or contaminants.
3. When a stream exceeds bankfull, it spills onto its floodplain, which acts like a safety valve, reducing stream flow and erosion during storms. Floodplains allow silt to settle out, keeping contaminants out of streams and lakes, and sustaining the floodplain habitat.



Landscapes providing benefits. *Riparian vegetation, with its roots in the water, takes up nutrients and other contaminants and stabilizes streambanks. Floodplains and wetlands store floodwater, keeping it out of lakes and basements, take up nutrients, and allow sediment and associated contaminants to settle out, enriching the habitat.*

Even the form of the stream channel helps maintain equilibrium and good water quality.

The stream channel form has developed in equilibrium with the slope, amount of water, and sediment coming in. The low gradient stream to the right meanders and shift horizontally but will maintain its vertical position, neither eroding nor silting in.

Meanders help regulate flow, allowing silt to be cleared out of channels in low flow and accommodating higher flows. The riffles (rough water over stones) and pools provide varied, habitats supporting various species. The flow over riffles adds oxygen.

Impacts of Altered Landscapes on Streams, Lakes, and People

People moving into an area develop and farm the land. Altering the natural landscape, replacing trees, wetlands, and floodplains with agricultural land and the hardened landscape of roofs, pavement, and sod, increases flooding, erosion, and contaminants going into the streams and lakes:

- Altering and hardening natural features increases the water that runs off the land, carrying contaminants from the agricultural and built landscape, including animal waste, chemicals, nutrients, metals, oil, and other toxins. (Figure 6.3)
- Certain uses discharge contaminants, e.g., septic systems, wastewater treatment plants, industries.
- Filling in wetlands and floodplains, removing deep-rooted riparian vegetation removes the features that slow down and store excess water. More water and contaminants enter and course through the streams. Stream banks erode more easily without deep-rooted vegetation to stabilize it ("nature's re-bar").
- The excess water has no place to go without accessible floodplains. Stream channels become unstable, eroding deeper and wider, increasing erosion, siltation, input of nutrients, metals, and other contaminants within the sediment, and severe flooding once it escapes the channel.

A developed watershed, decades of "mowing to the edge," and altered stream slope resulted in this eroded, incised stream. The short, thin roots of turf offer little bank stability, flood reduction, or contaminant removal. With no accessible floodplain to store floods, the channel continues to erode, exacerbating a hazard, sediment and pollutant load, and habitat degradation.

Figure 6.3 Hardened Landscape and Runoff

1 Rain runs off hardened surfaces, unvegetated landscape, and turf.
2 and 3 Runoff carries with it sediment, oil, toxic metals, chemicals, animal waste, pathogens, nutrients.
4 Excess water erodes channels deeper and wider, increasing sediment and everything attached to the sediment, reducing floodplain access, increasing downstream flooding, disrupting habitat, causing hazards. This torrent started off in small ditches along three neighborhood blocks with half-acre lots.

5-8 Runoff enters rivers and streams via storm drains and direct flow. 6 - Runoff entering the Upper Tuscarawas River. 7 - Sediment plume where runoff enters a river (stones are still visible in the clear water). 8 - Coalescing brown plumes show that runoff, laden with sediment and other contaminants, has entered the river from multiple sources, including a storm drain outfall.

The landscape changes affect water quality, flooding, stream function, habitat, aquatic life, and people.

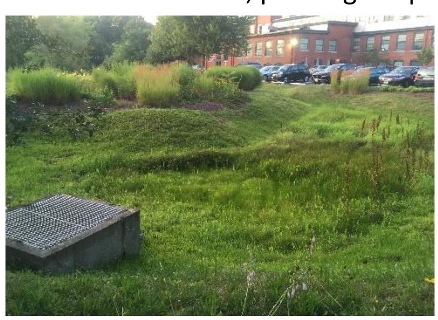
- Increased bacteria and toxins entering the water are harmful to wildlife and people.
- Increased nutrients promote excessive growth of aquatic plants, algae, and possibly HABs. which can harm people and aquatic animals.
- Sediment fills in habitat, overloads streams, and carries nutrients and other contaminants.
- Turbidity, related to sediment, decreases visibility for predators and raises water temperature.
- Destabilized stream channels from excessive runoff and channel alteration degrades habitat, reduces nutrient uptake, increases erosion and sedimentation, and increases flooding and erosion, which are harmful to water quality and habitat and pose hazards to people.



Reducing Impacts with Best Management Practices and Restoration

Because people live in communities within watersheds, watersheds can no longer be pristine natural settings. However, there are ways to reduce impacts to the watershed and waters, balancing water quality with people's use of the watershed:

- Protect the existing landscapes that provide the most benefit, such as floodplains, riparian vegetation, and floodplains,
- Restore lost functions, such as stormwater infiltration, nutrient uptake, or flood storage with Best Management Practices (BMPs), planting trees, shrubs, or native plants, or restoration.
- Reduce impacts by cleaning up after pets, discouraging geese, taking care of septic systems, controlling spills, limiting the use of chemicals, planting deep-rooted plants near the water.


Restoring natural landscape functions*. Best management practices range in scale and complexity, from replacing turf with native plants, shrubs, or trees, to addressing stormwater at the scale of a development or stream reach. Left - Deep-rooted native plants help rainwater infiltrate into the ground reducing runoff and taking up nutrients. Center – Stormwater detention basins temporarily store runoff. Vegetation, especially tall vegetation with deep roots, helps filter out, adsorb, and take up nutrients and other contaminants. Right – Stream channel restoration restores floodplains and meanders, improving flood storage, habitat, and resiliency of streams. Native plants planted along the riparian area will protect the stream. Restoration projects are typically protected by easements. With a range of costs, such projects can be funded privately, included in development requirements, or grant-funded.*

Portage Lakes Watershed Designated Beneficial Uses, Aquatic Life Use Attainment

Table 6.1 lists the Beneficial Use Designations for the Portage Lakes watershed.[5] Ohio EPA monitors attainment for water supply, recreation, and aquatic life use criteria.

Table 6.1 Beneficial Use Designations Portage Lakes Watershed

Water Body	Water Supply	Recreation	Aquatic Life Use
Tuscarawas	Agricultural, Industrial	Primary Contact	Warmwater Habitat
Canal			Modified Warmwater
Nimisila Creek	Agricultural, Industrial	Primary Contact	Warmwater Habitat
Tributaries	Public Water Supply	Primary Contact	Warmwater Habitat
Lakes	Public Water Supply	Primary Contact	Exceptional Warmwater

The Aquatic Life Use (ALU) attainment is an important indicator of the health of water courses. In order for a water body to attain its ALU standards, it must meet the standards for three biological indices that reflect the type and diversity of fish and macroinvertebrate populations (Index of Biological Integrity, IBI; Modified Index of Well Being, MiWB, and Invertebrate Community Index, ICI). Ohio EPA also monitors the habitat quality (QHEI), due to a strong link between habitat quality and the biological community. Map 6.1 and Table 6.2 present the ALU attainment for the Portage Lakes watershed.[6]

Map 6.1 Aquatic Life Use Attainment, Portage Lakes Watershed

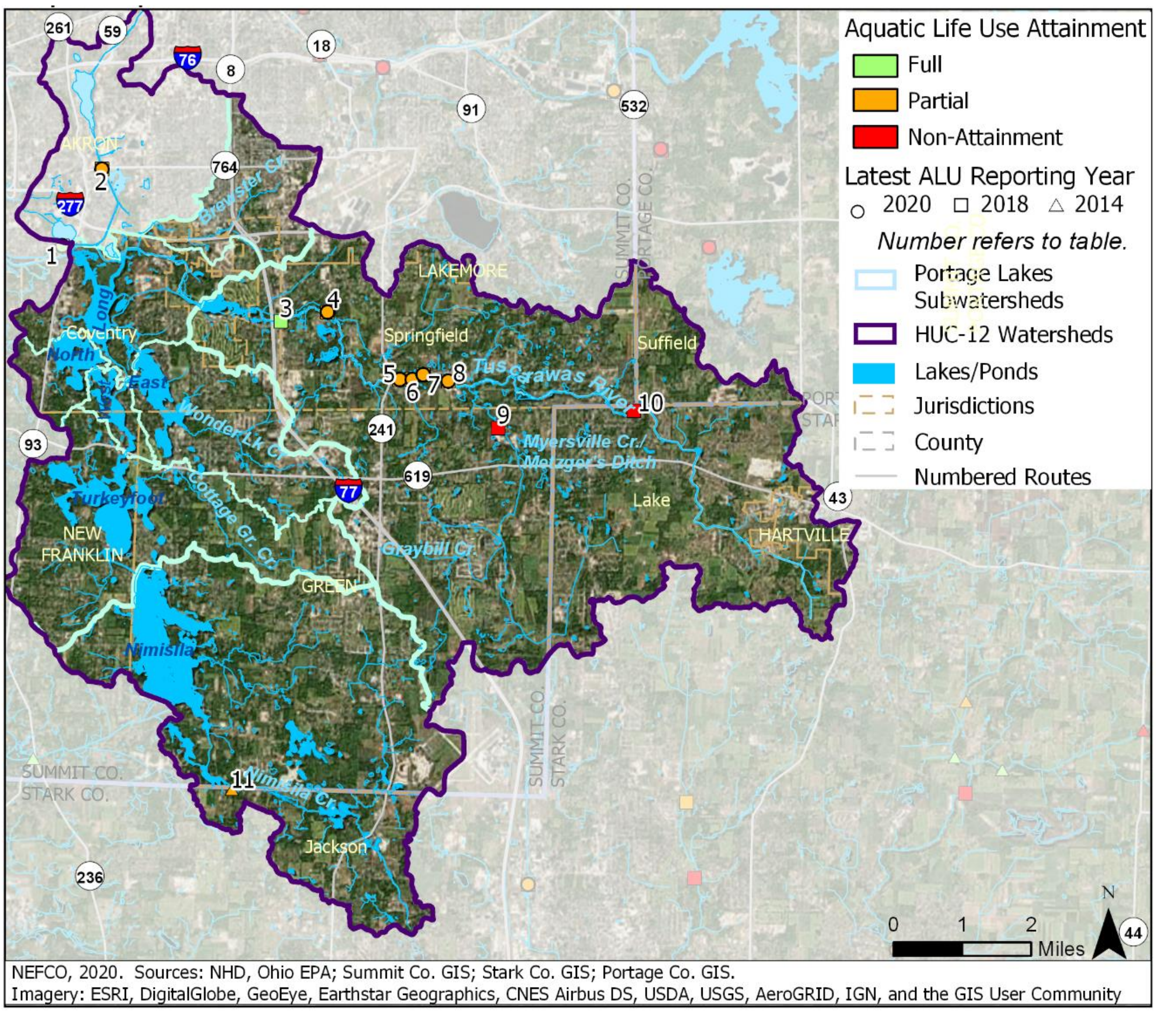


Table 6.2 Aquatic Life Use Attainment Portage Lakes Watershed

			Fish					Macroinvertebrates				
	Site	**Reporting Year(s)**	**Sample Year**	**IBI Score**	**IBI Narrative**	**MIwb Score**	**MIwb Narrative**	**Sample Year**	**ICI Score**	**ICI Narrative**	**QHEI Score**	**Attain.**
Ohio Canal, AU ID 050400010105, River Code 17-500-029 Modified Channel, Modified Warmwater Habitat												
1	303368 DST Manchester Rd, Lk Nesmith, RM 4.4	2018, 2020	2016	32	Fair	8.5888	Good	2015	30	Marginally Good	37	Full
2	Wilbeth Rd., RM 6.2	2018, 2020	2016	40	Good	8.8406	Good	2015	16	Fair	39.3	Partial
Tuscarawas River, AU ID 050400010101, River Code 17-500-000 Unless Noted, Warmwater Habitat												
3	Arlington Rd. RM 119.3	2014, 2016, 2018	2003	38	Good	7.7	Mar. Good	2004	40	Good	58	Full
4	UPST Summit Co. WWTP RM 120.1	2018, 2020	2015	41	Good	7.2649	Fair	2015	46	Exceptional	81.8	Partial
		2014, 2016	2003	38	Good	7.5	Mar. Good	2004	42	Very Good	75	Full
5	303016 Massillon Rd., RM 122.05	2018, 2020	2015	37	Mar. Good	7.2533	Fair	2015	46	Exceptional	63.5	Partial
6	R06K17 DST Killian Latex, RM 122.4	2016, 2018, 2020	2005	34	Fair	7.037	Fair	2005	18	Low Fair	71	Partial
	RM 122.5	2014	2005	34	Mar. Good	7.1	Fair	2005	18	Fair	71	Partial
7	R06P25 Near Uniontown, Adj. Killian Latex, RM 122.65	2016, 2018, 2020	2005	34	Fair	5.9463	Fair	2005	28	Fair	62.5	Partial
	RM 122.7	2014	2005	34	Mar. Good	6	Fair	2005	28	Fair	62.5	Partial
8	R06P27 Pressler Rd., RM 123.1	2018, 2020	2015	43	Good	6.6068	Fair	2015		Good	69.8	Partial
		2016	2005	34	Fair	5.67	Poor	2005	32	Mar. Good	70.5	Non
		2014	2005	34	Mar. Good	5.7	Poor	2005	32	Mar. Good	70.5	Non
9	R06K20 Metzgers Ditch Upst. Meyersville Rd., RM 0.5	2014, 2016, 2018	2003	28	Fair			2004		Fair	60.5	Non
10	R06S28 Mogadore Rd. RM 126.7	2014, 2016, 2018	2003	18	Poor			2004		Fair	70.5	Non
11	R06G11 Mt. Pleasant RC 17-538-000 RM 7	2014	2004	30	Fair			2003		Mar. Good	79	Partial

IBI - Index of Biological Integrity	**WWH Criteria:**	**IBI Score**	**MIwb Score**	**ICI Score**	**QHEI Score**	*Good*	*Excellent*
MIwb – Mod. Index of Well-Being		40	Wading 7.9	34	Headwaters	55-69	>=70
ICI – Invertebrate Community Index			Boat 8.7		Lg Streams	60-74	>=75
QHEI – Qual. Habitat Eval. Index							

Ohio EPA has monitored the Upper Tuscarawas River since before 2000 and found the river to be impaired. Ohio EPA's 2009 Total Maximum Daily Load (TMDL) study identified causes and sources of impairment. The TMDL indicates:

- Tuscarawas - full attainment at River Miles (RM) 119.3 and 120.1, (sites 3 and 4). However, recent monitoring found Site 4 was in partial attainment, with MIwb falling below the criterion.
- Tuscarawas RM 120.1-126.7 - partial attainment due to flow alteration, organic enrichment, and nutrients, from channelization and suburbanization.
- RM 126.7 (site 10) - non-attainment due to habitat alteration, siltation, organic enrichment, and pathogens from suburbanization and channelization.
- Metzgers ditch - non-attainment, due to a natural "wetland stream"
- Nimisila Creek -partial attainment - organic enrichment - suburbanization, failing septic systems.

Even though Ohio EPA has not monitored other tributaries in the Portage Lakes watersheds, the same factors likely affect the lakes and tributaries in those watersheds.

Portage Lakes Land Cover and Imperviousness

Land Cover

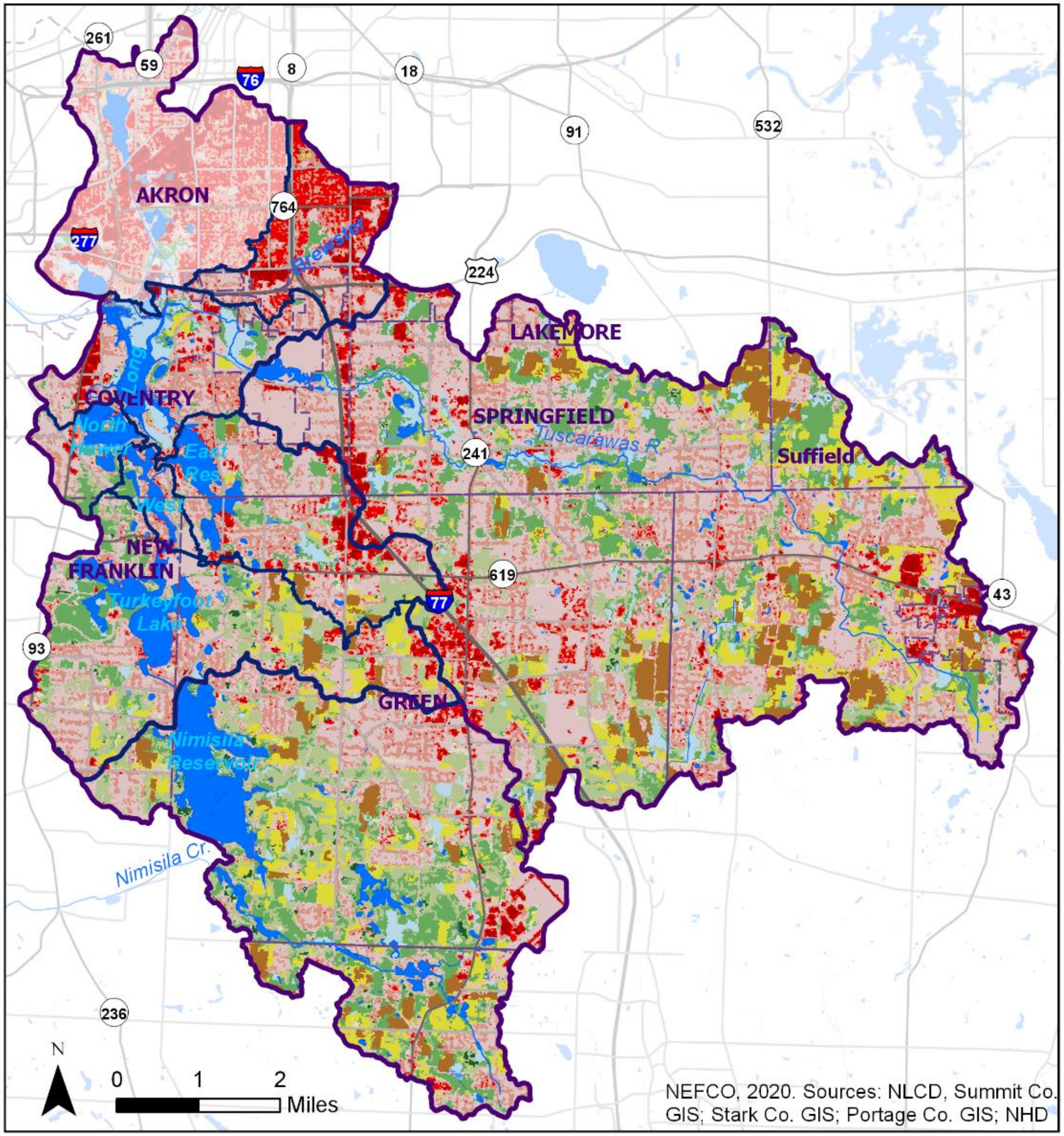
Suburbanization in the Portage Lakes watershed.

Land cover is mapped from aerial imagery and helps predict water quality impacts of the landscape. The Portage Lakes watershed is primarily altered by development and agriculture. Runoff from these landscapes can degrade water quality. Best management practices can reduce impacts.

- As shown on Map 6.2 and Table 6.3, the watersheds draining to the Portage Lakes, except Nimisila, and Brewster Creek are 50 to 67 percent developed, primarily with low-density development and developed open space.[7]
- The highest-density development is concentrated along interstate highways, major roads, and in Akron and Hartville. The Brewster Creek watershed is intensely developed at 97 percent.
- Nimisila, Turkeyfoot, and the Tuscarawas watersheds have the most agricultural land.
- Nimisila is the least developed watershed, with the most woods.
- Woods and wetlands, 20-35 percent of most watersheds, help protect water quality. The woods and wetlands along the water courses are especially beneficial.
- Substantial in the Long Lake, Tuscarawas River, Nimisila Reservoir, and East Reservoir watersheds are important for conservation. Long Lake has the most wetlands.

Imperviousness

- Imperviousness is the "hardness" of the landscape, how easily water runs off. Pavement and roofs are impervious, woods are not. Low-density development is in between. Developed open space, with its compacted ground, is largely impervious.



Map 6.2 Land Cover by Subwatershed

- HUC-12 Watersheds
- Subwatersheds
- Numbered Routes
- Other Major Roads
- Lakes/Ponds
- Jurisdictions

Note: Outline of Portage Lakes HUC-12 Watershed is shown. Area outside Portage Lakes drainage area is screened back.

NLCD Land Cover Classification Legend

- 11 Open Water
- 12 Perennial Ice/ Snow
- 21 Developed, Open Space
- 22 Developed, Low Intensity
- 23 Developed, Medium Intensity
- 24 Developed, High Intensity
- 31 Barren Land (Rock/Sand/Clay)
- 41 Deciduous Forest
- 42 Evergreen Forest
- 43 Mixed Forest
- 51 Dwarf Scrub*
- 52 Shrub/Scrub
- 71 Grassland/Herbaceous
- 72 Sedge/Herbaceous*
- 73 Lichens*
- 74 Moss*
- 81 Pasture/Hay
- 82 Cultivated Crops
- 90 Woody Wetlands
- 95 Emergent Herbaceous Wetlands

* Alaska only

Table 6.3 2017 Land Cover and Percent Impervious by Subwatershed

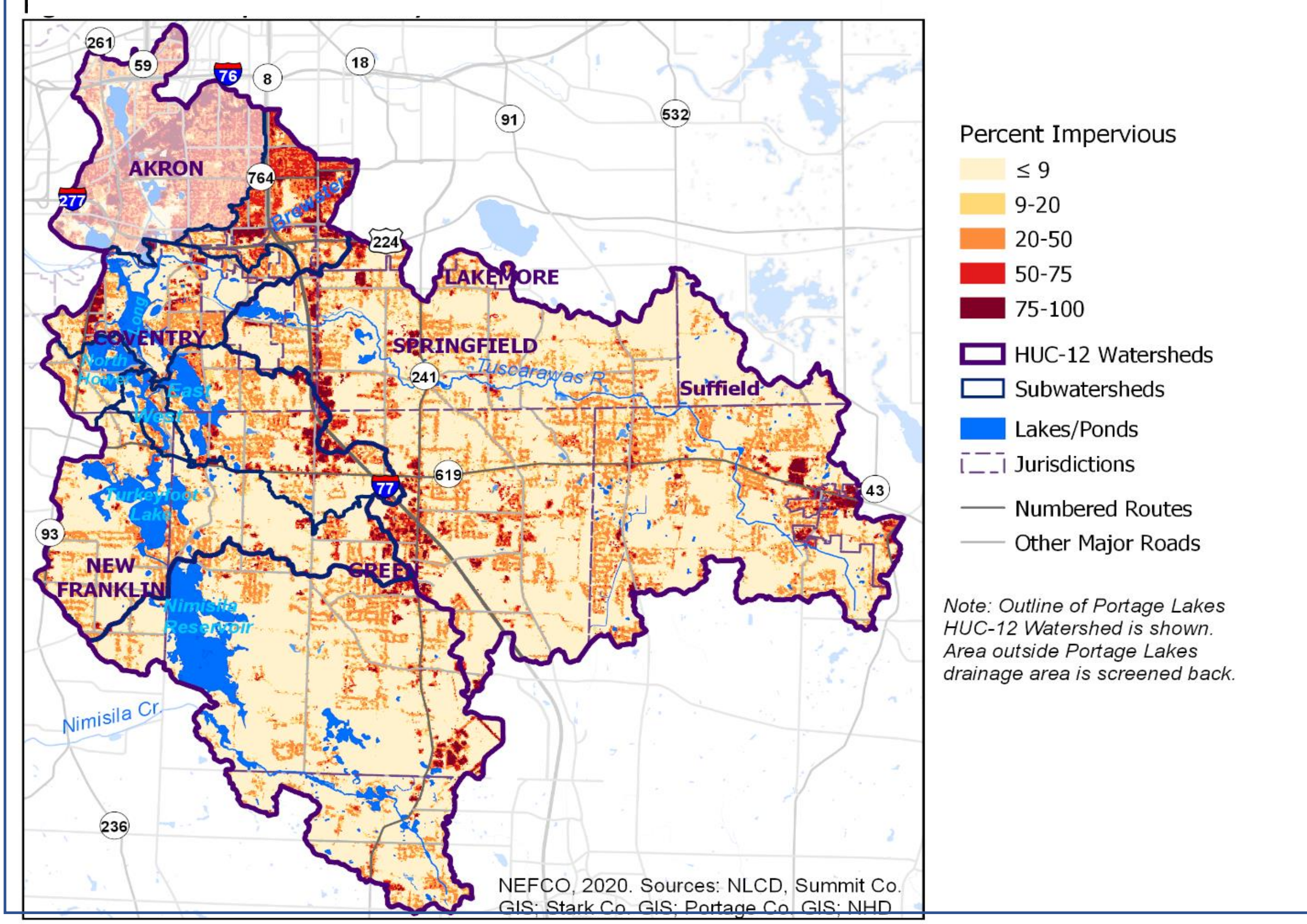
	Tuscarawas		Brewster Cr.		Long Lake		Hower-North		West		East		Turkeyfoot		Nimisila	
Land Cover	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.	Acres	Pct.
Open Water	146	0.6	0	0.0	202	8.4	161	22.8	103	22.8	230	7.5	480	9.4	922	8.3
Developed	13,534	59.2	1,772	97.4	1,510	62.9	387	55.0	256	56.6	2,048	66.7	2,569	50.2	4,275	38.3
Open Space	7,767	34.0	350	19.2	690	28.7	202	28.7	134	29.8	902	29.4	1,443	28.2	2,556	22.9
Low Intensity	4,268	18.7	560	30.8	554	23.1	145	20.6	94	20.7	746	24.3	915	17.9	1,383	12.4
Medium Intensity	1,077	4.7	636	35.0	181	7.5	30	4.2	23	5.1	275	9.0	169	3.3	244	2.2
High Intensity	421	1.8	227	12.5	85	3.5	10	1.5	4	1.0	125	4.1	42	0.8	92	0.8
Barren Land	2	0.0	2	0.1	0	0.0	1	0.1	1	0.2	1	0.0	0	0.0	1	0.0
Forest	4,476	19.6	35	1.9	198	8.2	149	21.1	86	19.1	542	17.6	1,420	27.7	3,801	34.0
Deciduous Forest	2,718	11.9	34	1.9	173	7.2	114	16.1	54	12.0	242	7.9	626	12.2	1,666	14.9
Evergreen Forest	33	0.1	0	0.0	0	0.0	0	0.0	0	0.0	4	0.1	20	0.4	111	1.0
Mixed Forest	1,724	7.5	1	0.1	24	1.0	35	5.0	32	7.1	296	9.6	774	15.1	2,024	18.1
Shrub/Scrub	23	0.1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.0	27	0.2
Herbaceous	181	0.8	3	0.2	10	0.4	5	0.8	5	1.1	31	1.0	67	1.3	144	1.3
Agricultural	3,709	16.2	6	0.3	51	2.1	2	0.3	1	0.2	147	4.8	510	10.0	1,686	15.1
Hay/Pasture	2,185	9.6	6	0.3	51	2.1	2	0.3	1	0.2	64	2.1	373	7.3	1,115	10.0
Cultivated Crops	1,524	6.7	0	0.0	0	0.0	0	0.0	0	0.0	83	2.7	137	2.7	571	5.1
Wetlands	802	3.5	0	0.0	430	17.9	0	0.0	0	0.0	72	2.3	69	1.4	312	2.8
Woody Wetlands	687	3.0	0	0.0	364	15.2	0	0.0	0	0.0	62	2.0	64	1.2	292	2.6
Emergent Wetlands	115	0.5	0	0.0	66	2.7	0	0.0	0	0.0	10	0.3	6	0.1	20	0.2
Impervious percent		13.1		45.7		17.8		13.0		13.0		19.7		10.8		7.7
Total acres	22,872		1,819		2,401		705		451		3,070		5,118		11,169	
Total square miles	35.7		2.8		3.8		1.1		0.7		4.8		8.0		17.5	

At watershed imperviousness of 10 to 15 percent, streams may degrade because of runoff intensity and volume. Well-vegetated riparian (streamside) corridors and wetlands can protect against the impacts of impervious watersheds. Best management practices, such as rain gardens, bioinfiltration measures, and permeable pavers, and planting trees, shrubs, and native plants can all improve infiltration of rain water, reducing runoff and impacts to water courses. Rain water collected in rain barrels can be used water gardens.

As shown on Map 6.3 and Table 6.3, imperviousness may lead to degraded streams in most watersheds:

- Most of the watersheds range from 13 to 20 percent impervious, making degradation likely.
- Turkeyfoot Lake watershed is over 10 percent impervious, and streams could start to degrade.
- Nimisila is under eight percent impervious. Depending on riparian vegetation and the effects of agriculture, many of the streams may still be relatively intact.
- Brewster Creek is highly impervious, reflecting its high degree of development.

Map 6.3 2016 Imperviousness by Watershed



Riparian Landscape and Water Quality

The riparian *corridor* is the low-lying landscape in direct contact with the stream, including flanking vegetation/land cover, wetlands, floodplains, and the stream channel itself. As the transition between upland and stream, it is one of the most important parts of the landscape for water quality and stream function. It affects flooding and erosion, nutrient processing, water quality, stream health and habitat. and includes flanking vegetation, wetlands, floodplains. The Ohio EPA habitat evaluations (QHEI for larger streams, HHEI for smaller streams) emphasize the importance of stream morphology, riparian corridor, and floodplain character in habitat and water quality.[8]

Riparian Buffer

The riparian *buffer* is the vegetation along the stream. The quality of the riparian (streamside) vegetation is related to both land use and water quality:

- A well-vegetated riparian stream corridor acts as a buffer between upland land uses and the stream, slowing stormwater, taking up nutrients and other contaminants, providing shade, habitat, and streambank stability. Well-vegetated riparian corridors can add resilience to streams in developing watersheds.
- In contrast, a developed or agricultural riparian corridor is a direct conduit for stormwater and contaminants, including nutrients and pathogens, to enter the stream, and cannot protect the stream against the warming sun or streambank erosion. Areas with degraded riparian corridors are at higher risk for water quality problems.

NEFCO characterized the quality of the riparian buffer along several tributaries, using aerial photographs, updating a study from 2000.[9] The assessment looked at width of wooded riparian buffer and type of land cover within a 100 m of each stream bank, in 600-foot segments. Points for each segment and stream bank were based on criteria similar to the QHEI and HHEI for riparian buffer/floodplain quality:

- Headwater streams (watersheds less than 20 square miles) require smaller buffers, and received maximum points for buffers greater than 10 meters.
- Mainstem Tuscarawas below Metzgers Ditch (watershed greater than 20 square miles) needed a wider buffer to receive full points.
- The "floodplain quality" category was applied to the width of the corridor. Woods, wetlands, and scrub-shrub received more points; agriculture and development received less, reflecting the potential impact of each land cover on the nearby stream.
- Scores were assigned to each side of the stream and averaged.

The riparian buffer of the Tuscarawas River near Arlington Road would be evaluated using the width for larger streams (vegetation beyond 10 m). The near side is a highly disturbed riparian buffer - low score. The far side is well-vegetated - high score.

The riparian buffer analysis is based on aerial imagery and cannot duplicate the field-based habitat evaluations. However, it may point out areas that are well-protected or at risk across the watershed.

Maps 6.4-6.6 and Table 6.4 present the results:[10]

- Map 6.4 shows the riparian buffer quality along with the Aquatic Life Use attainment data. The QHEI scores for the sites monitored by Ohio EPA were uniformly good to excellent. However, the impaired sites occurred on stream segments downstream of lower-quality riparian buffers. The TMDL notes that many of these sites were affected by suburbanization.
- Map 6.5 shows a close-up view of the results for Wonder Lake Creek and Cottage Grove Creek. In the red segments, there is little dense vegetation protecting the stream, and the nearby land cover is urban or agricultural. The green segments have large proportions of woods or wetlands protecting the streams. Appendix H contains large-scale maps of all the riparian analyses.
- Table 6.4 summarizes the riparian buffer quality results by stream. The Tuscarawas River and Nimisila Creek had the highest percent of high-quality segments. Cottage Grove Creek had the highest percent of low-quality segments.
- Map 6.6 shows that the riparian buffer quality largely reflects land cover. In developed and agricultural portions of the watershed, many of the segments are in the low or moderate categories. Many high-quality buffer segments occur in wooded areas. In some of the developed areas, the buffer may be present but not apparent at the regional scale of the watershed map. This comparison may help characterize streams that were not assessed, such as Brewster Creek.

Restoring or planting altered riparian buffers improves stream conditions and helps improve water quality. The riparian buffer analysis can help target buffer areas to restore or replant.

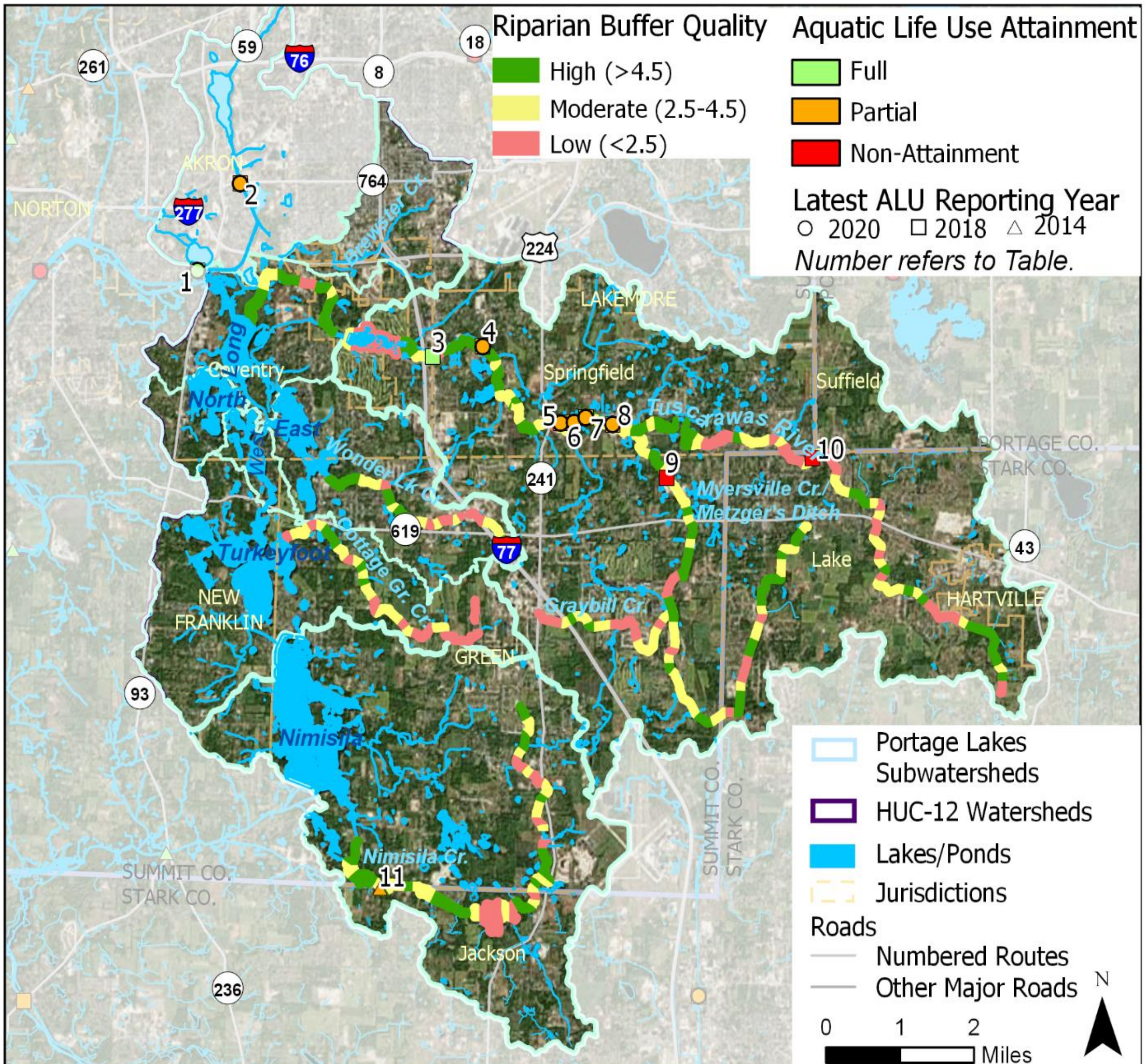



Riparian buffers in the watershed. *Left, center – low quality riparian buffers (along the Tuscarawas River and Metzger ditch) are direct conduits for stormwater and contaminants, and lack protective vegetation and habitat. Right, well-vegetated riparian corridor protects streams, habitat, flood storage, and water quality.*

Table 6.4 Summary of Riparian Buffer Quality

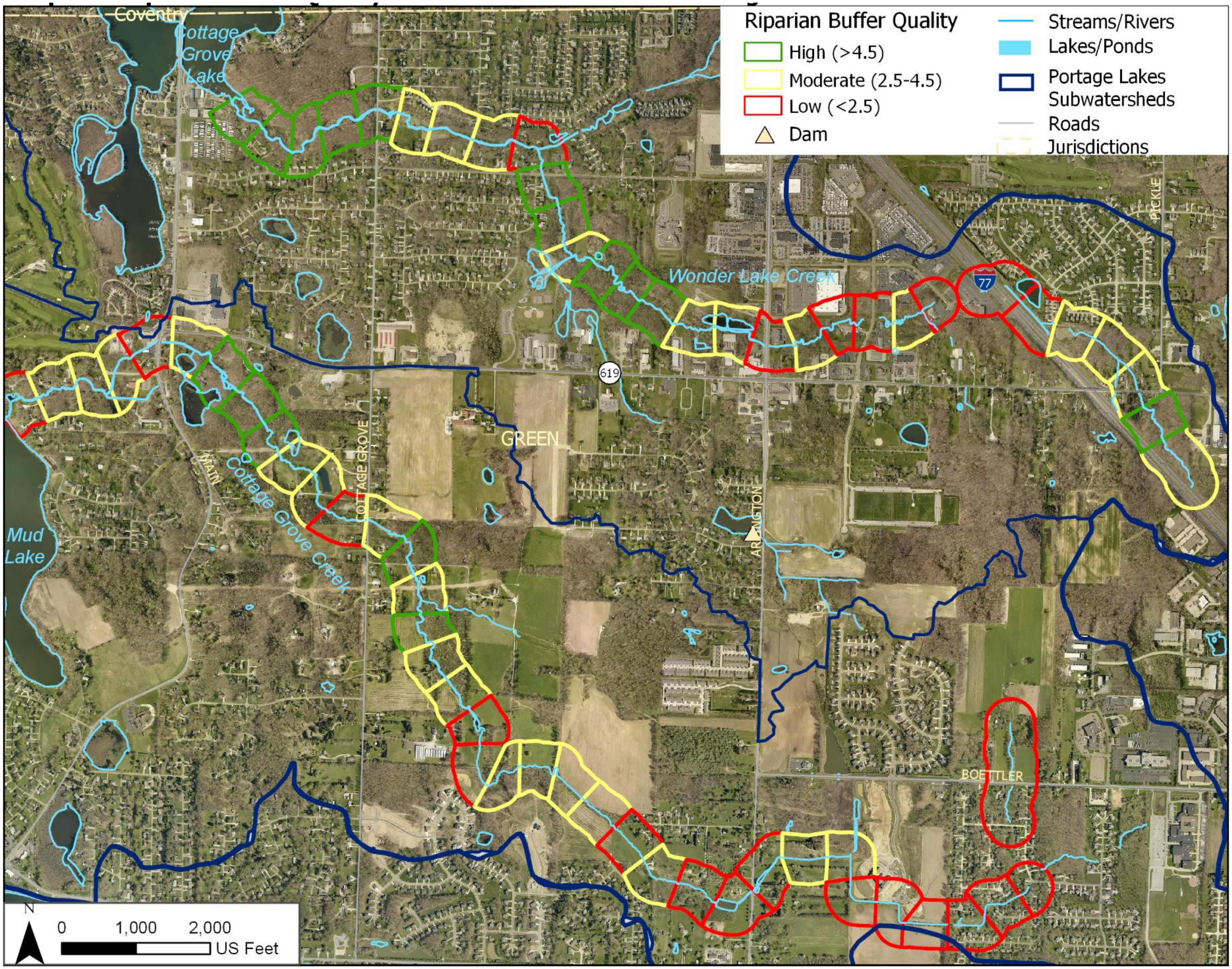
	High			Moderate			Low			Total	
Water Course	**Segments**	**Percent**	**Acres**	**Segments**	**Pct.**	**Acres**	**Segments**	**Pct.**	**Acres**	**Segments**	**Acres**
Tuscarawas R.	65	44	606	49	33	454	35	23	351	149	1,411
Metzger Ditch	31	33	278	44	47	395	18	19	171	93	844
Wonder Lk Cr.	11	37	93	12	40	108	7	23	64	30	265
Cottage Gr. Cr.	5	14	43	17	46	146	15	41	163	37	351
Nimisila Cr.	26	44	269	22	37	231	11	19	174	59	674

Map 6.4 Riparian Buffer Quality and Aquatic Life Use Attainment



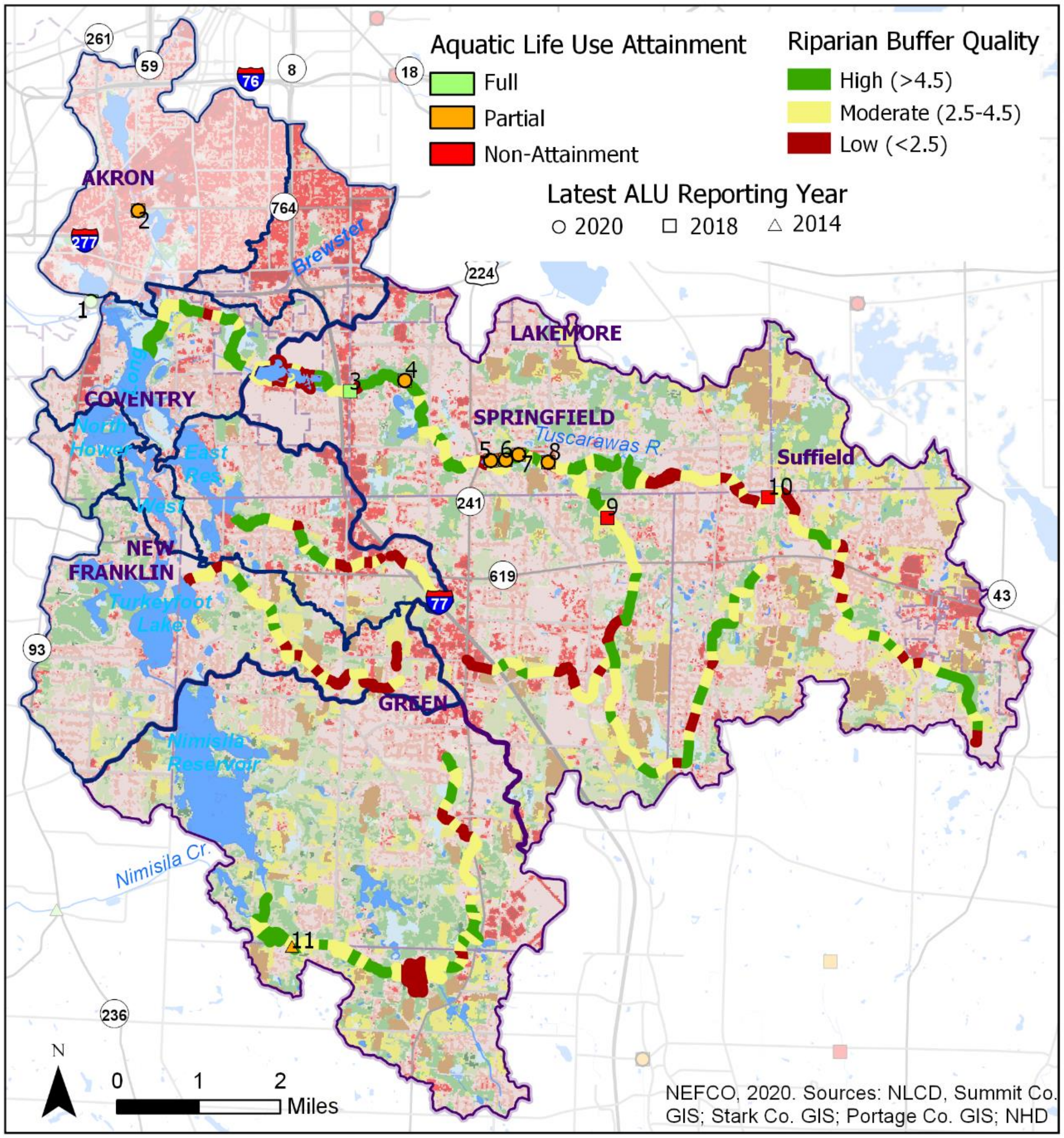
NEFCO, 2020. Sources: Ohio EPA; NHD, Summit Co. GIS; Stark Co. GIS; Portage Co. GIS. Imagery source: ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map 6.5 Riparian Buffer Quality – Wonder Lake Creek and Cottage Grove Creek



NEFCO, 2020. Sources: OSIP; ODNR; Summit County GIS; NHD

Map 6.6 Riparian Buffer Quality, Land Cover, and Aquatic Life Use Attainment



Wetlands


Wetland in Knapp Park

Wetlands, especially along streams and rivers, are one of the key landscape features protecting the health and functioning of streams, reducing impacts to the lakes. Map 6.7 shows potential wetland areas and flood zones, based on available mapping.

Wetlands help regulate flow, acting as sponges that absorb floodwater and release water during dry periods. They provide habitat for a diversity of animals and plants and are important in productivity of a system, providing a source of nutrients and organic matter, and taking up nutrients from stormwater.

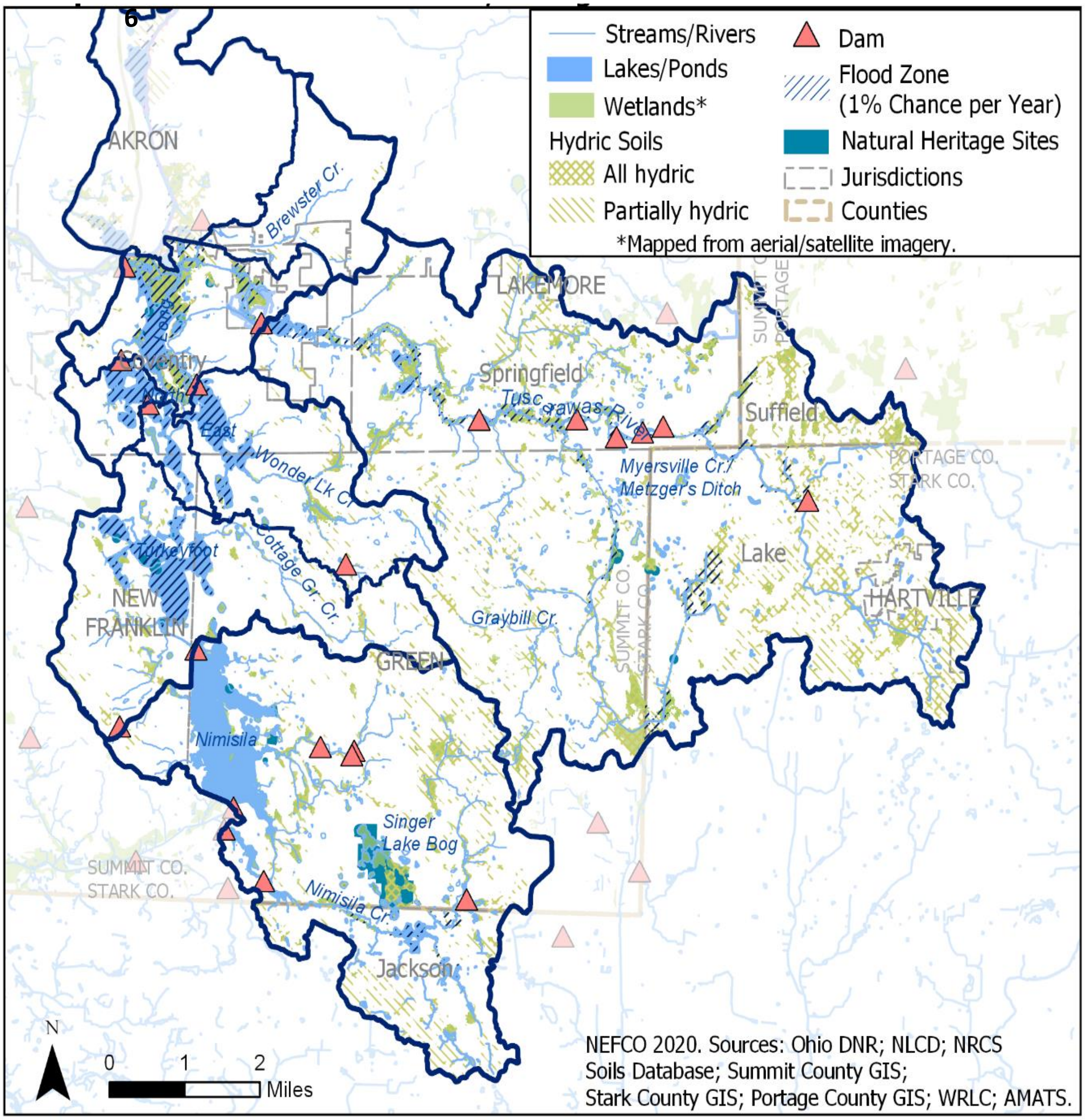
Wetlands are delineated through field work to identify soils and plants that are characteristic of saturated conditions. At the scale of this mapping, it is not possible to identify wetland boundaries or even small wetlands. However, it is possible to map *potential* wetlands especially the largest ones:

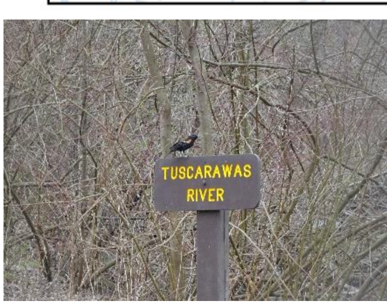
- *Hydric soils* are soils that are formed in saturated, ponding, or flooded conditions long enough during the growing season to develop anaerobic conditions (due to water between particles). Their presence is one of several indicators used to delineate wetlands. Mapped soil types can be used to identify potential wetland locations at a general level. The mapping is not precise enough to identify specific wetlands. Soils are mapped at a landscape scale rather than at a parcel scale, they may have inclusions with different characteristics, and may grade from one type to another. The mapping shows two categories – soils that are more than 86 percent hydric, and soils that have a lower percent of hydric inclusions.
- *Wetlands mapped from satellite imagery*
  The National Land Cover Database, used in Map 6.2 and others, classifies land cover at a scale of 30m pixels from satellite imagery. Map 6.7 includes several large wetland areas from Map 6.2.
- *Wetlands mapped from aerial photography.* In the early 2000s, Summit and Portage Counties had likely wetland areas identified from aerial photographs, combined with soil maps and limited ground-truthing. These represent areas with a high probability of being wetlands.

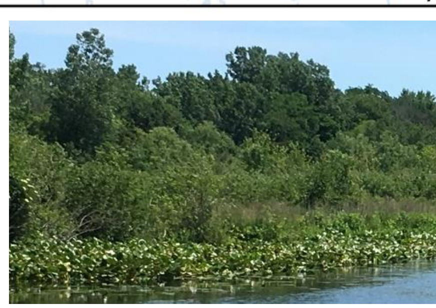
Map 6.7 shows wetland areas mapped from imagery or photography along many of the streams and the Tuscarawas River, including the large wetlands by Long Lake.[11] These helps protect the health of the streams, rivers, and lakes, and provide valuable habitat. Even small or less diverse wetlands provide important habitat, flood storage, and water quality benefits. The hydric soils, soils with hydric inclusions, and potential wetland areas are scattered throughout the watershed. Natural Heritage Database sites, Table 6.5, where species of concern have been identified, are concentrated in wetland areas and lakes. The mapping indicates potential resource areas and treats all potential wetland areas as equal. Field work is essential for determining the presence and quality of wetlands.

Wetland alteration is regulated by Ohio EPA and the Army Corps of Engineers. Summit County has included wetlands and wetland buffers as protected categories in its subdivision and zoning regulations, and many municipalities have adopted similar requirements.[12] Activities that may alter wetlands must minimize and mitigate impacts. The most stringent requirements apply to altering wetlands that have the most intact, diverse habitat. Wetlands can be affected by upland alteration, and mitigation for impacts may not be required on-site. The most effective protection is acquiring land or conservation easements surrounding the wetlands, which reduces the risks of alteration or impacts from off-site uses.

Map 6.7 Wetlands, Flood Zones, and Natural Heritage Areas, Portage Lakes Watershed








Left - The land surrounding the Tuscarawas River in Firestone Metro Park is mapped as likely wetland. Center – wetlands by Long Lake. Right – this wetland in a developed setting, affected by invasive Phragmites reeds, may have a less diverse/high quality habitat, but it still provides tremendous flood management and water quality benefits.

Table 6.5 Natural Heritage Database Sites in Portage Lakes Watershed

	Terrestrial Community	Vascular Plant	Vertebrate	Non-Vascular Plant	Invertebrate
Portage Lakes					
Long Lake Area	1	20	5		
Turkeyfoot		7	2		
Nimisila Res		14	2		
Watershed					
Firestone Park		7	4		
Singer Bog	2	73	1	1	4
Myersville Fen	1	15	1		1
Springfield Bog		6			
Sparrow Fen		2			
Total	4	144	15	1	5

Floodplains and Flood Hazard Zones

In highly altered Brewster Creek, a little extra room lets it spread out during high flow, reducing erosion, sediment transport, and downstream flooding. S. Main St.

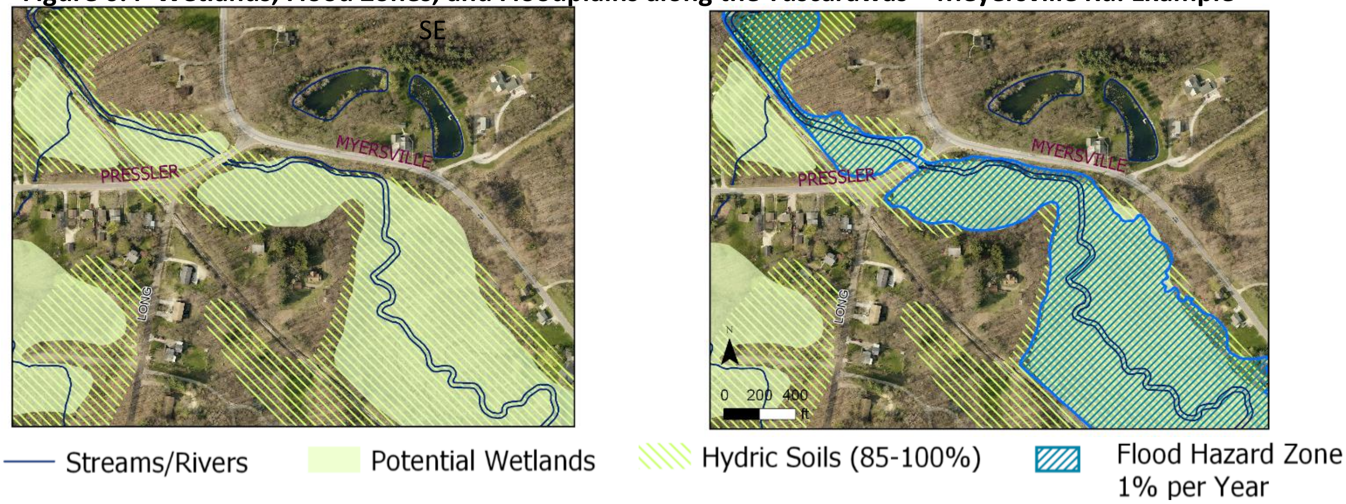
Floodplains are important for stream function, taking excess water. A *floodplain* is a natural, low-lying feature along a stream that allows water to spill out from the channel during high flow. Spreading water out slows it down and reduces its depth and erosive power – a quiet pool versus a raging torrent. Floodplains remove water, silt, and nutrients from the channel, and protect stream channel stability, water quality, and habitat. In altered stream systems, the stream may be entrenched and the floodplain inaccessible, due to erosion or filling in the floodplain for development. Altered channels often erode deeper, wider channels, increasing bank erosion and siltation. They lack access to a natural floodplain, but eventually high-water escapes from even deep channels, flooding nearby land.

The Federal Emergency Management Agency has mapped *flood hazard zones*, areas with a certain risk per year of flooding, to provide information about flood risk to property owners, banks, and insurance agencies. (See examples, Figures 6.4 and 6.5.) Areas with a one percent risk per year are often known as "100 year" flood zones. However, a one percent risk of flood *per year* is *26 percent chance* over the life of a 30-year mortgage that a property will be flooded in a severe event. *Flood hazard zones* may differ from natural *floodplains.* Flood hazard zones may extend beyond the functional, natural floodplain.

Map 6.7 shows flood hazard zones along many of the lakes, Tuscarawas River, and some large wetlands.[13] Floods in developed areas are hazardous to people and degrade streams and water quality, especially where toxic materials could enter the water. Flood hazard areas are mapped using models and topographic mapping. Delineation of requires field work to determine how far the stream can spill out onto the nearby land. Floodplains and flood hazard zones are best left undisturbed if possible.

In order to participate in the national flood insurance program, communities must develop building standards for flood hazard areas. The State of Ohio has developed minimum standards for building elevation and floodplain mitigation. Summit County's riparian setbacks apply to FEMA flood zones also.

Figure 6.4 Wetlands, Flood Zones, and Floodplains along the Tuscarawas – Meyersville Rd. Example



Streams, wetlands, and flood zones tend to coincide. Above left: potential wetlands identified using aerial photography overlain by hydric soils mapping. Wetlands are delineated in the field, using a combination of hydrology, vegetation, and soils. Mapping at this scale can only indicate potential wetlands – soil mapping is generalized, and does not show all the inclusions or gradations. If the landscape has been altered, it may no longer be wet. Above right: FEMA flood hazard zones overlain on the potential wetlands/hydric soil mapping. Below, the cross-section indicates that the tributary is within a broad, low-lying floodplain. The photograph was taken from the road crossing looking southeast. On this rainy day, the Tuscarawas flowed onto its floodplain, leaving water, silt, etc.

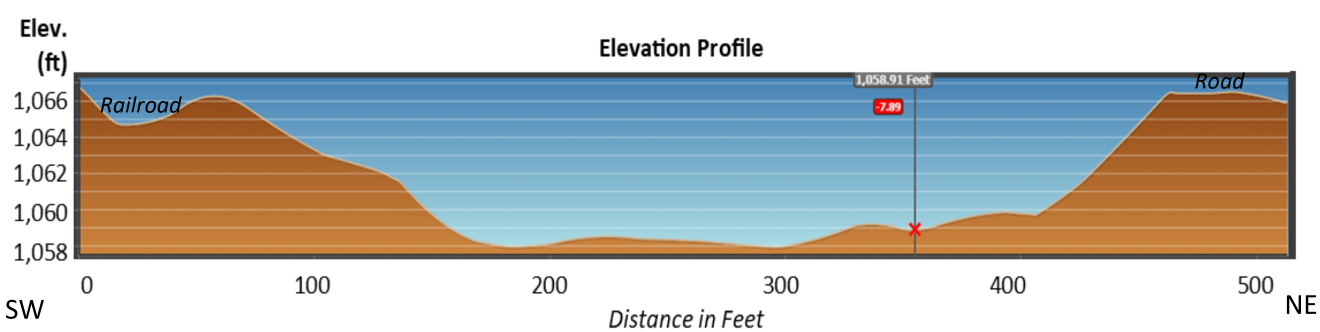
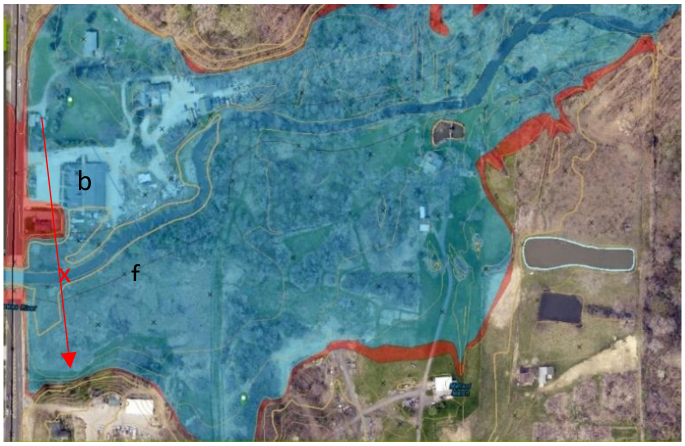
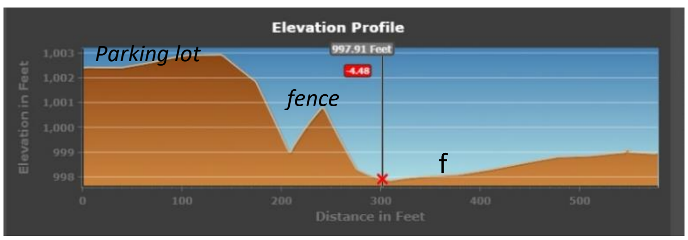


Figure 6.5
Altered Floodplain and Flood Zone



Altered Tuscarawas floodplain Arlington Rd. – The southern portion of the site is low-lying natural floodplain and is mapped as likely wetland. On the northern side, the building (b) is on filled land five feet above the natural floodplain. The 1% per year flood hazard zone extends up beyond the natural floodplain (f), past several buildings. When natural floodplain is filled, the water still goes somewhere, often up, putting buildings and people at risk. Buildings are permitted in the FEMA flood hazard zone if they follow the local requirements for the National Flood Insurance Program. The designated flood hazard zone can change over the years, with improved modeling, as more development upstream increases flooding downstream, and as people fill in the floodplain. This is likely an older use, pre-dating environmental rules.



Channel Morphology

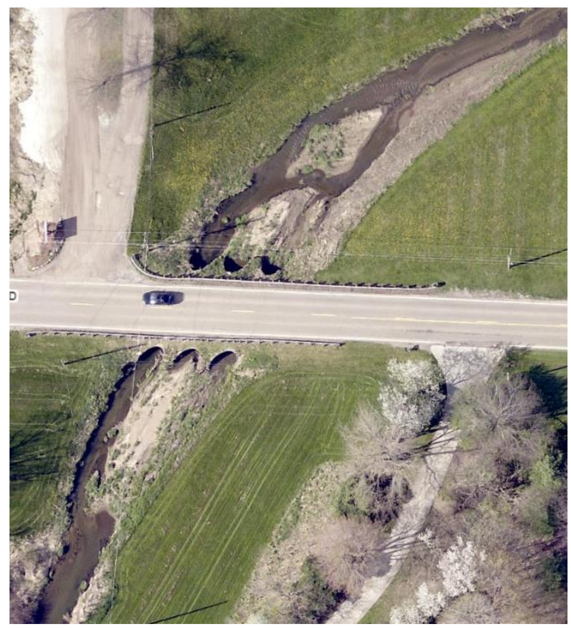
The form of stream channels reflects the slope and inputs from the landscape and is important in regulating flow, oxygenation, sediment, nutrient uptake, flood storage, and habitat. Sinuous, low-gradient streams with accessible floodplains, provide stable, varied habitat, move sediment through at low and high flow, and are resilient to flooding.

Wonder Lake Creek in Knapp Park shows many features of a healthy stream system. The sinuous form creates narrow areas of fast flow (thalweg, A), which clears out sediment during low flow. The wide, shallow channel accommodates high flow, which can also access the adjacent floodplain. The sinuosity slows down high flow. The substrate is stony, not silted in. It and the tree roots provide excellent habitat. The shallow riffles oxygenate the water and add to habitat. Cut banks due to the thalweg are on the outside of the curves and are paired with point bars (B), sediment deposited inside the curves in high flow. The smooth water in the background (C) may be a pool, increasing habitat diversity. Vegetation (greening up for spring) intercepts runoff, takes up nutrients, and stabilizes the banks.

In channelized and altered streams, many of the functions have been lost, affecting flood storage, nutrient and sediment transport, and habitat. Streams may adjust by eroding or silting in. Straightened channels are too wide for concentrated flow during low water. The channels fill with fine silt, which covers over habitat. Increased sediment from erosion is carried out during high flow, fills in the lakes, and carries with it nutrients and other contaminants. Storm flow, no longer contained within wetlands and floodplains, rises as floods onto higher ground.



Above left, center - Brewster Creek flows through a highly impervious, watershed, generating heavy "flashy" flows. The banks and stream form have been altered, reinforced, straightened, and there is minimal functional floodplain. The habitat is degraded, banks erode, the creek is full of sediment, and high flows may cause urban flooding.



Above right and right – Metzger Ditch at Raber Rd. Ditches are carved to convey water quickly. Without meanders and accessible floodplain, they have no mechanism to slow down or release storm flow. Metzger/Myersville ditch, has been largely straightened, has minimal buffer, and flows through a densely developed area, which increases runoff. Stormwater races through the ditch in high flow, in an erosive torrent, through three culverts. The sediment deposits and the sediment plume in the channel demonstrate the high sediment load, which fills in stream habitat and receiving waters and carries nutrients, pathogens, and other contaminants.

Observations from mapping, field visits, and aerial imagery indicate the following, which should be verified by field visits:

- Substantial portions of the Tuscarawas River in Summit County are sinuous, within floodplains and likely wetlands. In Stark County, more of the river has been straightened.
- Many of the streams mapped as having lower quality riparian buffers have also been straightened, degrading habitat, resiliency, flood storage, and water quality downstream.
- Brewster Creek was not part of the riparian buffer analysis, but field visits and aerial photographs, indicate that portions of the riparian corridor and stream channel are degraded.
- Local boaters have noted that Mud Lake seems to be silting in. Aerial photographs, (Map 6.5 and Appendix I), indicate that in many areas, the riparian buffer of Cottage Grove Creek has been altered, and the creek straightened, which tends to degrade stream function and water quality. On-going development nearby also may be increasing runoff and sediment load into the stream.

Dams

Dams are major alterations to stream channels, interrupting flow, often creating anoxic, silted-in areas along streams that disrupt habitat and nutrient uptake, and release nutrients in anoxic dam pools. The Portage Lakes dams are still in use, but many of the other old dams in the region are not. They may no longer provide economic benefit, may be in disrepair, and degrade water quality. Dam removal is a common practice to improve water quality, habitat, and safety. Map 6.7 shows dams in the watershed – it is worth evaluating their benefit versus the costs and risks of maintaining them. Dam removals and accompanying stream restoration can often be funded through water quality improvement funds.

Old dams in the Portage Lakes watershed. *As old dams are no longer used and fall into disrepair, it is worth evaluating whether to repair or lower/remove them. The latter improves the stream channel and water quality. Above, the water level behind Tritts Mill dam was lowered (temporarily) to reduce strain on the old dam. Image source Summit County Environmental Viewer. Left, Wonder Lake dam was lowered. The creek in the former dam pool area may be further restored.*

Wastewater Management in the Portage Lakes Watershed

Home Sewage Treatment Systems (HSTS)

Septic systems use filtration, biological, and chemical processes within the soil to treat wastewater and are generally effective if designed, installed, and maintained to meet the site conditions and use. When they do not function well, they may become "nuisance" systems, discharging incompletely treat wastewater and introducing additional nutrients and harmful organisms to receiving waters.

The following conditions pose a greater risk of "nuisance" wastewater systems:

- Small lots, which may not provide adequate space to treat household waste or which may not have enough space to accommodate setback requirements.
- Older systems – septic systems typically last about 20 years, and more recent designs are better suited for the wide range of soil conditions found in the watershed, and older systems were installed before more stringent regulations went into effect.
- Soil limitations – earlier soils data indicated that the soils of the Portage Lakes area had almost universally "severe" limitations for trench leach fields. Advances in septic system design have provided options to address certain soil limitations. The effectiveness of septic systems is still constrained by depth to limiting conditions such as high-water table or bedrock.
- Septic system maintenance – in order to function well, septic systems need to be inspected, maintained, and the accumulated solids need to be cleaned out periodically. Summit County has point-of-sale inspection and maintenance requirements, which help to reduce the occurrence of nuisance septic system discharges.

Maps 6.8 and 6.9 show the wastewater management characteristics in the watershed and the Portage Lakes vicinity, including parcel locations, small lots, areas served by sanitary sewers, and soil limitations for soil absorption wastewater treatment systems (septic systems) in areas without sewer service.[14] Map 6.9 identifies small lots with houses more than 20 years old, higher risk for nuisance systems. Note: It is likely that some parcels within sewered areas still rely on septic systems. Maps 6.8 and 6.9 show:

- There are several clusters of small lots in the Tuscarawas River Headwaters east of the Portage Lakes, many of which are served by sanitary sewer service.
- The greatest concentration of small lots, south of Akron and Lakemore, is around the Portage Lakes. While some of these are in areas served by sewers, there are clusters of small, unsewered lots with older homes around all the lakes, some of which are near swim areas.

In unsewered areas where soil-absorption systems will not work, it is possible to install a "wastewater treatment system of last resort," an NPDES-permitted individual wastewater treatment system, which is essentially a miniature discharging sewage treatment plant sized for a single lot, with increased maintenance requirements.

Wastewater Management Planning

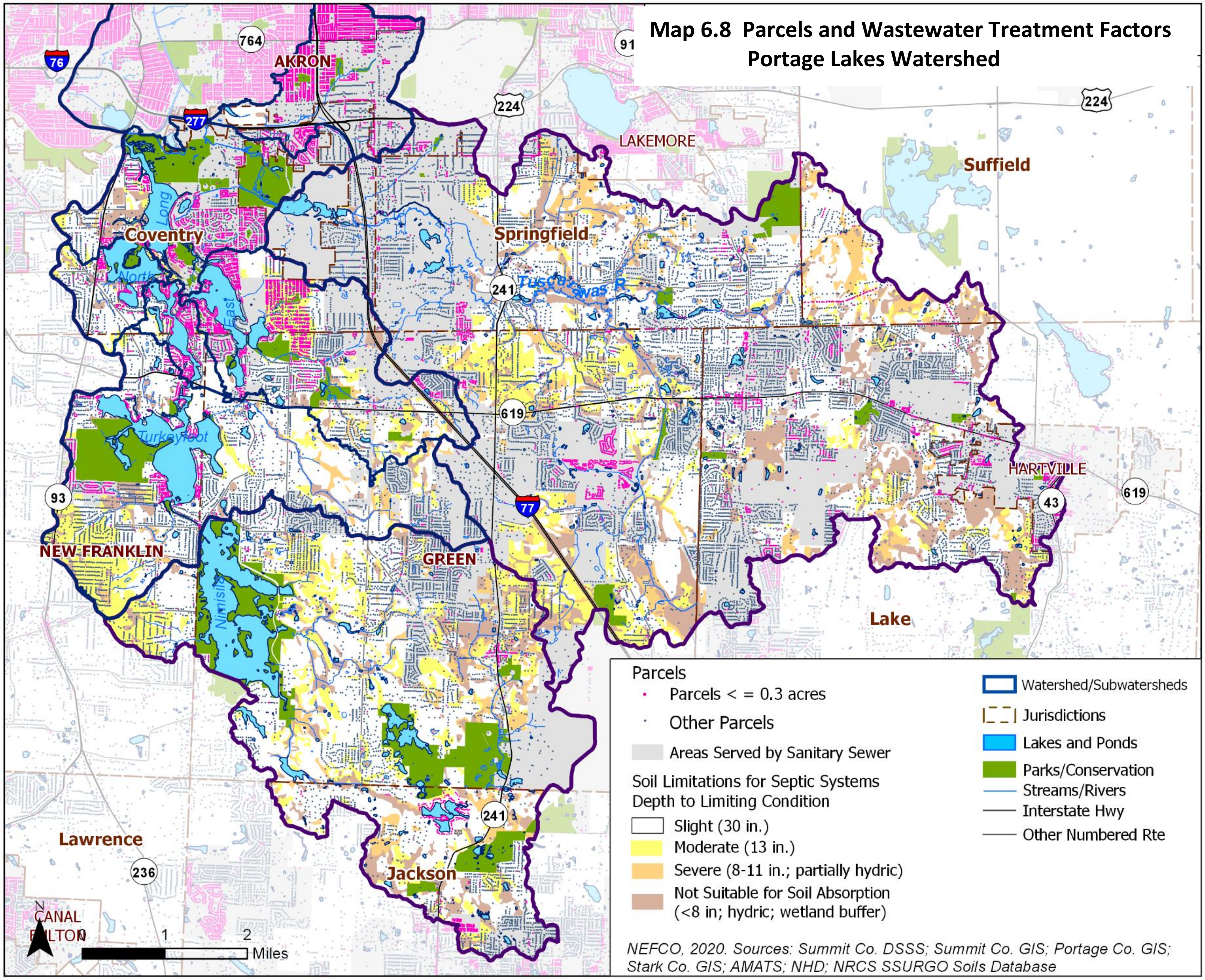
NEFCO has been designated by the Ohio governor to perform areawide water quality management planning for Portage, Stark, Summit and Wayne Counties under Section 208 of the Clean Water Act. NEFCO develops a "208 Water Quality Management Plan," which addresses a range of water quality issues on regional scale. The wastewater management chapter of the 208 plan is developed by local wastewater treatment providers (Management Agencies, MAs) in coordination with NEFCO and local governments. It specifies wastewater management "prescriptions" within Facilities Planning Areas (FPAs), Map 6.10. The prescriptions specify where sewers or on-site wastewater treatment measures can be approved by Ohio EPA or local health districts. Prescriptions can be modified with community input.

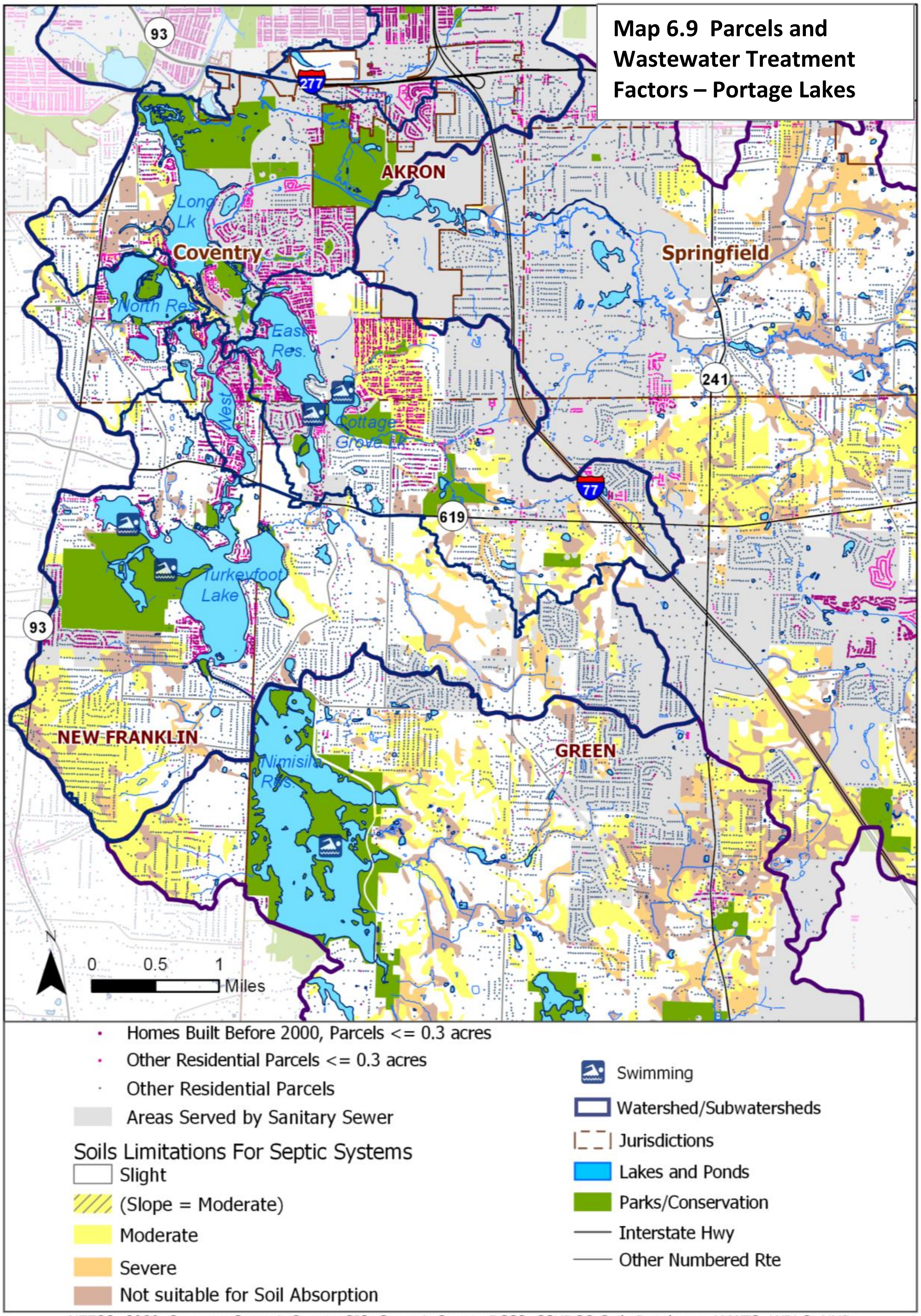
As shown on Map 6.10, the Portage Lakes watershed is primarily within the Springfield-91 and Franklin-Green Facilities Planning Areas (FPAs), which are served by Summit County Department of Sanitary Sewer Services. Other watershed FPAs include Akron, Canton-Nimishillen Basin, Barberton-Wolf Creek, Hartville, Portage County Water Resources, Fish Creek, and Massillon.

Comparing Maps 6.9 and 6.10, there are several areas around the Portage Lakes with small lots and older homes that are not served by sanitary sewer. These present greater risks of nuisance septic systems. Due to the small lot sizes, they may need to use the NPDES wastewater systems, which discharge phosphorus into the water. Summit County DSSS is working with communities to determine the need and feasibility for sanitary sewer service in the Portage Lakes vicinity.

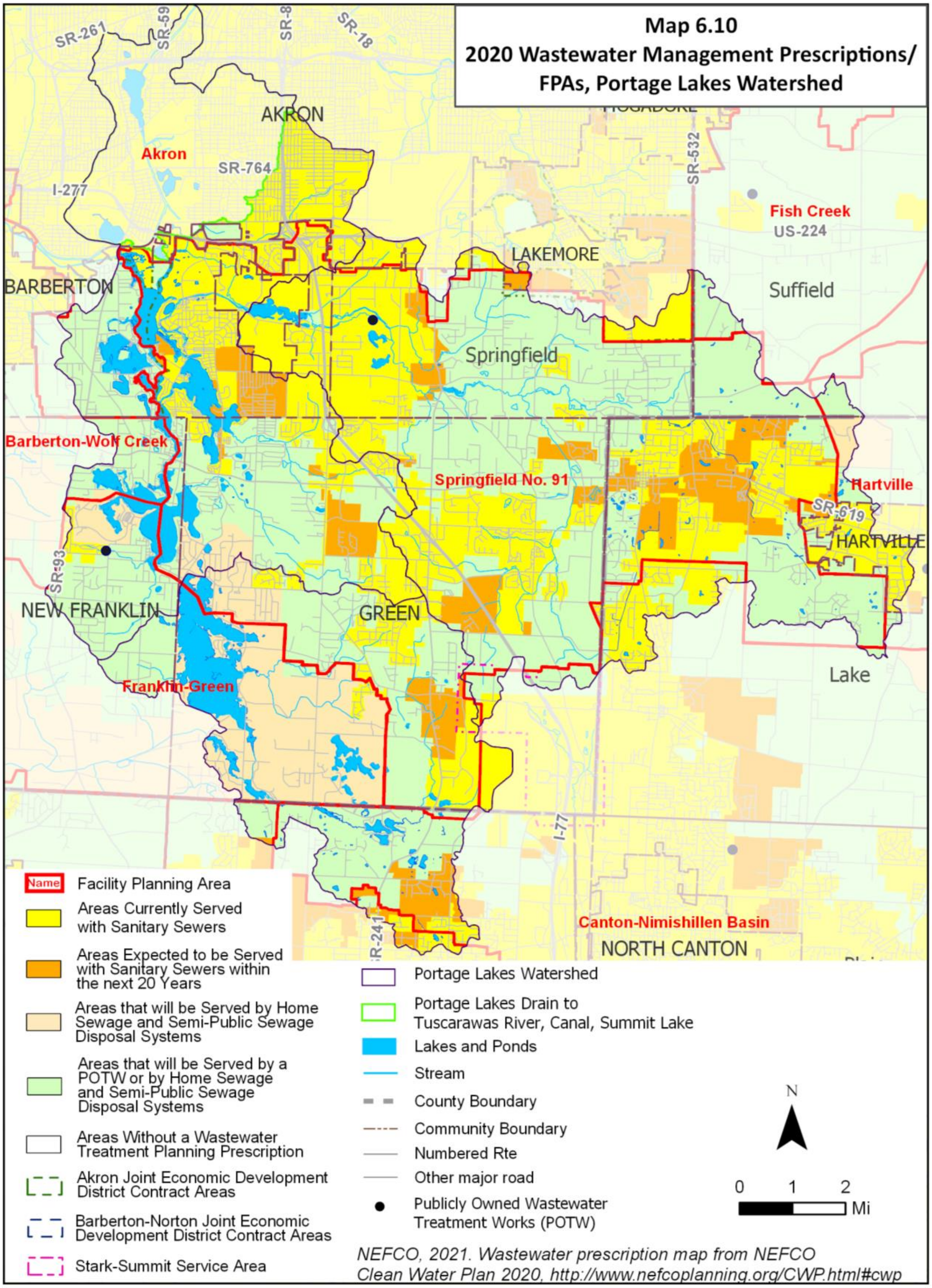
The FPA boundaries and wastewater management prescriptions shown are occasionally modified through an amendment or update process, in coordination with the MAs, communities, and NEFCO. NEFCO's website has the Clean Water Plan, with current wastewater prescriptions FPA boundaries, and MA contact information in the Clean Water Plan Appendix 3, http://www.nefcoplanning.org/CWP.html. Appendix I in this document has further discussion about wastewater management planning.

Communities are urged to work with the MAs and local Health Districts/Departments to support wastewater management options that reduce harmful bacteria and phosphorus entering the lakes.


Map 6.8 Parcels and Wastewater Treatment Factors
Portage Lakes Watershed
AKRON
LAKEMORE
Suffield
Coventry
Springfield
Tuscarawas R
HARTVILLE
NEW FRANKLIN
GREEN
Lake
Lawrence
Jackson
CANAL FULTON
Long
North
East
Turkeyfoot
Nimisila
76
764
277
91
224
241
619
93
77
43
236
0 1 2 Miles
Parcels
Parcels < = 0.3 acres
Other Parcels
Areas Served by Sanitary Sewer
Soil Limitations for Septic Systems
Depth to Limiting Condition
Slight (30 in.)
Moderate (13 in.)
Severe (8-11 in.; partially hydric)
Not Suitable for Soil Absorption
(<8 in; hydric; wetland buffer)
Watershed/Subwatersheds
Jurisdictions
Lakes and Ponds
Parks/Conservation
Streams/Rivers
Interstate Hwy
Other Numbered Rte
NEFCO, 2020. Sources: Summit Co. DSSS; Summit Co. GIS; Portage Co. GIS; Stark Co. GIS; AMATS; NHD; NRCS SSURGO Soils Database



NEFCO, 2020. Sources: Summit County GIS; Summit County DSSS; SSURGO Soils Database; AMATS; WRLC; NHD


Map 6.10
2020 Wastewater Management Prescriptions/
FPAs, Portage Lakes Watershed
SR-261
SR-59
SR-8
SR-18
AKRON
Akron
SR-764
I-277
SR-532
Fish Creek
US-224
LAKEMORE
BARBERTON
Suffield
Springfield
Barberton-Wolf Creek
Springfield No. 91
Hartville
SR-619
HARTVILLE
SR-93
NEW FRANKLIN
GREEN
Lake
Franklin-Green
I-77
SR-241
Canton-Nimishillen Basin
NORTH CANTON
Name
Facility Planning Area
Areas Currently Served with Sanitary Sewers
Areas Expected to be Served with Sanitary Sewers within the next 20 Years
Areas that will be Served by Home Sewage and Semi-Public Sewage Disposal Systems
Areas that will be Served by a POTW or by Home Sewage and Semi-Public Sewage Disposal Systems
Areas Without a Wastewater Treatment Planning Prescription
Akron Joint Economic Development District Contract Areas
Barberton-Norton Joint Economic Development District Contract Areas
Stark-Summit Service Area
Portage Lakes Watershed
Portage Lakes Drain to Tuscarawas River, Canal, Summit Lake
Lakes and Ponds
Stream
County Boundary
Community Boundary
Numbered Rte
Other major road
Publicly Owned Wastewater Treatment Works (POTW)
N
0 1 2 Mi
NEFCO, 2021. Wastewater prescription map from NEFCO Clean Water Plan 2020, http://www.nefcoplanning.org/CWP.html#cwp

Bacterial Monitoring

Image Source: Ohio Dept. of Health 2020. Beach Guard.

According to the 2020 Ohio EPA Integrated Report:[15]

- Ohio DNR conducts periodic monitoring at the swimming beach, posting advisory signs when bacteria reach 235 colony forming units (cfus)/100 ml and conducting additional testing. Between 2015 and 2019, the Integrated Report notes that Ohio DNR took 8 to 10 samples each summer, totaling 43 samples.
- During the five years, a total of five samples were high enough to post advisory signs, from zero to two samples each year. The intensely rainy spring-summer of 2019 resulted in advisory postings only once.
- The beach monitoring data does not fulfill the Ohio Qualified Data Collector requirements and is presented for informational purposes.

The 2009 TMDL notes that:[16]

- The Tuscarawas River from the Long Lake outlet upstream to Mile 126.7 (Site 10 on Map 6.2, Stark County border) is in full attainment of recreational use; at Mile 126.7 (Site 10), it is in non-attainment due to pathogens.
- Nimisila Creek was in full attainment for recreational use but affected by failing septic systems.

Reducing Inputs from Septic Systems

Many of the septic systems in the Portage Lakes are on small lots (< 0.3 acres) with limited soils. Summit County has requirements for inspection and maintenance of septic systems. It is likely that some will fail over the next 10-20 years, and it is also likely that some will be replaced, either with soil absorption systems or with NPDES direct discharge treatment systems.

Nuisance septic systems may introduce e. coli and other pathogens to the lakes. The Portage Lakes beach has been closed in the past due to high e. coli counts. Swim areas other than the beach are not currently monitored – those near unsewered areas may have higher bacteria counts.

Failing and direct-discharge systems may introduce phosphorus into the lakes, at an estimated rate of 4.6 pounds per household per year, the equivalent of a 50-pound bag of 10-10-10 fertilizer, which would support hundreds of pounds of aquatic plants per year per household. The phosphorus load from thousands of older systems on small lots would support hundreds of tons per year. With phosphorus loading also a concern for HABs, it is important to minimize this source.

Property owners can adopt practices that ensure septic systems function well, reducing the risk of nuisance septic systems. See Appendix I for a full discussion.

Recommended Best Management Practices (BMPs) for HSTS Owners to Prevent Premature System Failure and Negative Impacts on the Water Quality of the Portage Lakes *(Full discussion in Appendix I)*

- Make sure you always have a valid HSTS operation permit from the local health district
- Maintain continuous a service contract with a registered HSTS service provider—since registrations must be renewed annually, check with your local health district or its website every year to verify that your service provider is registered and bonded
- Do not put solid waste items in an HSTS; put them in a trash can, including food waste (use garbage disposals sparingly), paper towels and related rags, cloth, disposable diapers and other personal care items, hair, cat litter, cigarette butts, matchsticks.
- Microorganisms in the system break down the waste. Protect them. Do not put fats, grease, toxins, household chemicals, beer or winemaking waste, antibacterial soap, commercial septic tank additives, or prescriptions an HSTS.
- Have your septic tank(s) pumped when your registered service provider says its needed

Actions to Take to Reduce the Negative Impacts from Wastewater on the Lakes

- Contact your local health district when you observe an HSTS nuisance, which can be reported anonymously and may be able to be reported on its website
- Disseminate the HSTS BMPs listed above to lakeside property owners
- Learn about and seek ways to reduce nutrient loads from off-lot discharging NPDES HSTSs

Pollutant Loads from Land Use

Pollutant loading from land use has been studied for decades. The STEP-L (Spreadsheet Tool for Evaluating Pollution Load) is a relatively simple way to estimate the pollution load based on land cover and land management practices in a watershed.

Table 6.6 is an example of how land use affects pollutant loading and how BMPs can reduce loading.[17] It assumes: a relatively small 400-acre watershed, with equal areas (100 acres) of developed land, pasture, crops, and forest; one feed lot; a mixture of developed land; 100 septic systems; direct discharge of wastewater from 100 people; a shallow gully 100 feet long, and a shallow degraded streambank of 1,000 feet long.

The example shows that urban land, agricultural land, and septic systems contribute substantial loads of contaminants per year to streams and lakes. Applying Best Management Practices (BMPs) to each category can reduce the load. BMPs vary in efficiency, with greatest percent reduction in sediment.

Table 6.6
STEP-L Model for Example Watershed Total load by land use

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)*	Sediment (tons/yr)
Urban	441.5	68.0	1,678.1	10.2
Cropland	850.7	279.0	1,723.8	199.0
Pastureland	429.6	72.3	1,234.4	40.4
Forest	20.2	9.0	45.6	3.0
Septic	976.0	207.1	5,279.9	0.0
Gully	10.5	4.0	20.9	5.7
Streambank	11.6	4.5	23.2	6.3
Total	2,740.0	643.9	10,005.9	264.7
BMP Reduction	-872.6	-265.3	-1,649.7	-217.3

** Biological Oxygen Demand – organic matter that uses oxygen during decomposition.*

STEP-L was used to estimate pollutant loading in the Portage Lakes watersheds, based on Portage Lakes watershed land cover data, estimated septic systems (Table 6.7), and modest use of BMPs applied to 20-50 acres per watershed.

Tables 6.8 and 6.9 show the results of the STEP-L model for the Portage Lakes watershed. These are estimates based on assumptions about the watershed.

Table 6.7 Estimated Septic Systems by Watershed

Brewster	0
Long	646
Tuscarawas	6,985
Hower-North	727
West	580
East	1,753
Turkeyfoot	2,885
Nimisila	2,148

Table 6.8
STEP-L Model for Portage Lakes Watersheds Total Pollutant Loading by Watershed with BMP

Watershed	N Load (lb/year)	P Load (lb/year)	BOD (lb/year)	Sed. Load (tons/year)
Brewster	4,895	769	19,520	114
Long	8,334	2,229	31,955	114
Tuscarawas	50,934	9,505	167,210	2,340
Long Lake total	*64,193*	*12,503*	*218,685*	*2,568*
Hower-North	1,245	304	4,802	22
West	5,867	1,083	20,923	246
East	1,572	503	6,357	12
Turkeyfoot	9,858	2,087	33,724	403
Main Chain/HN total	*18,542*	*3,976*	*65,806*	*684*
Nimisila	*18,232*	*3,582*	*59,058*	*1,041*

Table 6.9 STEP-L Pollutant Loading by Land Cover Main Chain/Hower-North and Long Lake

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Long Lake, Brewster Creek, and Tuscarawas River				
Urban	40,099	5,934	143,210	934
Cropland	6,928	1,959	14,329	1,197
Pastureland	7,861	958	24,234	374
Forest	691	323	1,405	62
Septic	8,643	3,329	35,507	0
Long Lake Total	*64,193*	*12,503*	*218,685*	*2,567*
Main Chain plus Hower-North				
Urban	11,351	1,669	40,561	264
Cropland	1,274	405	2,713	270
Pastureland	1,556	226	4,971	106
Forest	372	170	860	44
Septic	3,989	1,506	16,702	0
Main Chain/H-N Total	*18,542*	*3,976*	*65,806*	*684*
Nimisila Cr.				
Urban	9,338	1,372	32,289	219
Cropland	2,935	860	6,081	549
Pastureland	3,745	497	12,254	215
Forest	586	272	1,372	59
Septic	1,628	582	7,062	0
Nimisila Total	*18,232*	*3,582*	*59,058*	*1,041*

Tables 6.8 and 6.9 use present a rough idea of the external loading coming from each watershed and land cover type, affecting stream and lake habitat, biota, and water quality.

- The water entering Long Lake from its watershed, Brewster Creek, and the Tuscarawas River is about three times the load from the Main Chain and Hower-North.
- Urban land is the largest source of pollutants, followed by septic systems and agriculture.
- The influence of agriculture is higher in the Tuscarawas and Nimisila watersheds.

The phosphorus entering the lakes as external loading generates hundreds of pounds of plant matter per pound of phosphorus as it is recycled. Ohio EPA has set targets for streams of 0.08 to 0.1 mg/l of phosphorus.[18] Reducing the external loading from the watershed is necessary for addressing nuisance plants and the risk of HABs. Practices include reducing runoff, reducing contaminants entering the water, and protecting/restoring important landscapes.

Watershed Priorities

Priorities in all the watersheds include reducing phosphorus, protecting and restoring important landscape features, and encouraging the use of BMPs to reduce sediment, pathogens, nutrients, and other contaminants. Considering each lake and its watershed may help identify specific priority areas.

Lake/Watershed	Concern	Observations
Brewster Cr.	Degraded stream channel	Highest percent imperviousness, urban land cover, altered channel and floodplain.
Long	Dense aquatic vegetation	Receives water from Brewster Cr., the Tuscarawas River, and the Main Chain. Small, unsewered lots along the Feeder.
Tuscarawas	Largest watershed, highest loads	Some altered channels; several areas protected by parks, wetlands.
North-Hower	Dense aquatic vegetation Most eutrophic	Small, unsewered lots, receives some water from West Reservoir but may not be well-flushed.
East	Dense aquatic vegetation in the north	
Cottage Grove	Dense aquatic vegetation Swim areas	Neighborhood with small unsewered lots. Wonder Lake Creek altered as it passes through Arlington commercial area and other densely developed area. Older stormwater management measures may have focused on volume.
Miller	Dense aquatic vegetation	Some small lots with septic systems. Abuts golf course. Miller Lake may not be well flushed out.
West		Small lots with septic systems.
Turkeyfoot	Swim areas, areas of dense vegetation at margins	Neighborhoods with small lots and septic systems. Large phosphorus load for Turkeyfoot/Rex/Mud .
Rex	Swimming area	Small lots with septic systems. May not flush well.
Mud	Silting in	Development and stream alteration along Cottage Grove Cr., which is developing rapidly.
Nimisila	Dense aquatic vegetation, high P loads, mesotrophic.	Lowest percent imperviousness, high percent forest, high percent agriculture.

- Almost all lakes have small lots with septic systems in the watershed.
- The area around East Reservoir is largely served by sewers. Nutrients from other sources include development and the golf course near West Reservoir, Turkeyfoot Lake, and Miller Lake.
- Small semi-isolated coves may not flush out as well.
- In the shallowest lakes, phosphorus in the sediment may be stirred up more easily.
- Streambank and stream channel alteration are factors in Brewster Creek, and may be factors in Cottage Grove Creek (Mud Lake) and Wonder Lake Creek (Cottage Grove Lake).
- Brewster Creek is also affected by the dense development of its watershed.
- Long Lake and North Reservoir, especially, may be affected by upstream loading.
- The mapping and pollutant loading analyses is based on remotely obtained data, proxies, approximations, and assumptions. It is important to determine landscape conditions in the field, identify resources, and monitor water quality to characterize water entering the lakes and identify opportunities for protection or restoration.

Reducing Impacts from Land Use - Best Management Practices and Conservation

Much of this chapter has focused on impacts of the altered watershed on water quality, flooding, stream functions, and habitat. Because the watersheds are the communities where people live, work, shop, go to school, raise or grow food, and recreate, it is not possible or desirable to return to pristine watersheds. There are many types of Best Management Practices (BMPs) that can reduce the impacts, which can be applied on a small, individual scale or to dozens of parcels, tens of acres, thousands of feet of stream corridor. As the impacts are incremental, the improvements can also be made incrementally, by many individuals helping protect their watershed, streams and lakes.

Below are some examples. Some of these can be done by individuals or scaled up. The longer-term, large scale efforts generally should be done on properties under long-term control of institutions, communities, parks, other public entities, or conservancies. Some of these efforts may require external funding, land acquisition, or other resources, and may take years to realize, e.g., tree planting or corridor acquisition - planning for and beginning a long-term effort is a good way to start.

Protect important landscapes

Intact wetlands, riparian corridors, stream corridors, floodplains provide important benefits for stormwater and flood management, habitat, and water quality. Map 6.11 shows important landscapes within the watersheds and conservation lands.[19] These are best left undisturbed, because they provide important benefits and are often not suitable for structures or HSTS.

Some tools to protect landscapes are described below, with examples from the watershed:

Ownership/Easements/Deed Restrictions

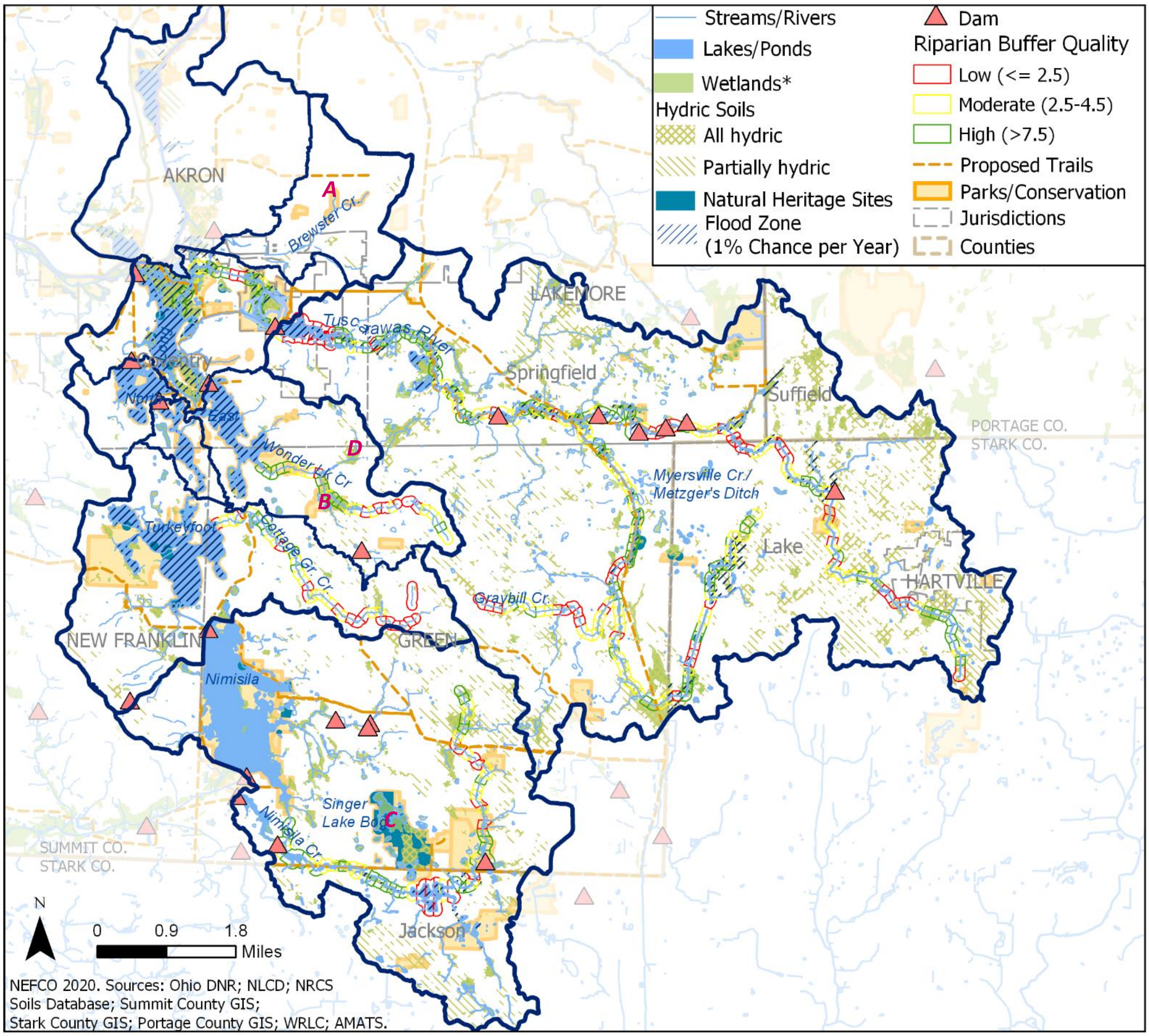
- Owning land or conservation easements around sensitive resources, especially with deed restrictions, is the one of the most effective ways to control what happens to that portion of the resource over the long term. Public or non-profit ownership is often required for externally funded restoration projects.

Wilbeth-Arlington Park protects Brewster Creek headwaters. (A)

Above - ownership by community and Cleveland Natural History Museum protects a portion of the Wonder Lake Creek (B) as a park and Singer Lake Bog (C) as conservation land.

Land development can protect land as buffers or open space within a development. (D) Above, some are deeded setbacks, the area just open.

Map 6.11 Important Natural Resources for Conservation or Restoration



- Stream corridors provide valuable protection and can be used for passive recreation such as trails. The Metro Parks of Summit, Stark, and Portage Counties and other organizations like the Nature Conservancy and Cleveland Natural History Museum have focused efforts on acquiring certain stream corridors for conservation and passive recreation.
- Conservation easements pay landowners to cede the rights to further develop the land. The property owners retain the property but cannot develop the land further. In addition to being paid for the easement, landowners may get a tax benefit, since the land cannot be developed. Various organizations (e.g., SWCDs) hold the easements separately from the owner.
- Land can be acquired as opportunities arise, and then restoration work can be done if necessary.

Setbacks and Buffers Vegetated buffers are one of the most effective – and relatively straightforward – tools for protecting streams. Setbacks are requirements to leave undisturbed or vegetated buffers and are part of many environmental regulations. Buffers are best sized for the size of the stream/watershed. In Summit County's Riparian setback regulations, headwater streams draining less than 32 acres have a 30-foot setback, while water courses with larger watersheds have larger ones, up to 300 feet for drainage areas greater than 300 square miles. Additional setbacks apply to wetlands, FEMA flood zones, and steep slopes.[20] In many cases, however, stream banks are covered with turf, rather than deep-rooted vegetation.

- Summit County and many of the municipalities have adopted riparian setbacks that require development (and disturbance) be set back from streams.
- Land use development laws can require open space buffers/setbacks. Many of these are the minimum required by the laws, so the laws should specify percent of open space and percent undisturbed. In some cases, development codes can provide for larger setbacks if density is increased elsewhere (on-site or on a different parcel, through transfer of development rights.)
- Leaving an undisturbed buffer protects streambanks from erosion and filters runoff.

Fencing agricultural fields (A) is an effective way to keep livestock off most of the bank and protects the streambank from erosion.

BMPs – Reducing Stormwater Runoff and Contaminants

Rain on pavement generates a lot of runoff, laden with sediment, nutrients, pathogens, and chemicals. A wide variety of practices is available for reducing and treating stormwater runoff at different scales – for individual use or large-scale projects. Their purpose is to reduce the amount of stormwater leaving a site or entering the water, and to reduce the amount of contaminants in the water. It is best to infiltrate or use the water on-site, if possible, to reduce overloading of streams and the erosion, sedimentation, bank instability, and contaminant loads that goes with stormwater.

Construction sites within Municipal Separate Storm Sewer Service areas (MS4s) are required to develop stormwater management plans, both during and after construction. These use many of the tools described above. SWCDs implement stormwater programs. Ohio DNR has fact sheets on BMPs.[21]

Rain gardens are depressions designed to capture and infiltrate stormwater. Water-tolerant plants use the water and nutrients and bind other contaminants with their roots. Rain garden instructions are widely available. Individual property owners can make their own with a good site, a bit of planning and labor, soil amendments if necessary, and plants. SWCDs are a good place to start.

Bioinfiltration devices are similar to rain gardens but more highly engineered. They infiltrate and treat stormwater. Many are put in or next to parking lots to capture and treat stormwater. They are often connected to storm drain systems in case of high flow.

Detention basins/retention basins Stormwater regulations require developments to reduce the peak flow leaving the property, which has resulted in a lot of dry detention basins. These temporarily store water, and release them within a few hours. They provide minimal water quality benefits due to the short detention time, and may contribute to bank erosion, since high (not peak) flow continues for a longer period of time than pre-development conditions. Retention ponds or basins store the water on-site and may include wetland vegetation. These are more efficient at removing nutrients and binding other contaminants. These occasionally need to be cleared out. They are regulated as wetlands.

Covering Soil - Runoff can be reduced by covering soil. Individual property owners can use straw to reduce erosion from disturbed soils. Cover crops on agricultural fields protect the soil from erosion, and their roots infiltrate stormwater and use nutrients.

Containing contaminants – Silt fences are used on construction sites to contain disturbed sediment. Coir tubes or mats also can be used. Larger development sites often have sediment basins.

Reducing runoff from sites – Use cisterns/rain barrels to catch roof runoff. Reduce commercial parking requirements and replace spaces with bioinfiltration measures. Both of these reduce runoff and require adjustments to regulations.

Other Best Practices focus on reducing the materials that can enter the water, including Fixing septic systems, cleaning up after pets, using fertilizer according to instructions, discouraging geese.

Restore altered landscapes – these are often large-scale projects

Formerly incised stream, with restored channel and floodplain. Photo source: R. McCleary, 2014.

- Restore floodplains, and stream channel morphology – this improves flood resilience, sediment removal, nutrient uptake, habitat, cooling, oxygen levels, water quality, etc. These are often large-scale projects but are often eligible for outside funding, which can be done in pieces, e.g., land donation, labor, various water quality improvement funding. "Daylighting" culverted streams gives them room to spread out and allows vegetation to grow, which slows and filters water.
- Restoration projects with external funding generally need to be done on land protected by a conservation easement and/or owned by public or certain non-profit organizations.
- Wetland restoration often focuses on habitat. (Wetlands can also be used for stormwater treatment, but the two may not overlap due to the effects of stormwater.)
- Plant riparian corridors, host tree-plantings, replace turf with native plants, shrubs, trees. These are good opportunities for volunteers. Riparian corridors identified on Figure 6.11 as low or moderate quality are good targets.
- In many cases, old dams no longer used for their purpose are in disrepair, unsafe. Dam removal is often considered a water quality improvement, eligible for water quality funding. These are often done with stream restoration, together or as phased projects.
- Channel or floodplain restoration projects are most effective when connected to others or in the headwaters. Small, isolated projects mid-stream in a highly altered corridor are less likely to withstand flooding from upstream. Stream restoration projects are often phased in segments.
- In some cases, developers need to mitigate for unavoidable large-scale wetland alteration. Identifying target areas for restoration and acquiring the land in advance allows future restoration opportunities to move more smoothly and quickly, providing a better potential for moving the project forward.
- There are some organizations that have established wetland restoration/mitigation banks, allowing developers to alter wetlands and pay for restoration in another area. These need to have competitive pricing per acre of restoration. They tend to be large undertakings.

Left - Volunteers planting a former dam pool. Right – View of the bank they planted several years later.

Reduce imperviousness, increase rainwater infiltration, reduce runoff

- Plant deep-rooted plants, shrubs, trees, especially along the water's edge.
- Rain gardens, bio-infiltration, rain barrels/cisterns help reduce runoff and increase infiltration. Some people use rain barrels/rain chains in connection with disconnected downspouts.
- The State Park has a lot of high visibility sites for stormwater Best Management Practices such as rain gardens and lakescaping.
- Establish cover crops and buffers in agricultural lands.

Reduce contaminants that can enter the water.

Many of these are individual stewardship practices

- Compost plant matter, keep it out of streams.
- Clean up after your pet, clean up litter.
- Discourage geese (plant tall native plants by the water, try other techniques)
- Be careful cleaning equipment, so the water doesn't go into drains or ditches
- Don't dump chemicals into road drains or ditches.
- Test your soil for nutrients, apply only the necessary amount per instructions.
- Cover exposed soil.
- Don't wash your car where the water will run into the ditch or drain.
- Don't dump toxic chemicals into your septic system.
- Maintain your septic system with periodic pumping, etc., according to "O&M guidelines."

Best practices related to Best Practices

- Look for opportunities to increase awareness and participation.
  - Seek high visibility public sites for demonstration projects and restoration.
  - Be sure to include signage!
  - Plantings can look attractive or weedy. Attractive enhances the setting and message.
  - Involve volunteers, e.g., plantings, monitoring, signage, art projects, tour guides.

Signs help a lot.

- Mowing to the edge of streams is harmful. Streamside vegetation does a lot to protect streams – and property.
- Look for projects that can address multiple interests for multiple potential partners, e.g., flood control, nutrient reduction, wastewater management agencies, recreation, the arts, urban beautification, transportation, environmental education, LEED-certification, Audubon golf course certification, garden clubs, watershed districts, civic/religious organizations, schools, eco-related businesses, foundations.
  - Partner assistance can often serve as local match for external funding, e.g., land, labor, financial, design, materials, etc. It also broadens the discussion about project design.
  - Stream corridors make great transportation corridors for hiking trails, provided the stream buffer becomes or remains well-vegetated.
  - Look for opportunities to connect new passive recreation/ conservation/restoration projects to existing ones.

  - Water quality protection or stormwater management funding can often be used for projects that accomplish multiple goals.
  - Wastewater management agencies may be able to help with funding or labor.
  - Design for water quality, as well as flood control.
  - Sites by schools are high visibility and can serve as an eco-lab.
  - Shared interests will likely increase the number of people who view the improvement.
  - Partners may be able to share resources, offer staff time or land.
  - Recreation funds can pay for a canoe pull out, hiking trail, or parking area.
  - Mini-parks along a stream can incorporate community art projects, a place to rest and enjoy a bit of greenery, and signage celebrating the local history and environment.
- Acquiring conservation easements or properties in environmentally sensitive areas protects resources and provides opportunities for future projects. For example, FEMA funds may be used to acquire properties in frequently flooded areas, which can be a first step toward restoration. Publicly funded projects generally need to be protected by conservation easements or occur on publicly owned land.

- Replace turf with taller, deeper-rooted vegetation. When planting or re-planting areas, use native species appropriate to the setting as much as possible. Get professional advice. SWCDs, OSU extension, and plant suppliers are good places to start. If planting trees, get an arborist's advice on proper installation. Protect them from deer.
- Remember to account for maintenance, if necessary.
- SWCDs implement stormwater management requirements for development in urbanized areas. Summit County land development regulations address water resource protection.
- Document the need, conditions, and planned project, before and after. Many funding sources prefer "shovel-ready" projects. A Non-Point Source Implementation Strategy plan (NPSIS) is required for projects before applying for "Section 319" grants from Ohio EPA, which are often used to fund large-scale water quality improvement projects.
- Make sure local regulations encourage rather than hinder stormwater best management practices like disconnecting downspouts.

Key Considerations

The lakes and streams of the Portage Lakes watershed are affected by the watershed landscape. Development and alteration affect stream function, floodplains, riparian zones, and water quality.

There is a considerable amount of loading of stormwater, nutrients, pathogens, sediment, and other contaminants from the land uses, septic systems, and altered stream channels. Nutrient loading from the watershed begins as external loading but then is recycled within the lakes as internal loading, which can last for years. It is important to reduce both sources of nutrients. BMPs, conservation, restoration, and plantings will help reduce flooding and input of nutrients and other contaminants.

- The lakes are in the upper Tuscarawas River watershed. The Tuscarawas flows into northern Long Lake. The Tuscarawas River and Nimisila Creek are the only water courses that have been monitored in the watershed, and they have minimal to no effect on the Main Chain lakes. Water quality monitoring indicates that attainment of Aquatic Life Use standards ranges from non-attainment to a few sites in full attainment. The two water courses have been affected by flow alteration, habitat alteration, siltation, organic enrichment, pathogens and nutrients, from channelization, suburbanization, and failing septic systems. Nimisila Creek and the Tuscarawas River represent approximately three-fourths of the modeled pollutant loading, but their effect on the Main Chain lakes is minimal to none. The tributaries primarily affecting the Main Chain have not been monitored, but because of landscape similarities, it is likely they exhibit similar impacts from these sources. They need to be monitored to determine what is entering the lakes.
- Lake conditions should be evaluated in light of the watershed characteristics, land cover, and the presence of small lots with septic systems. Intact stream channels, floodplains, vegetated riparian buffers, and wetlands help protect water quality, reduce flooding problems, and improve stream resilience to high flows. The riparian buffer analysis, resource mapping, and review of aerial photographs indicates that some of the stream and river segments appear to be intact, flowing through vegetated buffers, wetlands, and low-lying floodplains. Some of these are within parks and conservation areas. Many areas have been disturbed, which harms stream function and water quality, increasing loading of nutrients, sediment, bacteria, and other contaminants to the lakes.
- The numerous small unsewered lots makes nutrient loading and pathogen input from septic systems extremely likely. Several swim areas are located near unsewered neighborhoods, which should be monitored for bacteria. Some of these neighborhoods are near lakes with especially dense vegetation, possibly contributing nutrients to the eutrophic conditions. Discussions among representatives of wastewater management agencies, communities, and health districts that were started during development of this plan should continue concerning the need and feasibility of various wastewater treatment measures. The focus should be on reducing phosphorus loading and pathogens in a way that is acceptable to the MAs and communities.
- The imperviousness (hard surfaces) of the watersheds affects runoff and stream quality. The watersheds generally range between 10 and 20 percent, which is high enough to cause stream degradation. Nimisila Reservoir is 7.7 percent impervious, and Brewster Creek is 45 percent impervious. Vegetated riparian buffers can reduce stream damage.
- An analysis of potential pollutant loading indicates that urbanized landscapes are a major source of nutrient loading into the lakes, followed by septic systems and agricultural land.

Reducing the external loading coming from the watershed is an important part of protecting lake health.

- There are many practices available to reduce the impacts and protect and improve water quality in the streams, river, and lakes. Protecting and restoring riparian buffers, stream corridor landscapes is an important part of watershed protection. Conservation, protection, and BMPs can and should be widely used by individuals, organizations, and communities. These can be individual activities, like planting deep-rooted vegetation or reducing materials that can enter water, to large-scale stormwater management BMPs and restoration efforts. Small efforts and demonstration projects can be tried and scaled up.
- Public sites, like the State Park, are well-suited for demonstration projects and restoration of stream-side and lakeshore vegetation and other important habitats. Some large private landowners, e.g., churches, golf course, may be open to increasing the use of BMPs.
- An innovative approach to reducing nutrients from the watershed is to harvest and compost aquatic plants. This requires additional staffing and location(s) to off-load harvested materials.
- Where possible, communities and organizations should continue to protect and restore important landscape features, such as wetlands, riparian corridors, floodplains, and streams. The mapping in the chapter of important natural features and the riparian buffer quality could help identify target sites for acquisition or restoration. The Summit County Environmental Viewer is a good online tool for viewing environmental data on an aerial photo base. It also has topography and an elevation profile tool.
- Watershed streams should be monitored, to determine substances are entering the lakes.
- Altering wetlands, streams, and floodplains is regulated by federal, state, and county laws, many of which require undisturbed buffers around resources. Summit County has adopted riparian setbacks. In many cases, parcels either pre-date the regulations or are not covered by them, and streambanks lack vegetated buffers. Landowners should be encouraged to plant deep-rooted plants along streams.
- There are many land use regulations that can encourage practices that protect water quality, such as buffer guidelines and ordinances concerning roof drains. These regulations should be reviewed to encourage "green" practices that reduce runoff and increase vegetated buffers.
- The City of Green has developed NPS-IS documents for certain streams in the Portage Lakes watersheds. These documents, which are required for certain external funding, can be amended to address additional streams in each watershed.
- Many of these efforts rely on and can encourage public stewardship and partnerships. Events like creek clean-ups and planting events (trees or other native species) would build public involvement and understanding, and would improve conditions in the streams feeding the lakes.

---

[1] Woods, A.J., J.M. Omernik, C.S. Brockman, T.D. Gerber, W.D. Hosteter, and S.H. Azevedo. 1998. Ecoregions of Indiana and Ohio (2-sided color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, VA. Scale 1:500,000. Retrieved June 18, 2020, from: https://www.epa.gov/eco-research/ecoregion-download-files-state-region-5#pane-33 . This chapter also includes many aerial images of watershed features, from: Summit County, Ohio, 2021. Environmental Viewer 2.1 https://summitmaps.summitoh.net/EnvironmentalViewer2.0/ and Parcel Viewer https://summitmaps.summitoh.net/ParcelViewer2.0/ GIS applications. Retrieved June, 2020 and March, 2021.

[2] Clean Water Act, enacted as the Federal Water Pollution Control Act of 1972, amended 2018. U.S. EPA, Laws and Regulations, Summary of the Clean Water Act. https://www.epa.gov/laws-regulations/summary-clean-water-act Accessed June, 2020.

[3] Modified after Ohio EPA, 2006, as amended. Rainwater and Development Manual, Appendix 7, Planning for Streams. https://epa.ohio.gov/Portals/35/storm/technical_assistance/6-24-09RLDApp7.pdf Accessed 2015.

https://ohiodnr.gov/wps/portal/gov/odnr/discover-and-learn/safety-conservation/about-ODNR/water-resources/water-inventory-planning/stream-management-guides

[4]Fig. 6.2 - Modified from: USDA Forest Service, 2004. Riparian Restoration, p. 4. Accessed June, 2020 from: http://www.remarkableriparian.org/pdfs/pubs/TR_1737-22.pdf

[5] Ohio EPA, 2020. Water Quality Standards, Beneficial Uses. Ohio EPA, Columbus, OH. Accessed June, 2020 from https://epa.ohio.gov/dsw/wqs/index#123033406-beneficial-use-designations

[6] Ohio EPA, 2009. Total Maximum Daily Loads for the Tuscarawas River Watershed, Final Report. Ohio EPA, Columbus, OH. https://www.epa.state.oh.us/portals/35/tmdl/TuscarawasRiverTMDL_final_jul09_wo_app.pdf accessed June, 2020. Map sources:

Ohio EPA GIS ALU Attainment data sets 2014, 2016, 2018, 2020.
https://data-oepa.opendata.arcgis.com/search?tags=surface%20water, accessed June, 2020;

Base map: Portage County GIS; Stark County GIS; Summit County GIS; USGS National Hydrography Dataset (NHD) https://www.usgs.gov/core-science-systems/ngp/national-hydrography/national-hydrography-dataset?qt-science_support_page_related_con=0#qt-science_support_page_related_con; ESRI base map (DigitalGlobe, GeoEye, Earthstar Geographics, CNES Airbus DS, UDA, UGS, AeroGRID, IGN and the GIS user community)

[7] Multi-Resolution Land Characteristics Consortium (MRCS), National Land Cover Database (NLCD) 2016. Land Cover and Imperviousness 2016 data set. https://www.mrlc.gov/data Retrieved June, 2020.

[8] Ohio EPA, 2006. Methods for Assessing Habitat in Flowing Waters Using the Qualitative Habitat Evaluation Index (QHEI). OHIO EPA Technical Bulletin EAS/2006-06-1. Division of Surface Waters. Groveport, OH. https://www.epa.state.oh.us/portals/35/documents/QHEIManualJune2006.pdf accessed March, 2017;

Ohio EPA Primary Headwater Streams in Ohio. https://www.epa.state.oh.us/dsw/wqs/headwaters/index, Accessed June, 2020.

[9] Northeast Ohio Four County Regional Planning and Development Organization, 1999. Upper Tuscarawas River Watershed Action Plan. Akron, OH. Pp. 73-83.
http://www.nefcoplanning.org/publications/upper%20tusc/upper%20tusc%20full%20report%206-1999.pdf

[10] Ohio Geographically Referenced Information Program (OGRIP), 2012. OSIP II imagery for Summit, Portage, and Stark Counties. http://gis3.oit.ohio.gov/geodatadownload/osip2.aspx Retrieved March, 2017;

OGRIP, 2018. OSIP III imagery tiles for Portage Lakes watershed. http://gis5.oit.ohio.gov/geodatadownload/ obtained June, 2020.

USDA Farm Service Agency, 2017. NAIP imagery August, 2018. M_4008104, M_4008105, M_4008106, M_4008160, M_4008162 series. https://earthexplorer.usgs.gov/ Obtained March, 2017.

[11] Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Gridded Soil Survey Geo for Summit, Stark, and Portage Counties, OH. Available online at https://websoilsurvey.nrcs.usda.gov/. Retrieved Jan., 2017;

MRCS NLCD 2016 op. cit.; Summit County GIS 2000 wetland mapping data set;

Ohio DNR Natural Heritage Database: https://ohiodnr.gov/wps/portal/gov/odnr/business-and-industry/services-to-business-industry/environmental-review-lab-services/environmental-review-and-lab-services. Obtained Mar., 2017.

[12] Summit County OH. 2007. Riparian Setback Ordinance. Accessed from https://sswcd.summitoh.net/sites/default/files/2018-11/CHAPTER%20937.pdf Mar., 2021.;

Ohio EPA 2021. Water Quality Certification and Isolated Wetland Permits. https://www.epa.ohio.gov/dsw/401/permitting Accessed Mar., 2021.

[13] Image sources: OSIP 2017, op. cit.; USDA NRCS SSURGO soils;

Federal Emergency Management Agency, 2020. National Flood Hazard Layer https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cdViewer

Summit County GIS, Summit County, OH 2021. Environmental Viewer 2.1. – The Environmental Viewer has many environmental feature layers that can be viewed, and an elevation profile tool. https://summitmaps.summitoh.net/EnvironmentalViewer2.0/ Accessed Mar., 2021.

Ohio DNR 2005. Ohio Floodplain Management Handbook, A Resource for Local Floodplain Officials to Administer Flood Damage Reduction Regulations, 2005 revisions. ODNR Division of Water, Columbus, OH. https://ohiodnr.gov/wps/portal/gov/odnr/business-and-industry/municipalities-and-public-entities/floodplains/floodplain-management-handbook. Accessed Mar., 2021.

[14] NEFCO 2020 Clean Water Plan Update Appendix 3. Available at: http://www.nefcoplanning.org/CWP.html;

Akron Metropolitan Area Transportation Study (AMATS), 2013. Parks dataset. Obtained 2013.

Portage County GIS, op. cit. parcels data set, obtained May, 2020.

Stark County GIS, op cit. parcels data set. Obtained May, 2020 Summit County Department of Sanitary Sewer Services GIS dataset of service areas, obtained May, 2020.

Summit County GIS, op cit. parcels data set. Obtained April, 2020.

Western Reserve Land Conservancy (WRLC) 2013. Parks and Protected Land dataset. Obtained 2013.

NRCS 2017, SSURGO soils database. Op. cit.

[15] Ohio EPA 2020. Recreation standards, Section F. Integrated Water Report. https://epa.ohio.gov/Portals/35/tmdl/2020intreport/2020_SectionF.pdf accessed July, 2020.

[16] Ohio EPA, 2009. op. cit.

[17] US Environmental Protection Agency (EPA), 2018. Spreadsheet Tool for Estimating Pollutant Loads (STEPL) version 4.4. Polluted Runoff: Non-Point Source Pollution. https://www.epa.gov/nps/spreadsheet-tool-estimating-pollutant-loads-stepl. Retrieved June, 2020.

[18] Ohio EPA 2021. OAC Chapter 3745-1, Water Quality Standards. Most recent version available at https://www.epa.ohio.gov/dsw/rules/3745_1. Accessed Mar, 2021.

[19] AMATS, 2013. op. cit. Parks and Trails data sets.; Portage County GIS, op. cit.; Stark County GIS, op. cit.

Summit County GIS, op. cit.; WRLC, 2013. Op. cit.

[20] Summit County, OH. 2007. Op. cit.

[21] Ohio DNR, n.d. Stream Management Guides. Division of Water. Columbus, OH. https://ohiodnr.gov/wps/portal/gov/odnr/discover-and-learn/safety-conservation/about-ODNR/water-resources/water-inventory-planning/stream-management-guides Accessed Mar., 2021. Ohio's H2Ohio program focuses on water quality, phosphorus reduction, and wetlands. http://h2.ohio.gov/natural-resources/