Tinkers Creek Watershed Plan

Tinkers Creek Watershed Land Conservation Priority Plan

Tinkers Creek
Land Conservancy

Acknowledgements

Prepared for:

Tinkers Creek Land Conservancy

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More information on the Tinkers Creek Land Conservancy and information on this report can be found on our website:
www.tinkerscreek.org

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"As communities need to address haphazard development, they also need to address haphazard conservation - conservation activities that are reactive, site-specific, narrowly focused, and not well integrated with other efforts"

from Green Infrastructure: A strategic approach to Land Conservation. American Planning Association

Tinkers Creek Land Conservancy

The **Tinkers Creek Land Conservancy** was established in 1995 as a non-profit, 501(c)(3) organization dedicated to preserving natural areas and open spaces. The Tinkers Creek Land Conservancy (TCLC) promotes natural diversity, water quality, scenic beauty and cultural heritage in the Tinkers Creek watershed, and is a member of the Ohio Watershed Council. At the present time, the Tinkers Creek Land Conservancy is the only exclusive direct advocate for land conservation and for the ecological health and welfare of the entire watershed. The TCLC works with land owners and municipalities to preserve valued resources such as forests, wetlands, riparian buffers, open space and farmland. The preservation of land is accomplished by holding or maintaining land "in trust" in a protected state. Currently, the conservancy protects approximately 300 acres of forest and high quality wetlands in seven (7) preserves within the Tinkers Creek Watershed.

Tinkers Creek Watershed Stakeholders:

Tinkers Creek Land Conservancy
Northeast Ohio Area Coordinating Agency (NOACA)
Northeast Ohio Four County Regional Planning and Development Organization (NEFCO)
Cleveland Metroparks
Geauga Park District
Portage County Park District
Metroparks Serving Summit County
Cuyahoga Soil and Water Conservation District
Geauga Soil and Water Conservation District
Portage Soil and Water Conservation District
Summit Soil and Water Conservation District
Ohio Department of Natural Resources
Army Corps of Engineers, Buffulo District
Ohio EPA, Division of Surface Water
National Park Service – Cuyahoga Valley National Park
Cuyahoga County
Geauga County
Summit County
Portage County
Cuyahoga River RAP
Pond Brook Watershed Initiative
Beachwood
Bedford
Bedford Heights
Glenwillow
Highland Hills
Maple Heights
North Randall
Oakwood Village
Orange
Solon
Valley View
Walton Hills
Bainbridge Township
Aurora
Franklin Township
Streetsboro
Hudson Village
Macedonia
Northfield
Sugar Bush Knolls
Reminderville
Twinsburg
Twinsburg Township

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Tinkers Creek Watershed Land Conservation Priority Plan

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Goals & Need for Planning

Why do we need a watershed priority plan?

The Tinkers Creek watershed has experienced a high rate of population growth and development expansion. This trend has become particularly apparent in the last twenty years, largely due to the outward migration of people from the traditional urban population centers in the region. One result of this development and growth has been the destruction and degradation of natural areas within the watershed, as land is developed with little regard to the long-term consequences and detrimental impacts that are taking place. Degradation of the watershed and water resources is generally not the result of any single activity taking place on or near water bodies. Instead it is more often related to the cumulative result of many individual activities and impacts throughout an entire natural drainage area, or watershed. *(Source: Coastal America)*

A major complicating factor and a challenge in addressing the issues and problems facing Tinkers Creek is that due to its size, the watershed itself spreads across the boundaries of numerous political and regulatory agencies. Included among these are four counties (Cuyahoga, Summit, Geauga and Portage), four soil and water conservation agencies, two major planning organizations (NOACA and NEFCO), several state and federal agency districts to include the Cleveland Metroparks, Metroparks Serving Summit County, Cuyahoga County Planning Commission, Ohio EPA and National Park Service, and 24 municipalities, including the cities of Bedford, Bedford Heights, Solon, Twinsburg, and Streetsboro, and the villages of Glenwillow, Valley View and Walton Hills. A complete listing of these entities can be found in the appendices.

The spread-out nature of the watershed is a particular problem as there is no single cognizant agency (except for the Cuyahoga RAP which is responsible for the entire Cuyahoga River Watershed) that is responsible for the health of the entire Tinkers Creek watershed, as it is not wholly located within one jurisdiction. There is currently no unified effort in identifying, understanding and dealing with problems in the watershed. Issues such as water pollution, increased soil erosion and flooding may occur as a result of the cumulative changes occurring in the whole watershed, but their impacts might mainly be concentrated in a few jurisdictions. A comprehensive strategy and watershed protection plan is therefore needed in order to address many of these current issues.

The need to develop a comprehensive plan includes the following watershed issues:

- *The water quality of tinkers Creek is not in compliance with current Ohio Environmental Protection Agency (OEPA) standards. Many portions of the waterway are either in non-attainment, or only in partial attainment.*
- *The watershed is spread across the boundaries of two major planning organizations, four counties, four soil and water conservation agencies, 24 municipalities, and several state and federal agency districts. The Cuyahoga River Remedial Action Plan (RAP) does include the Tinkers Creek subwatershed, but is also responsible for the entire lower portion of the Cuyahoga River Watershed.*
- *Given historic growth patterns, the watershed contains several areas that are threatened by future urban sprawl (Streetsboro, Twinsburg, Reminderville, Aurora and Solon).*
- *The TCLC currently does not have a process or plan in place to identify key areas to prioritize for preservation.*

A master plan is critical in securing funding for future preservation efforts within the Tinker's Creek Watershed. Grants and other sources of funding may be available to support a variety of activities related to preservation efforts in the watershed. This may also include funding to expand the amount of land held in trust by the TCLC. For this reason, a comprehensive master plan is necessary in order to be able to pursue and secure the type of funding and assistance that is necessary to protect land resources within the Tinkers Creek Watershed.

Overall Goals of Project/Study

The goal of this study is to initiate a comprehensive conservation plan in order to preserve the quality of the Tinkers Creek Watershed through the protection of ecological resources. The plan will analyze the watershed in order to identify the areas of highest value to target for future protection and conservation efforts, in order to protect the overall quality of the watershed. This plan is intended to function as a long-term guide and action plan to assist the Tinkers Creek Land Conservancy and other watershed stakeholders in making future decisions that will best protect the natural features and ecosystems of the watershed. On a broad basis, this plan can help to help to facilitate a watershed-wide approach to conservation and protection, and assist stakeholders in prioritizing their decisions in a way that best commits to a strategy of implementing sustainable goals and management practices. As such, one purpose of this plan is to provide a document that can be used as a stewardship tool for the various watershed stakeholders. This will allow the various stakeholders to make informed decisions in order to protect the most sensitive, vulnerable, and valued ecological resources of the watershed before they are negatively impacted or destroyed. The six main objectives of this study are:

1. ***Land Conservation** – Identify important areas that need to be protected to ensure a sustainable watershed and preserve critical natural resources and ecosystems within the watershed.*
2. ***Watershed Awareness** – Encourage and facilitate responsible growth practices through public, municipal, and stakeholder education, outreach and advocacy.*
3. ***Regional Policy, Planning & Regulation** – Promote the development of planning goals and regulations to collectively facilitate sustainable watershed management goals.*
4. ***Protection of Aquatic and Terrestrial Habitat** – Manage natural habitat to promote biodiversity and to maintain, protect, and enhance natural systems.*
5. ***Water Quality and Quantity** – Maintain and improve water quality throughout the watershed and ensure that an adequate quantity of surface water and groundwater is maintained.*
6. ***Historic, Cultural, and Natural Resource Protection** – Ensure that the historic resources of the Tinker's Creek watershed are preserved and interpreted as educational examples of the area's heritage.*

Recommendation to Tinkers Creek Land Conservancy

As a result of the information gathered in the comprehensive study as well as the rapid pace of ongoing land development within the Tinkers Creek Watershed and its surrounding region, it is recommended that the Tinkers Creek Land Conservancy examine ways to better preserve the dwindling supply of vacant or undeveloped land as well as the quantity and quality of it water resources left in the watershed. In so doing this examination, the Tinkers Creek Land Conservancy should consider ways to expand its influence in protecting these important natural resources by working with other stake holders within the watershed including all of the twenty-four government entities as well as the Summit County Metroparks and the Cleveland Metroparks. As a part of this recommendation the Tinkers Creek Land Conservancy should examine the establishment of a Tinkers Creek Watershed Council that work with the twenty-four government agencies in the watershed to improve quality and management of watershed quality including ground and surface water in the watershed. Such a council has already greatly benefited the Chagrin River in Geauga, Lake, and Portage Counties and is now being established for Mill Creek in Cuyahoga County and Yellow Creek in Summit County. It is an opportune time to this for several reasons:

1. The EPA Tinkers Creek stressor study is now being conducted to identify factors keeping Tinkers Creek from meeting water quality standards.

2. Communities are more aware of water problems due to the Phase II requirements and therefore may be more accepting of working together on a watershed council.

3. This study provides information regarding the amount of hard surfaces in the communities of the watershed and makes it clear what effect this has on causing surface runoff and water quality problems.

Given consideration of all of the above factors, This report recommends that the Tinkers Creek Land Conservancy work with the Cuyahoga County Board of Health and other groups to begin the process of establishing this Watershed Council by hiring a Watershed Coordinator for Tinkers Creek.

Responses to Watershed Quality

The overall health and quality of the watershed ties into environmental factors that impact natural systems and processes far beyond the boundaries of the watershed system itself. These are often referred to as "responses to watershed quality". Some of these interrelated impacts include the following:

Protect water quality – The development of land in a watershed may impact stream quality by contributing an increase in non-point source pollution into water bodies. This occurs as pollutants that are deposited on impervious surfaces such as road surfaces (i.e. – oil, antifreeze, etc.), are washed away during precipitation events, and enter a stream channel as part of the precipitation runoff. Water quality degradation can also occur through a mechanism/process known as eutrophication that is tied to urban development. Eutrophication is the result of excess nutrients in a water body that results in excessive plant growth such as algae and weeds. This enhanced plant growth reduces the amount of oxygen dissolved in the water as the plants decompose, impacting aquatic habitat and organisms in the foodchain. Common sources of nutrients include fertilizers applied to suburban lawns, golf courses and agricultural areas; erosion of soil into a watercourse; and the discharge from sewage treatment plants. *(Source: UNEP Report)*

An even more important aspect to consider in relation to protecting water quality is the negative effects that it has on our sources of drinking water. The turbidity of water may increase due to poor land management practices. This can impact human health, and creates additional expenses for local governments in treating the raw water supply in order to bring it up to safe and acceptable standards for human consumption. A study by the Trust for Public Land in 2002, showed a direct link between forest cover in a water source area, and water treatment costs. Protecting the sources and quality of our drinking water supplies should be seen as a cost-effective long-term strategy for local governments to reduce the costs associated with treatment and contamination. *(Source: Trust for Public Land)*

Reduce flooding - As development expands, small stream tributaries are often covered over with infrastructure,and replaced by a system of roads and culverts, while the natural floodplain of a river or creek may be simultaneously filled in or otherwise developed. During precipitation events, the remaining streams suffer an increase in volume, velocity and energy, as water is more quickly able to flow into a stream or river through culverts and other devices,than might occur naturally. In addition, if the stream's floodplain has been altered or filled in, its size and capacity may be reduced, limiting its use as a temporary storage reservoir for additional water volume during periods of peak flow. Subsequently, downstream communities may experience more frequent and severe flooding from this increased volume of water runoff that enters a stream channel. *(Source: Marsh & Marsh. 1995)*

Minimize erosion and siltation – Impervious surfaces collect and direct a larger volume of water into the channels they drain into. This additional water flow can result in increased erosion taking place within a stream channel, and along its banks. Activities such as construction and agriculture expose bare soil, allowing it to be easily carried away with precipitation and runoff and be deposited in stream channels and other water bodies. The silt can negatively impact both plant and animal life in a waterbody, impact the water for human consumption, and reduce the aesthetic value of the water resources. Streamflow that eventually reaches large rivers and other water bodies deposits this additional dirt and silt within those water bodies. In order to maintain commerce and navigation by larger ships on large waterways, it becomes necessary to dredge out ship channels in order to keep them deep enough for vessels to pass. The dredging process is costly, and the removed spoils (mud and silt) create additional problems as they may be contaminated with heavy metals and other toxic substances. The U.S. Corps of Engineers annually dredges the ship channels at the mouth of the Cuyahoga River in Cleveland to maintain the necessary depth of 23 feet. The cost of dredging activities is $1.5 - $2 million per year, and 350,000 cubic yards of material is removed for disposal. The soil and other material must be disposed of in a special facility. A new disposal facility will be needed in about four (4) years, and is expected to cost approximately $75 million. These costs are eventually passed along to taxpayers. *(Source: Cuyahoga River RAP)*

Reduce runoff and maximize the recharge of streams – Conserving and protecting land resources in the watershed can reduce the amount of impervious cover, and maintain forests and other vegetation that decreases the volume and speed of runoff. This allows for precipitation to soak into natural surfaces and become part of groundwater. During months when precipitation is low, streams can receive much of their volume from groundwater entering through the banks and stream bed. This is known as "recharge". Recharge rates vary along the course of a stream, with some segments receiving very little, while significant amounts of water entering other portions of a stream may be from recharge. However, as a general rule a high percentage of the water flow in a river or stream during dry periods originates from recharge. For Tinkers Creek, the amount of dry season flow that stems from treated effluent or wastewater can be considerable. The EPA estimates that on average, approximately 50% of the water flowing in Tinkers Creek during the summer months comes from effluent. Preserving natural cover in the watershed can help to increase recharge, keeping a stream in better health during periods of low precipitation. *(Source: Ohio EPA)*

Protect terrestrial and aquatic habitats – Preserving natural cover and open space provides protection for critical habitat, allowing both animals and plant species to co-exist in a more natural state. Healthy ecosystems are thought to be a factor in keeping natural systems in balance, and in helping to avoid the negative consequences that occur when some organisms become too numerous or out of check within a system. Sometimes called a "domino effect", this is thought to contribute to problems such as an overpopulation of deer in some areas, or the occurrence of West Nile Virus, as a result of natural predators being absent within a system due to habitat and range loss. Finally, preserving natural spaces often makes an area more attractive in terms of aesthetics, which has a positive impact upon nearby property values.

Mitigate air pollution – Scientific studies have shown that the positive impacts of preserving vegetation can be realized on air quality, through a natural process known as carbon sequestration. Carbon sequestration is the process whereby vegetation stores carbon dioxide (CO_2), and thus prevents it from entering the atmosphere. Vegetation can have a positive impact upon reducing air pollution by helping to remove harmful components such as Nitrous oxide (NOX) and sulfur dioxide (SOX) from the atmosphere. Vegetation may also help to facilitate the removal of fine particulate matter from the air, which results from all types of combustion including vehicle sources, agricultural burning, industrial processes, and power plants. Larger tracts of woodlands and forested areas may provide additional removal capacity to assist in mitigating air pollution issues at the local level.

Support responsible and sustainable growth – A pattern of growth that takes into account the conservation and preservation of open space is considered more sustainable than many current development patterns. Current patterns of development are often referred to as sprawl or urban sprawl, a term denoting a pattern of growth is characterized by significant land consumption, low population densities, automobile dependence, and limited and fragmented open space. This pattern of development usually does not take into account natural features, and does little to preserve open space, or preserves it only in a very haphazard and fragmented manner. The fragmentation of open space negatively impacts wildlife as there may not be enough land to establish the proper territory needed to sustain some species. This spread out pattern also creates additional impervious cover which can contribute to an increase in water pollution and runoff from these surfaces, and more frequent flooding downstream. For these reasons, growth patterns that are characterized by more compact patterns of development, with protected open space are considered more sustainable.

For the various stakeholders in a watershed, municipalities, agencies and citizens, it is important to keep in mind that a comprehensive strategy aimed at preserving the overall health of the watershed can be directly linked to numerous economic considerations and impacts. This should be of particular concern to cities that may be under government mandate to address these issues. Issues such as stormwater pollution and runoff must be addressed by many municipalities. Proper planning and the positive impacts of land preservation may be one tool to deal with these issues in a cost effective manner.

Problems and the damage associated with flooding are issues that cities, agencies and individual property owners must deal with. The natural volume of streamflow increases with distance from source areas, as a larger drainage area contributes water to a stream. This additional volume of water requires communities to install larger infrastructure downstream in order to deal with the increased volume. Repairing the damage caused by flood events, and cleaning up after these events can be very costly. Reducing the frequency and intensity of flooding makes economic sense.

Introduction

Watersheds & Subwatersheds

This plan relates to the Tinkers Creek watershed. The Tinkers Creek watershed is a sub-basin of the Cuyahoga River, a major tributary to Lake Erie in northeastern Ohio. The watershed encompasses an area of approximately 100 square miles, and includes portions of four counties (Summit, Portage, Geauga and Cuyahoga).

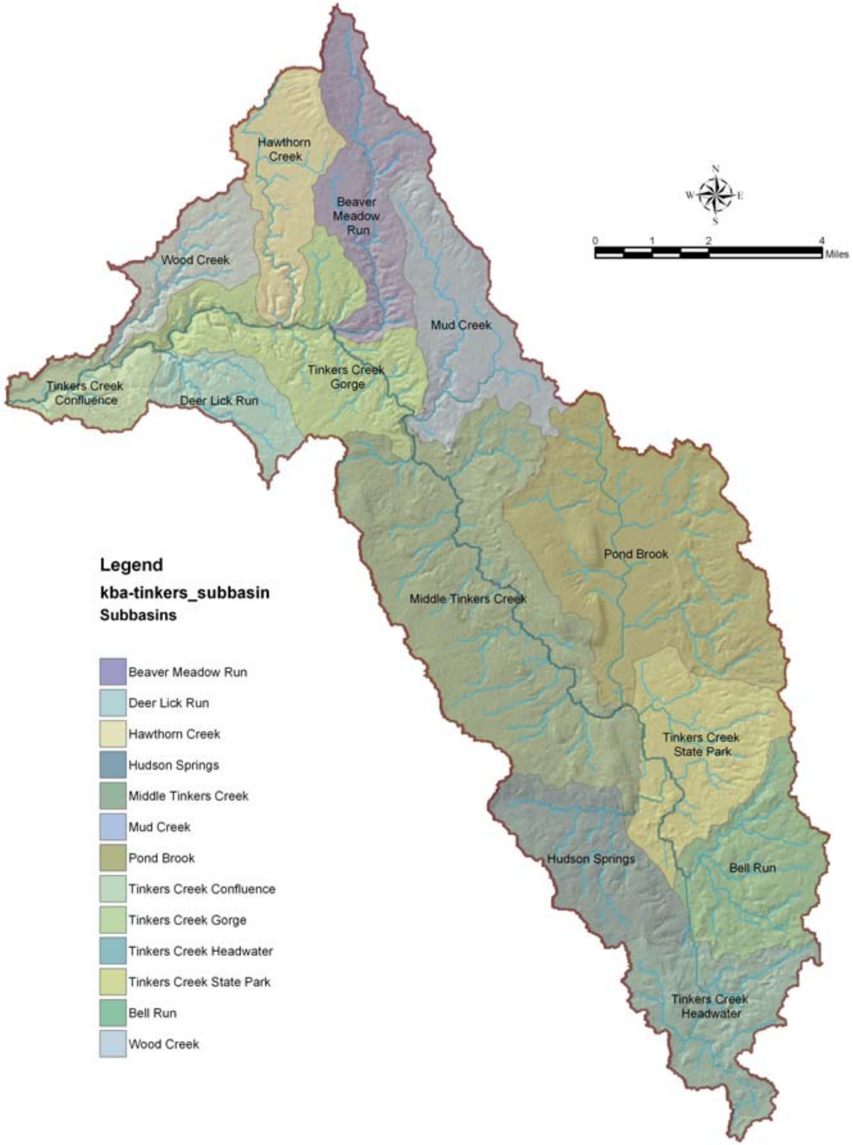
In simple terms, a watershed is an area of land within a drainage divide from which precipitation (rain and snowmelt) drains via gravity to a body of water. This body of water could be a lake, stream or river. The flow is however not restricted to surface water flow, and can include interaction with subsurface water. In urban watershed management, a watershed is seen as all the land which contributes runoff to a particular water body; all the land that serves as a drainage for a specific stream or river. A visual analogy might be to think of a maple leaf. The stalk of the leaf would represent the river. The veins threading into the stalk are tributaries that flow into that river. The complete leaf represents the river's drainage system, or watershed. (Adapted from information on TCLC website)

A subwatershed is defined as a subdivision of a watershed based on hydrology, generally corresponding to the area drained by a small tributary, as opposed to a major river.

The Tinkers Creek watershed can be divided into a number of subwatersheds as defined by the topography within the area of the entire watershed. Within the Tinkers Creek watershed, there are thirteen (13) distinct sub-watersheds that can be identified. The subwatersheds are: Beaver Meadow Run; Bell Run; Deer Lick Run; Hawthorn Creek; Hudson Springs; Middle Tinkers Creek; Mud Creek; Pond Brook; Tinkers Creek Confluence; Tinkers Creek Gorge; Tinkers Creek Headwater; Tinkers Creek State Park, and, Wood Creek. These subwatersheds vary greatly in size. The largest is Middle Tinkers Creek (19.47 square miles), and the smallest is the Tinkers Creek Confluence (2.85 square miles).

The thirteen identified subwatersheds will be used in the analysis and recommendations presented within this plan. Analyzing and considering the watershed at a smaller subwatershed scale allows for more detailed analysis and identification of land parcels to target for conservation and preservation activities.

Cuyahoga River Watershed



Political Boundaries

Tinkers Creek Watershed Land Conservation Priority Plan

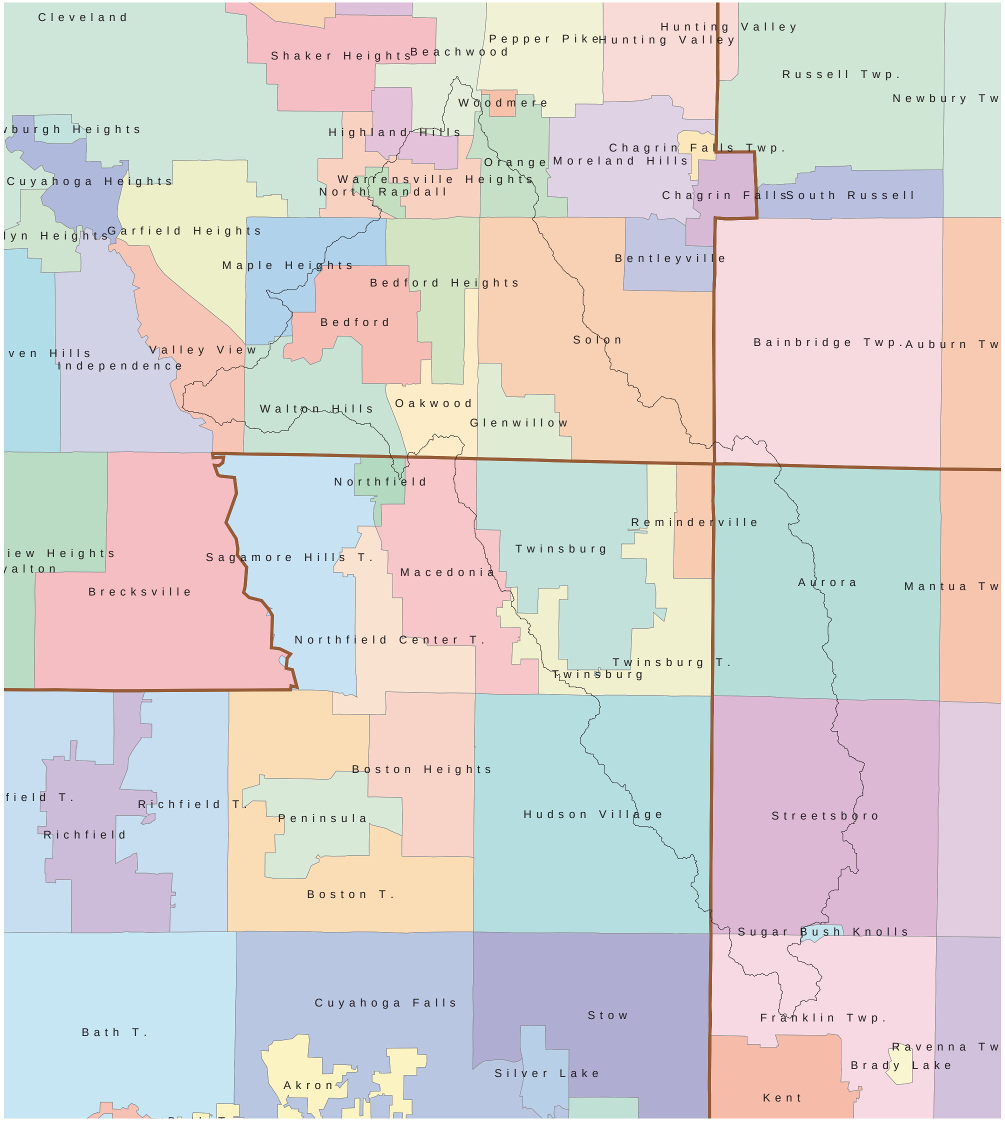
Communities within the Tinkers Creek Watershed

Cuyahoga County
Beachwood
Bedford
Bedford Heights
Glenwillow
Highland Hills
Maple Heights
North Randall
Oakwood Village
Orange
Solon
Valley View
Walton Hills
Warrensville Heights

Geauga County
Bainbridge Township

Portage County
Aurora
Franklin Township
Streetsboro
Sugar Bush Knolls

Summit County
Hudson Village
Macedonia
Northfield
Reminderville
Twinsburg
Twinsburg Township



Political Subdivision Table

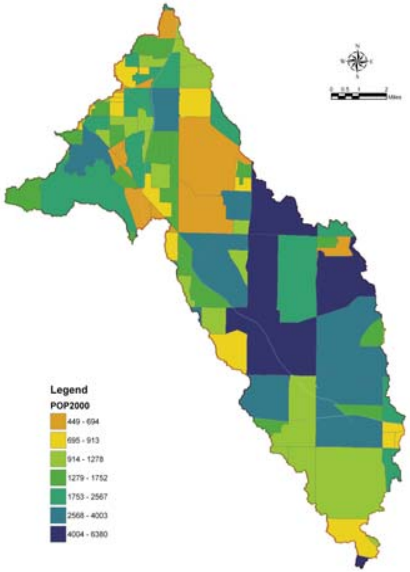
County	Political Subdivision	Size (acres)	% of Political Area of watershed	US Census Population Data 2003	2000	1990	Total Political Area (acres)	% of political subdivision in the watershed (%)	Population Density (#/sq mi)	Projected Population (by density)	% of Total Watershed Population	Stream (4-7) Length Miles
Tinkers Creek		**62,681**	**100%**							**109,389**	**100%**	**199.65**
CUYAHOGA COUNTY		**26,129**								**63,341**	**57.9%**	
CUY	Beachwood	490	0.78%	11,906	12,186	10,677	3,362	14.57%	575	440	0.40%	1.06
CUY	Bedford	3,402	5.43%	13,790	14,214	14,822	3,402	100.00%	2,674	14,214	12.99%	12.86
CUY	Bedford Hgts	2,901	4.63%	11,189	11,375	12,131	2,901	100.00%	2,509	11,375	10.40%	10.84
CUY	Glenwillow	1,830	2.92%	491	449	455	1,830	100.00%	206	590	0.54%	8.87
CUY	Highland Hgts.	504	0.80%	8,512	8,082	6,249	1,267	39.78%	856	674	0.62%	0.49
CUY	Maple Heights	916	1.46%	25,490	26,156	27,089	3,319	27.60%	4,905	7,020	6.42%	1.94
CUY	North Randall	372	0.59%	886	906	977	500	74.40%	1,335	776	0.71%	2.03
CUY	Oakwood Village	1,976	3.15%	3,643	3,667	3,392	2,216	89.17%	1,086	3,353	3.07%	5.18
CUY	Orange	993	1.58%	3,366	3,236	2,810	2,431	40.85%	781	1,212	1.11%	2.93
CUY	Solon	7,688	12.27%	22,248	21,802	18,548	13,080	58.78%	1,056	12,690	11.60%	21.32
CUY	Valley View	741	1.18%	2,157	2,179	2,137	3,604	20.56%	550	637	0.58%	2.79
CUY	Walton Hills	2,893	4.62%	2,391	2,400	2,371	4,418	65.48%	369	1,669	1.53%	10.39
CUY	Warrensville Heights	1,423	2.27%	14,719	15,109	15,745	2,639	53.92%	3,909	8,691	7.95%	4.20
GEAUGA COUNTY		**369**								**196**	**0.18%**	
GEA	Bainbridge Twp	369	0.59%	1,022	1,012	968	16,522	2.23%	340	196	0.18%	0.43
PORTAGE COUNTY		**17,036**								**15,408**	**14.1%**	
PORT	Aurora	6,765	10.79%	14,270	13,556	9,192	15,428	43.85%	652	6,889	6.30%	18.51
PORT	Franklin Township	1,146	1.83%				9,274	12.36%	303	543	0.50%	3.65
PORT	Streetsboro	9,122	14.55%	13,822	12,311	9,932	15,591	58.51%	560	7,976	7.29%	35.12
PORT	Sugar Bush Knolls	3	0.00%	226	227	211	155	1.94%	-	0	0.00%	-
SUMMIT COUNTY		**19,147**								**30,444**	**27.8%**	
SUM	Hudson Village	4,665	7.44%	23,053	22,439	17,108	16,534	28.21%	1,020	7,433	6.80%	10.96
SUM	Macedonia	576	0.92%	10,087	9,224	7,509	6,200	9.29%	1,288	1,159	1.06%	0.27
SUM	Northfield	58	0.09%	3,771	3,827	3,624	689	8.42%	3,719	337	0.31%	-
SUM	Reminderville	1,289	2.06%	2,377	2,347	2,163	1,289	100.00%	600	1,208	1.10%	6.42
SUM	Twinsburg	7,910	12.62%	17,236	17,006	9,606	7,910	100.00%	1,256	15,529	14.20%	25.01
SUM	Twinsburg Township	4,649	7.42%				5,247	88.60%	658	4,778	4.37%	14.38

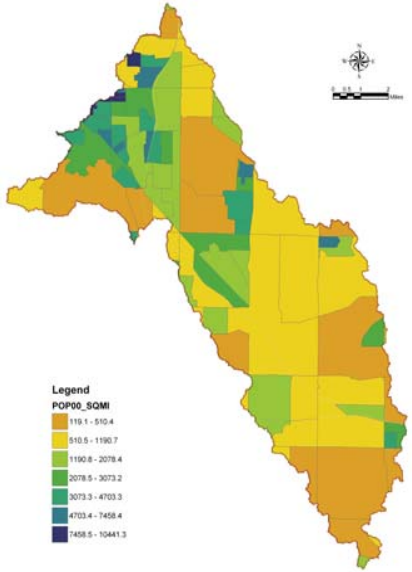
Demographics

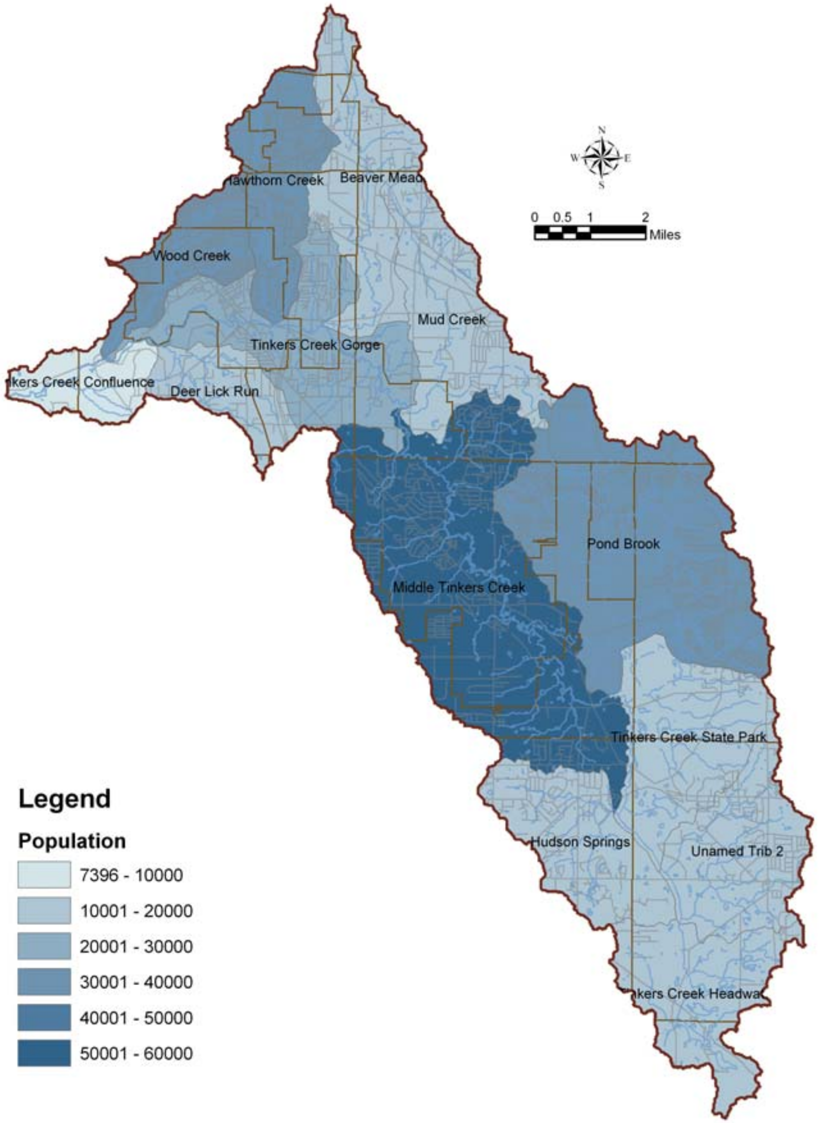
The predicted future patterns of growth in the region show that the trend of migration away from the larger cities is expected to continue. Overall, the total population of northeast Ohio is expected to grow very little over the next 20 years. However, the population base is expected to continue its shift away from the traditional urban population centers in the region. While the region is not adding a significant number of new people, we are still consuming new land. Growth will likely shift toward once rural areas, consuming formerly undeveloped land as the existing population base spreads out in what is often referred to as an "exurban" pattern of development. An exurban pattern is typified by a mix of active farms, low density residential development, new subdivisions, and mobile homes. The areas are located farther from urban population centers, and may appear to be in transition from a rural to more urban setting. Many of the communities within the Tinkers Creek watershed are already experiencing this type of growth. The cities of Streetsboro, Solon and Twinsburg serve as good examples of municipalities that have experienced rapid growth and urbanization in recent years.

Population calculations for the analysis use density were based upon individual blocks from the 2000 U.S. Census. For each municipality, the percentage of the entity that is located within the watershed is used to calculate the projected population for that entity using density. From this, the percentage of the total watershed population that each individual entiity accounts for is calculated, and a value is derived for the percent influence on the total watershed that each municipal entity would represent. This methodology assumes that there is an even population distribution or density across the entire watershed.

The total calculated population of the watershed using this method was 109,389 people. In general, most communities in the watershed showed positive growth since the 1990 U.S. Census, although a few did lose population, or were stagnant. For example, during that time period, Hudson increased from 17,108 to 23,053 people, Twinsburg increased from 9,606 to 17,236 people from while Bedford had a net loss of approximately 1032 people, and the population of Valley View remained relatively unchanged.



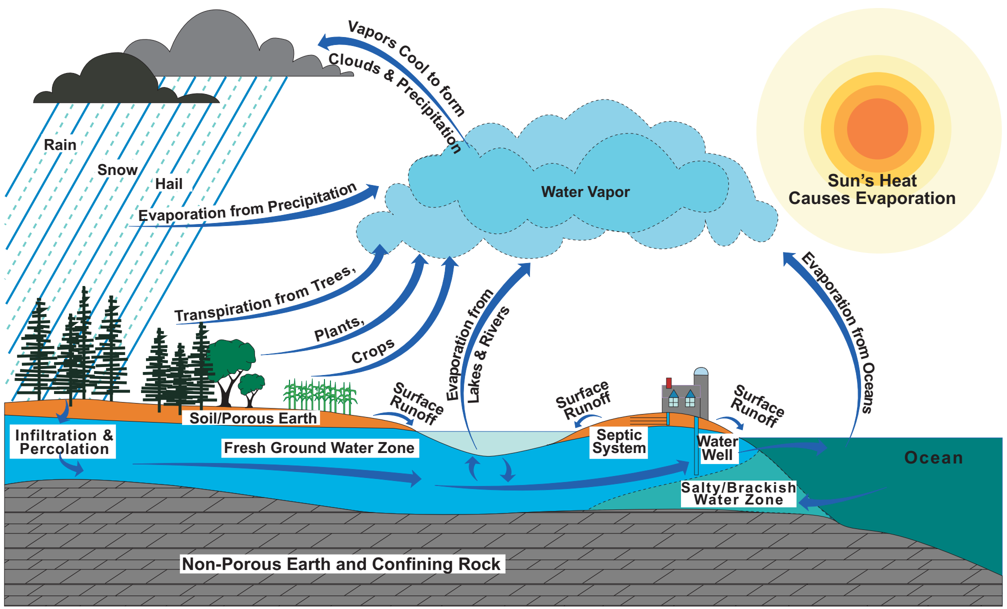




Natural Resources
Inventory

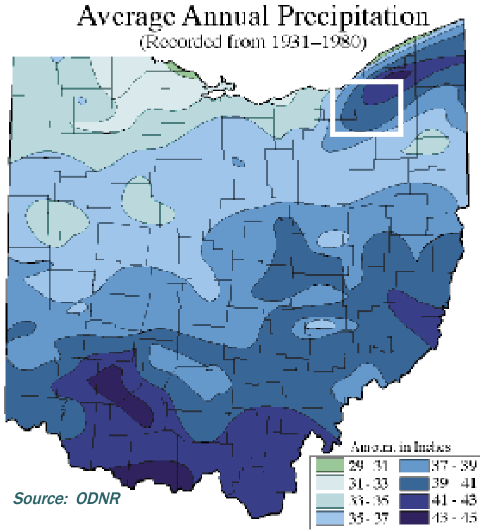
Climate & Precipitation

Northeast Ohio is located in a temperate zone, characterized by a climate with distinct seasons, including cold winters, and warm summers. Temperate climates have precipitation throughout the year. The average winter temperature is 30 degrees Fahrenheit and the average summer temperature is 70 degrees Fahrenheit. The term hydrologic cycle refers to the process of water movement from the atmosphere (precipitation) to the earth and its return to the atmosphere through various processes. As a generalization, total average annual precipitation is approximately 38 to 39 inches per year across the watershed, which includes the liquid equivalent of snowfall based on annual data for the last 30 years. Monthly precipitation varies, with the driest months being January and February, and the wettest period coming during the late spring and summer months, April to September. Within the watershed, precipitation is subject to some variance due to the climatic influence of Lake Erie, particularly as it impacts snowfall in the winter months due to "lake effect snow". Areas closer to the lake and at the higher elevations receive more snow than those further inland. These differences in snowfall amounts will have the greatest impact during the spring, when snowmelt contributes to runoff entering the stream system. This also affects the management of Lake Erie, in terms of water level and other coastal issues.

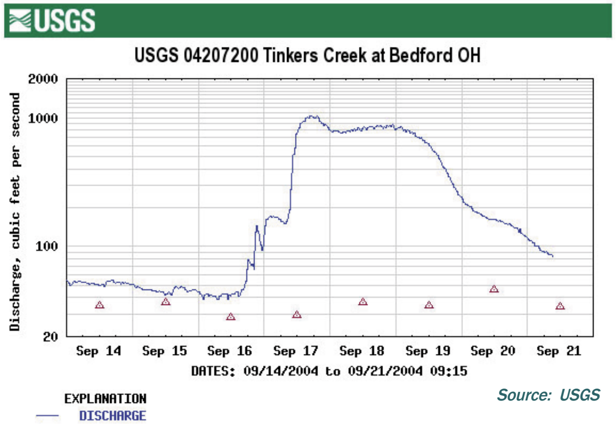


Source: EPA

Hydrologic Cycle



Source: ODNR



Source: USGS

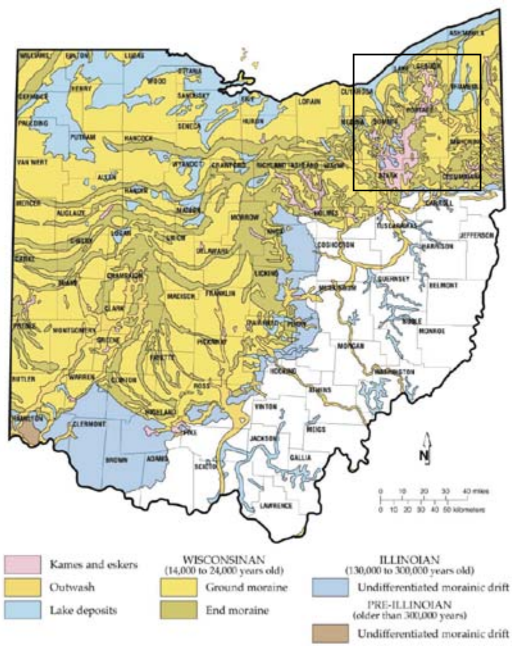
Physiography

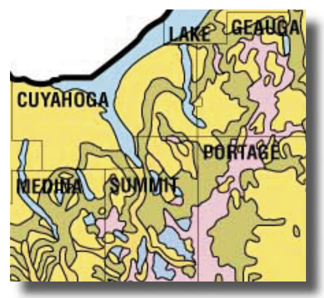
The physiographic features of the watershed are those characteristics related to both the topography and geology of the basin. The topography of the watershed relates to the physical properties and configuration of the land surface, including its relief and the position of natural and man-made features. Geology relates to the physical make-up of the earth's surface in relation to rocks and other inorganic material, and the study of the forms and structures that these materials make up.

Elevations in the watershed vary, with the highest elevation point being 1200 feet above mean sea level, and the lowest elevation point lying at 620 feet above sea level, where Tinkers Creek flows into the Cuyahoga River.

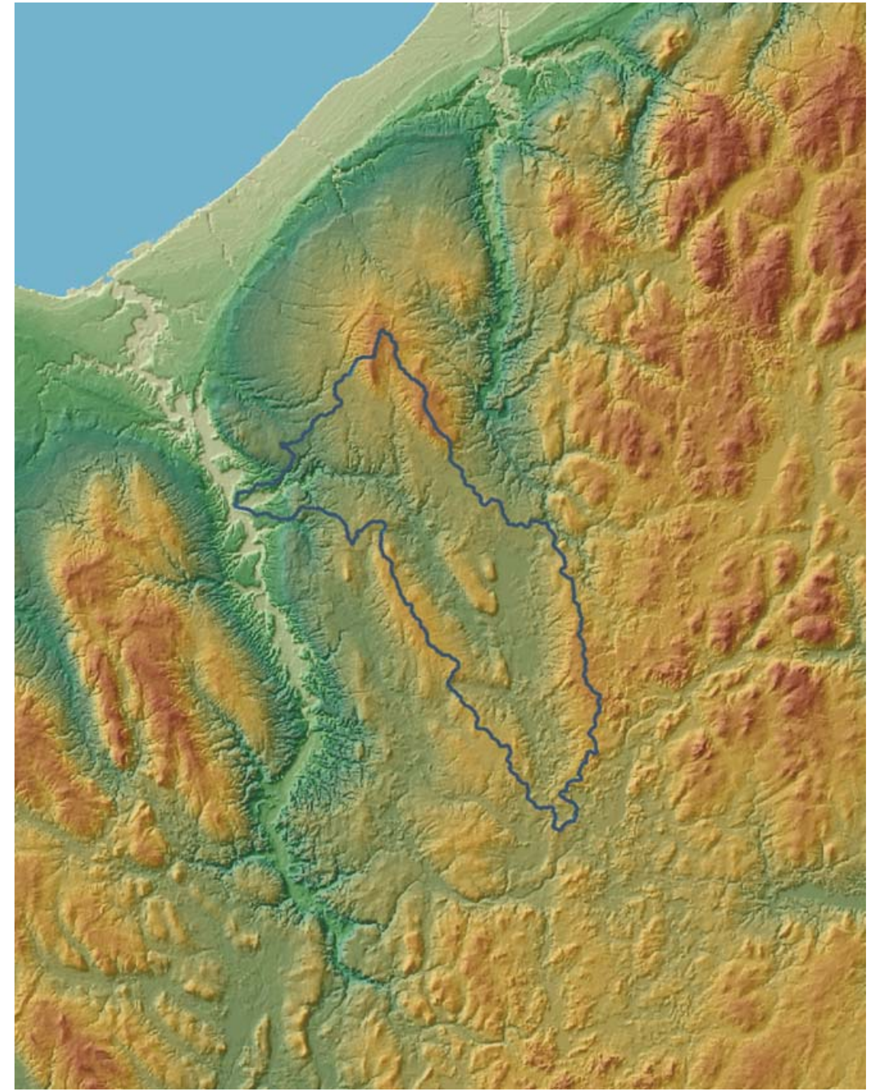
The watershed lies on a glaciated plateau, which consists predominantly of silty loam and clayey loam soils. Portions of the stream are on bedrock, which form waterfalls that act as a natural barrier to the passage of fish. The lower stream portions have carved the Tinkers Creek Gorge, which is listed as a National Natural Landmark within the National Park Service's program. (Source: Ohio EPA, Division of Surface Water)

Geological Regions of Ohio





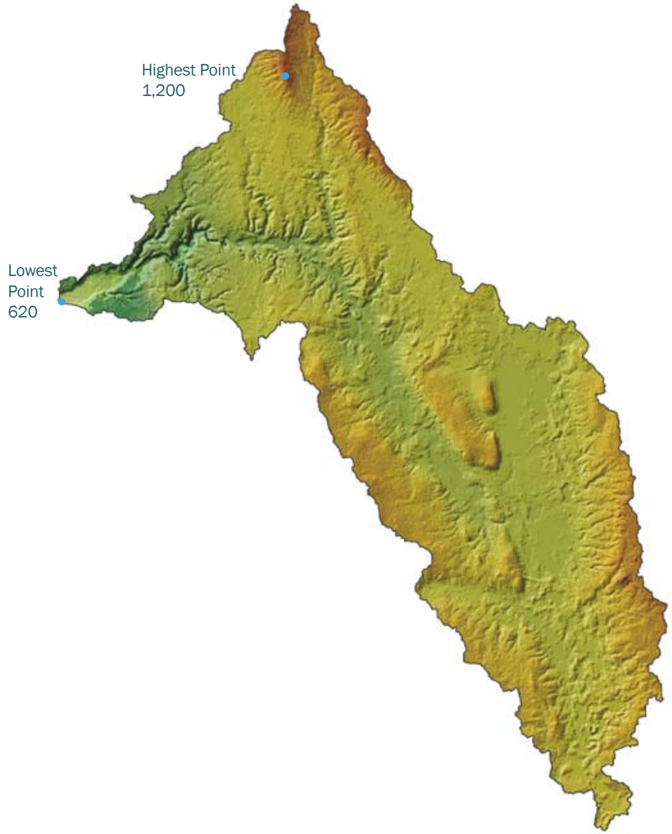
Source: ODNR

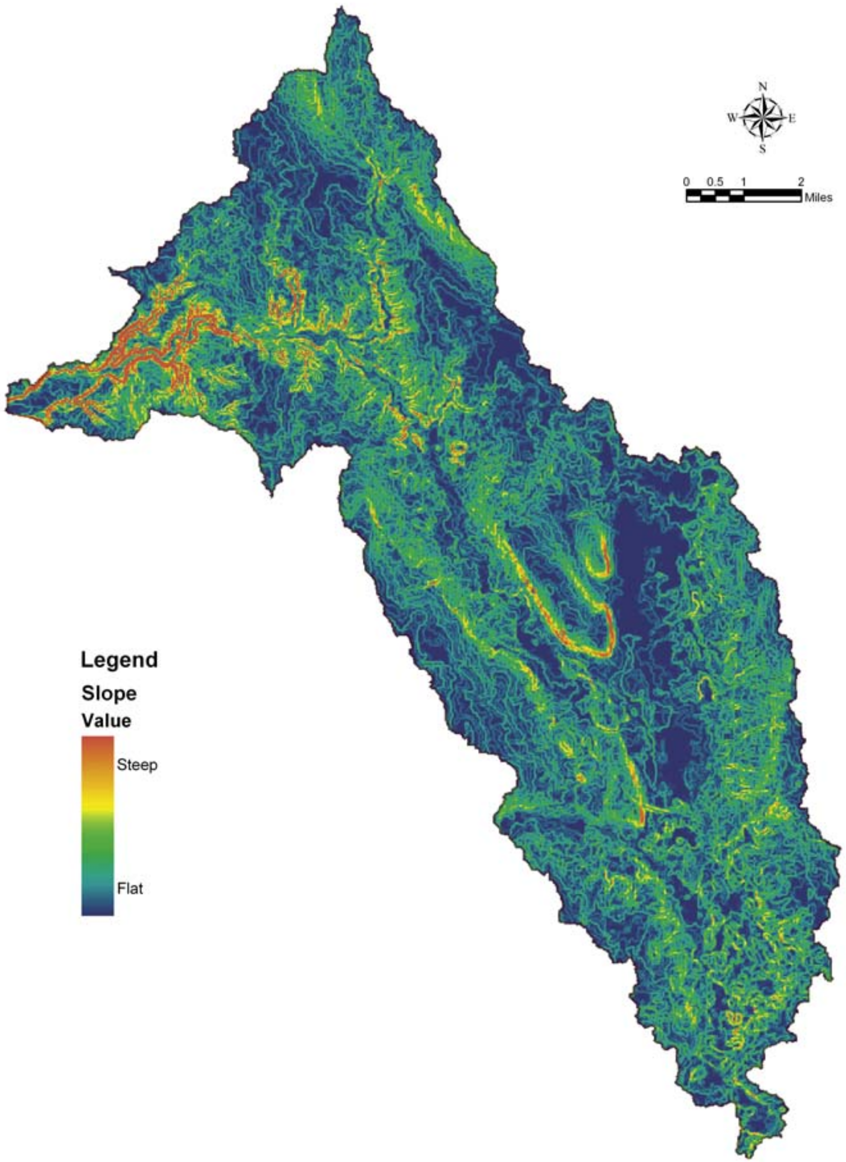


Shaded Relief

Slopes & Topography

Slopes vary greatly within the Tinkers Creek Watershed. They range from steep gorge areas where the river has cut its way down through the bedrock, to gentle slopes, flat areas, marshes and wetlands. Rock outcroppings exist in several areas. The pattern of slopes within the watershed is gentle, with the steepest gradients found along the stream banks, and where Tinkers Creek flows into the Cuyahoga River. Deeply incised and steep slopes define the valleys and gorges nearer the confluence point, partially as result of increased downstream erosion, due to higher water flows Slopes are mapped using a scale that ranges from flat to steep. Steep slopes generally have the highest erosion potential from runoff, or from channel undercutting of the stream banks. For our analysis, we looked at identifying the steepest slope areas that either would contribute to higher erosion potential or offer the most value for sensitive and unique habitats. For example, many portions of the middle Tinkers have steep slopes that create waterfalls and other unique topographic areas.





The composition and characteristics of soils within a watershed are important for their potential impacts on water quality. Soil properties related to this are their ability to store nutrients essential to plant growth, their erosion potential, permeability, that is, the soil's ability to allow precipitation to percolate into the ground and become part of the groundwater system, and for their hydric value.

Erosion Potential - K-factor

Soils within the watershed were classified and analyzed with respect to multiple attributes. One soil attribute that was considered was the K-factor. The K-factor is defined as the soil's erosion potential, that is, how easily soil may be removed and transported away by natural processes such as water and wind. The K-factor is based on the Universal Soil Loss Equation, and represents a relative index of bare, cultivated soil to erosion. The erosion potential of the soil is critical as eroded material or silt can be introduced into a stream as a component of runoff, clouding a stream, negatively impacting natural habitat, and impairing other stream functions. The potential for soil erosion is also a factor in the stream gradient, slopes and amount that a stream may incise its stream bed.

Hydric Soils

Soils defined as hydric are also identified. Hydric soils are those that are typically found in wet or saturated environments, such as the edges of streams and rivers, or in wetlands. They support hydrophytic, or water adapted plant life. This type of vegetation provides shelter and habitat for aquatic organisms, and are part of a healthy riparian system. Riparian systems are described in detail in another s ection.

Soil Class

Soils are also classified as being in one of four (4) groups which are also considered. The soil classes or groups are based upon hydrologic properties. Soils of the same group have similar runoff potential under similar storm and cover conditions. Soils in the United States are placed into four groups, A, B, C, and D, and three dual classes, A/D, B/D, and C/D. In the definitions of the classes, infiltration rate is the rate at which water enters the soil at the surface and is controlled by the surface conditions. Transmission rate is the rate at which water moves in the soil and is controlled by soil properties. Definitions of the classes are as follows:

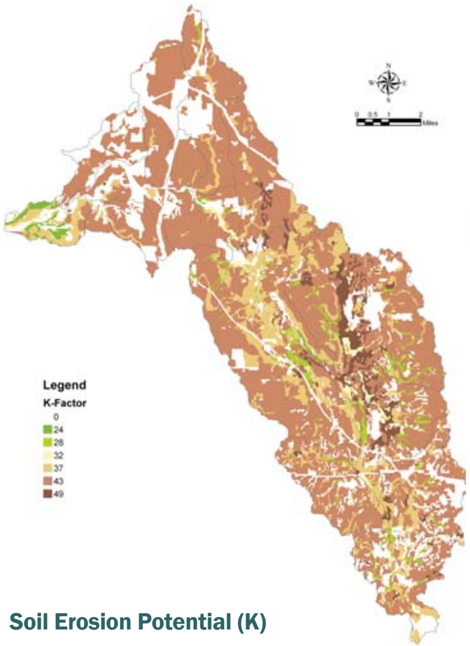
Soil Class A - Low runoff potential soils Class A soils have a high infiltration rate even when thoroughly wetted. They chiefly consist of deep, well drained to excessively drained sands or gravels. They have a high rate of water transmission.

Soil Class B - Soils in this class have a moderate infiltration rate when thoroughly wetted. They are chiefly moderately deep to deep, moderately well drained to well drained soils that have moderately fine to moderately coarse textures. They have a moderate rate of water transmission.

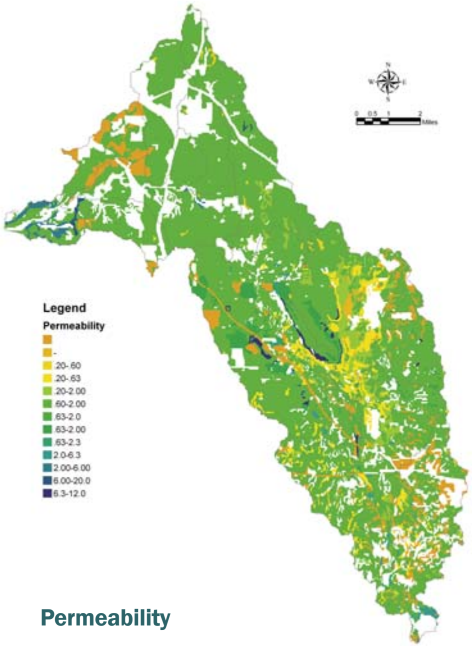
Soil Class C - These soils have a slow infiltration rate when thoroughly wetted. They chiefly have a layer that impedes downward movement of water or have moderately fine to fine texture. They have a slow rate of water transmission.

Soil Class D - High runoff potential soils Class D soils have a very slow infiltration rate when thoroughly wetted. They chiefly consist of clay soils that have a high swelling potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. They have a very slow rate of water transmission.

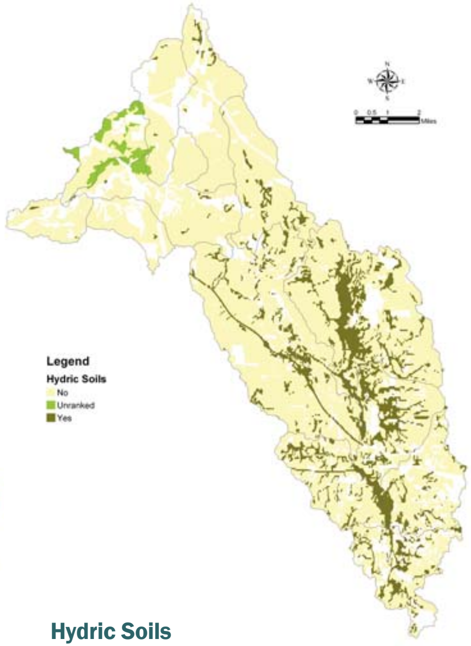
From: U.S. Department of Agriculture, Natural Resources Conservation Service, 2002. National Soil Survey Handbook, title 430-VI. [Online] Available: http://soils.usda.gov/procedures/handbook/main.htm.



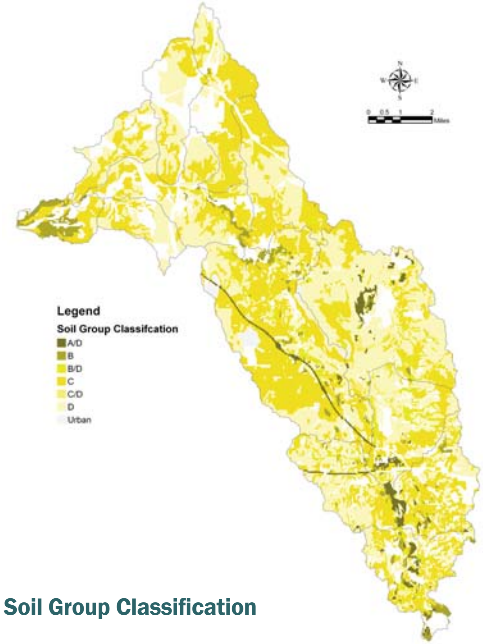
Soil Erosion Potential (K)



Permeability



Hydric Soils

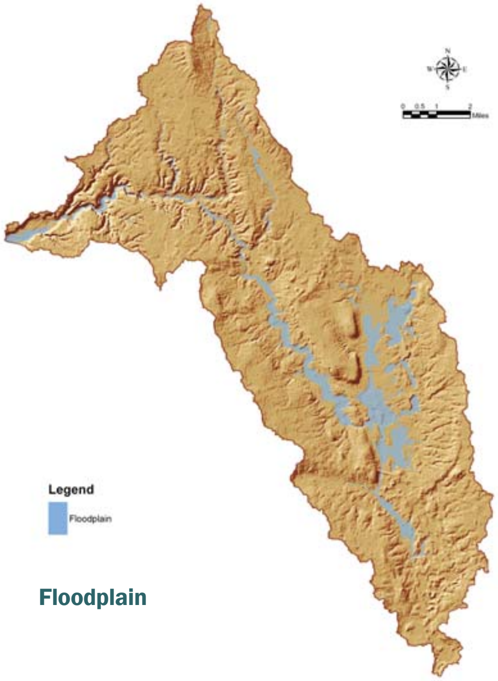


Soil Group Classification

The term hydrology refers to the science dealing with the properties, distribution, and circulation of water on the earth's surface and under the ground. Streams are a significant conduit in this process as they function to transport and transfer water volumes within the system, from surfaces, to streams, to rivers and then eventually to lakes or other water bodies. Water in Tinkers Creek flows into the Cuyahoga River, and eventually reaches Lake Erie as part of the larger overall drainage network of northeast Ohio.

Stream Order

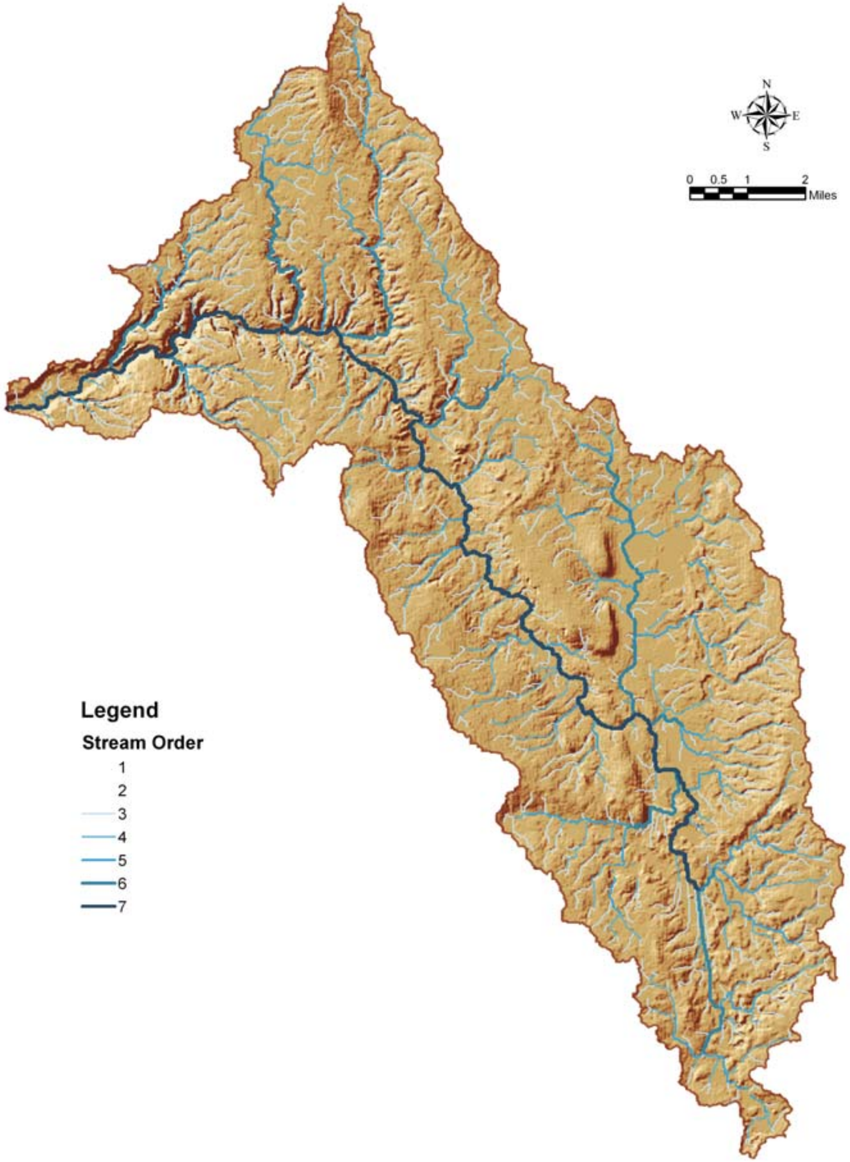
For watershed analysis, a stream ordering system is used to classify the drainage network. Utilizing a stream ordering system, a headwater stream, that is, the smallest un-branched tributary is classified as a first order stream. The stream receiving it is classified as a second order stream, and so on. The main stream in a given watershed network is always the highest order classification using this system. The USGS Digital Elevation Model (DEM) was used to derive stream order classifications for the Tinkers Creek watershed. Within the watershed, the stream network comprises a seven (7) tier system, with Tinkers Creek itself being a 7th order stream. The headwaters streams, classified as first order streams tend to be less defined, may not carry surface water during normal flows and tend to be the most impacted by development. First through third order streams, while documented in the raw data, are not displayed for graphic reasons. The total derived length of streams within the Tinkers Creek watershed is calculated as 199.65 miles.



Floodplain

Tinkers Creek Stream Flow

The volume of flow for Tinkers Creek varies throughout the year depending upon precipitation events, but the average annual streamflow is 169 cfs (cubic feet per second) based on 40 years of stream data at Bedford, OH (Source: Ohio EPA). The average annual streamflow varies from 72.1 cfs to 205 cfs. On a monthly basis, average streamflow varies from 63.9 cfs to 236 cfs, with monthly streamflow rates highest February to April, and lowest from August to October. As noted previously, the EPA estimates that on average, approximately 50% of the water flowing in Tinkers Creek during the summer months comes from treated effluent. The maximum recorded daily flow of Tinkers Creek is 7,220 cfs which occurred on July 20, 1969. (Source: USGS Stream Data, gage # 04207200).



Classified Land Use Land Cover

Classified Land Use

Land use refers to the major function that a particular piece of land is currently being used for. Some land may have several concurrent functions, so for the sake of analysis, the main use of the land is only considered. Data for land use and land cover (LULC) analysis came from 2001 LANDSAT imagery, provided by the Cuyahoga Remedial Action Plan (RAP). It should be noted that a data limitation is that for some areas information may be outdated, particularly given the rapid nature of development and urbanization within parts of the watershed. Some areas may have changed significantly in recent years, which is not reflected in the data. More detailed land cover information from 1992 is available, but given its age, the 2001 data was considered more reflective of current LULC conditions within the watershed. This data qualifier also applies to subsequent sections of the plan.

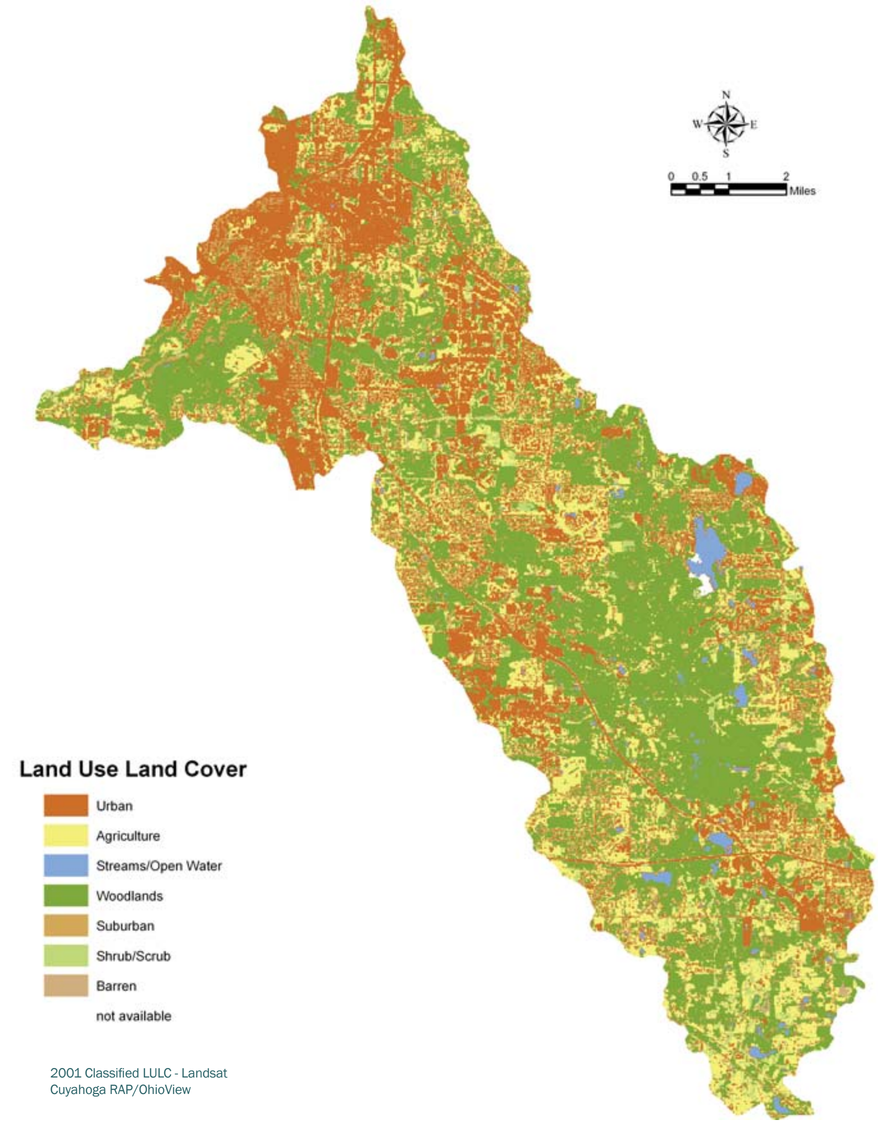
Land use and land cover was classified and mapped using seven (7) standard categories. These categories are: 1) urban; 2) agriculture; 3) streams/open water; 4) woodlands; 5) suburban; 6) shrub/scrub vegetation; and, 7) barren. An eighth category is for areas where data is not available. The areas for which data was not available represent very little of the land within the watershed. Using these standard classification categories allows us to gain important information from the data, and still provide for a high degree of accuracy within the limits of the existing data. Current land uses are vitally important for the impact that they have on a stream system, as they are a major factor related to other characteristics such as impervious cover, runoff, non-point source pollution, and available natural habitat.

Suburban

Scrub/Shrub - Woodlands

Agriculture

Urban



2001 Classified LULC - Landsat
Cuyahoga RAP/OhioView

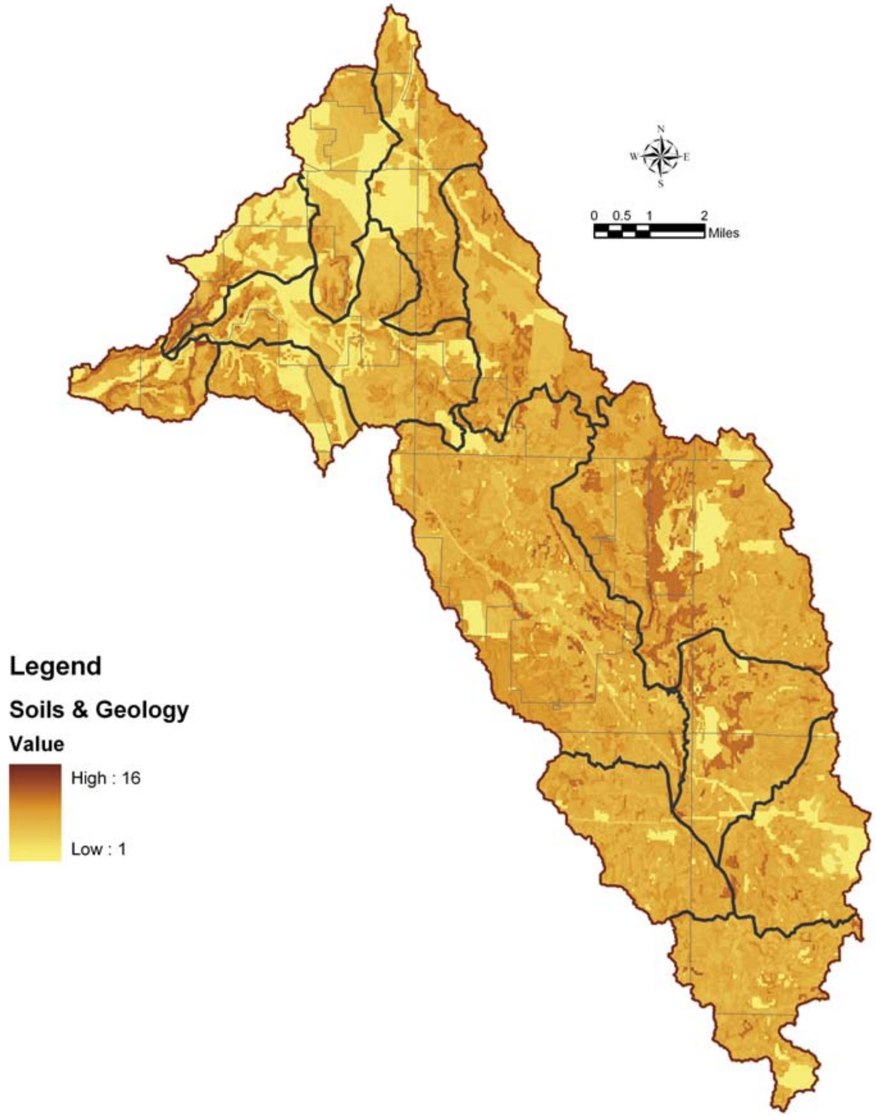
Ecological Systems Inventory & Analysis

Soils & Surface Geology Value

The final soil/geology map takes into account multiple attributes. The attributes include the K-factor (soil erosion potential), soil class (A-D), hydric soils, soil permeability, and slope. Based on these factors, the final soil/geology map reflects a range of values low to high. The most valuable soils (highest rated) are those that are most sensitive to erosion, provide the most aquifer recharge, and /or are hydric in nature. Hydric soils are usually associated with wetland and/or riparian areas, and support aquatic plant and animal life. Wetland restoration activities may be targeted toward areas with hydric soils.

Tinkers Creek cuts through layers of Berea Sandstone & Bedford Shale

Urbanized Runoff increases streambank erosion and stream siltation



Wetland Value

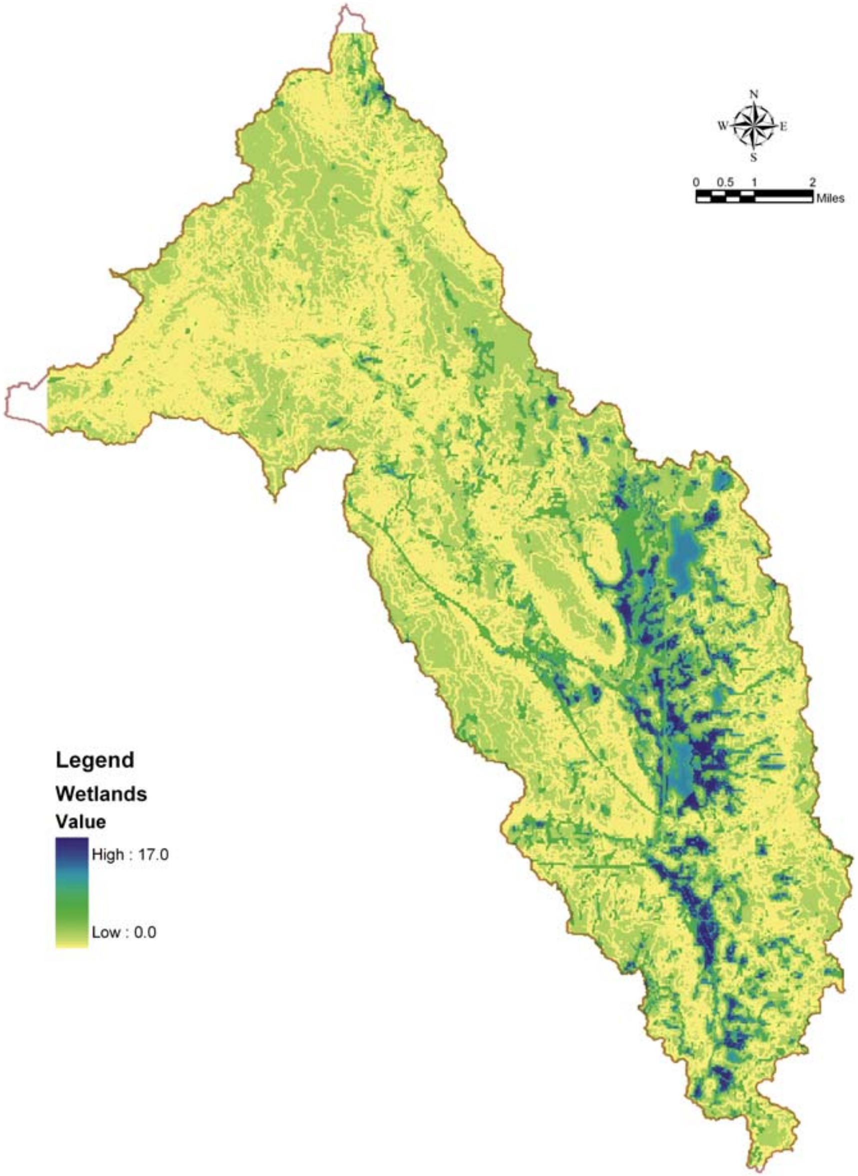
Tinkers Creek Watershed Land Conservation Priority Plan

Wetlands within a watershed serve several purposes that are important to the overall health and function of the system. Wetlands provide for flood water storage, that is, they provide a place for river and stream floodwaters to flood into during peak and overflow storm events. Like riparian systems, wetlands may also act to filter out contaminants and sediment within the watershed. Wetlands provide shelter and breeding habitat for many organisms, and may be a critical source of drinking water for organisms during certain periods.

Wetland values were ranked on a scale from high to low. The value of wetlands considered the location of hydric soils, information from both county and wetland studies, the Ohio/National Wetland Inventory, slopes, wetland size and degree of connectivity to other wetland parcels. Wetlands that were ranked most valuable showed a concentration in or around headwater areas of the upper watershed.

The location and size of wetlands within the watershed is important in determining their overall benefit to the system. Larger and interconnected wetlands provide better quality wildlife habitat for species that require a certain habitat range or size. In general, the more intact, larger and more connected that wetland areas are, the more beneficial they will be in maintaining the health of a natural system. Mapped wetlands within the Tinkers Creek watershed were given an assigned value based upon the considerations mentioned above.

Larger interconnected wetlands are more valuable than small isolated wetlands



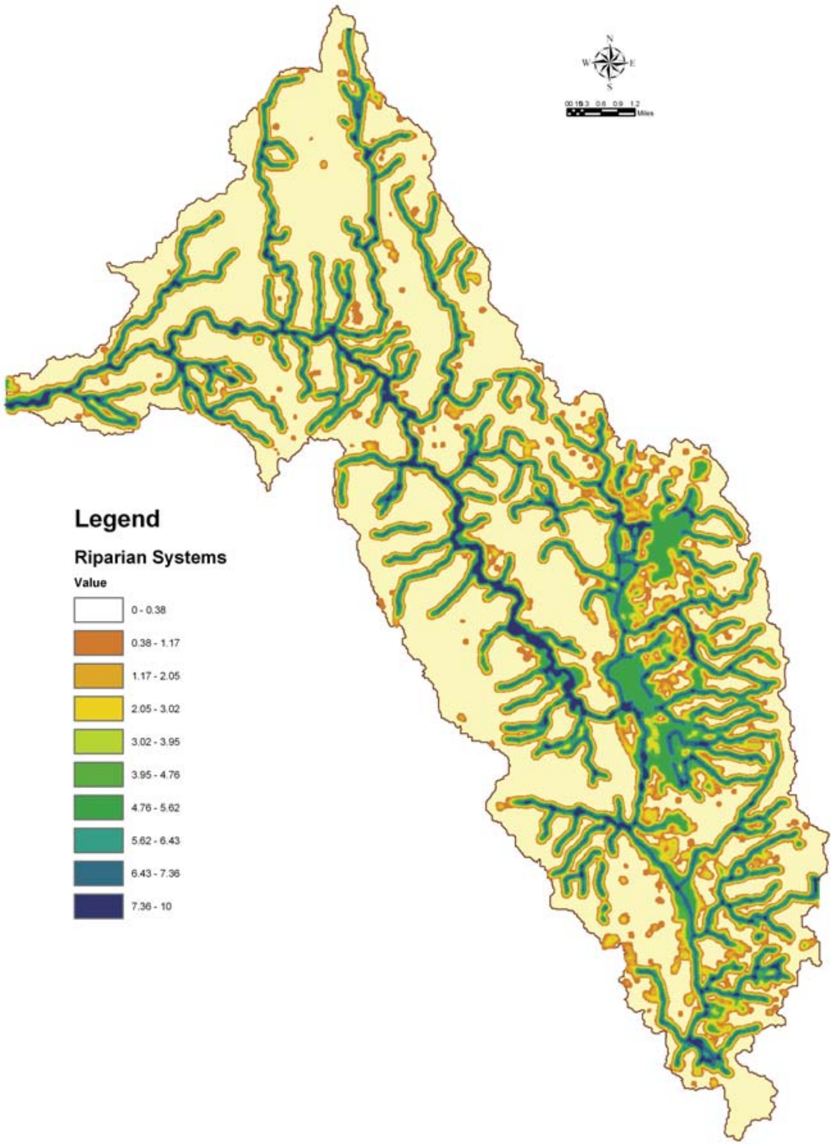
The term riparian refers to land that lies adjacent to the banks of a stream or other body of water. A riparian area along a stream in a natural healthy state generally consists of variety of vegetation layers including groundcover (sedges and grasses), understory shrub and trees, and canopy trees. Riparian areas or systems are considered a very important influence on a stream's water quality. Healthy vegetative riparian zones can act as a buffer that filters out contaminants and sediment from entering a stream as part of runoff, stabilizes stream banks, reduces erosion, provides wildlife habitat, and, provides shade that helps to keep the water temperature cooler. (Source: Cuyahoga River RAP – Life at the Water's Edge. December 2000)

Riparian systems can be broken down into the Aquatic Zone, Riparian Flood Zone and the Riparian Upland Zone. The Aquatic Zone encompasses the stream channel, up to what is considered the bankfull line, that is, the point at which the stream's natural banks end before flooding occurs – usually considered a flood event that happens in frequency every one and half to two years. The Riparian Flood Zone lies adjacent to a water body and its functions include nutrient and pollution removal, temperature and microclimate regulation, and sediment removal. This area is still prone to flooding, but far less frequently. This area usually contains the commonly referred to 100-year flood zone. The Riparian Upland Zone lies farther away from the edge of the water body, and its functions include bank stabilization and detrital input, wildlife and plant habitat functions, and water quality, flood reduction, and wildlife protection.

The width of an adequate riparian buffer varies depends upon the desired management goal. As a general rule, wider buffers are needed as stream order – and thus larger contributing watershed - increases. Also, wide buffers are needed if the goal is to protect ecological features or to protect species habitat, while smaller buffers may suffice if the goal is only to address water quality issues only. Based on the majority of scientific findings, the Environmental Law Institute derived recommendations for the size of buffer strips. The mean recommendations suggest buffer strips of 25 meters minimum to provide pollution removal; 30 meters minimum for temperature regulation and sediment removal; a minimum 50 meter strip to provide bank stabilization; and 100 meters or more to provide wildlife habitat. To provide adequately for both water quality and wildlife protection, a buffer zone of at least 100 meters is recommended. (Source: Environmental Law Institute)

The Summit County setback ordinance establishes the minimum riparian setback widths that must be excluded from development near a water body based on drainage area, historical floodplain, slope, and, wetlands.

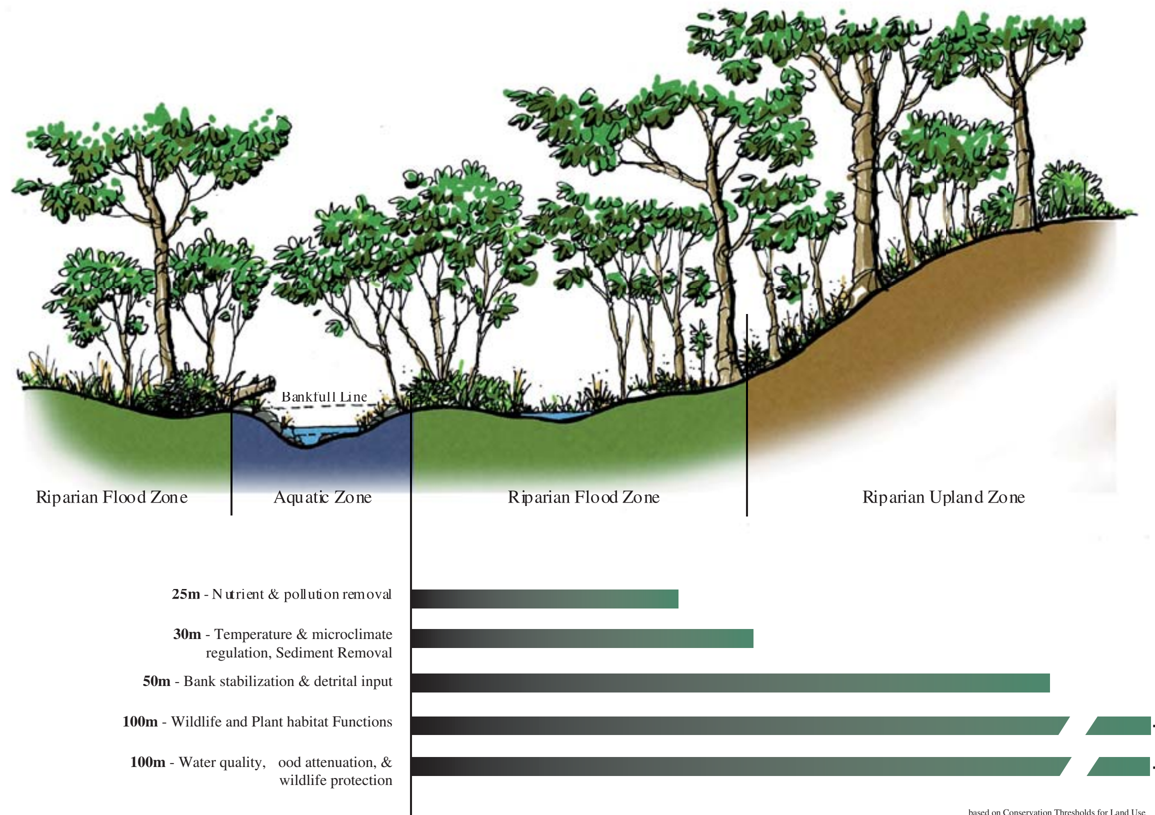
Scoring of riparian systems was based on stream order and the width of buffers. We recognize that the value of the riparian system decreases as we move out from the aquatic zone. Thus we have scored the riparian systems as decreasing scale from the this zone out to 100m but included areas such as known floodplains, which can be identified through FEMA floodplain maps, alluvial soils and topographic maps. We have also addressed the stream order by placing higher values on the larger stream orders, understanding that wider widths on these larger streams will be needed to provide the same benefit as smaller headwaters streams.



Riparian Systems

Healthy Riparian System

Urbanized/Impacted Riparian System



Kerr+Boron Associates, Inc.

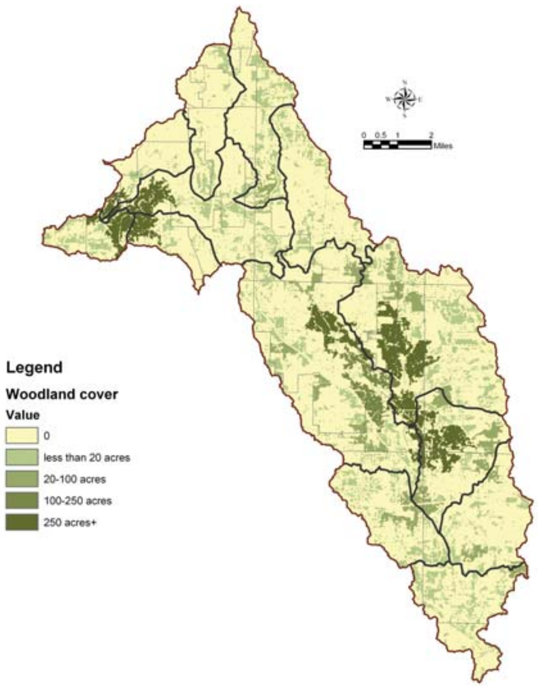
based on Conservation Thresholds for Land Use Planners (2003) Environmental Law Institute

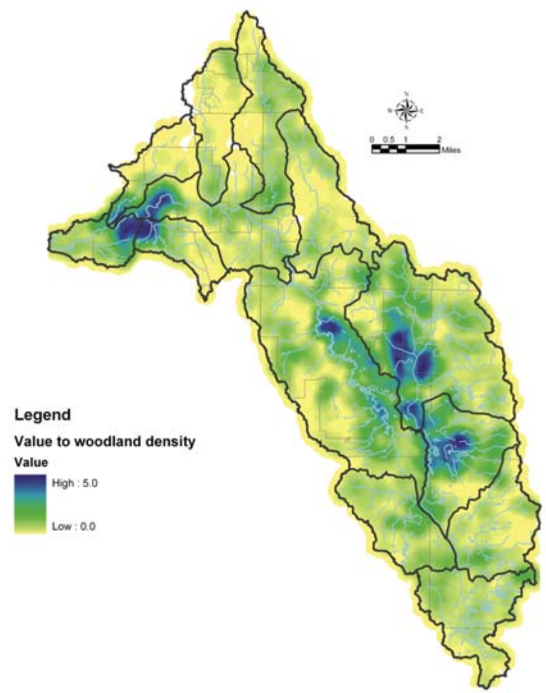
Woodland Patch Value

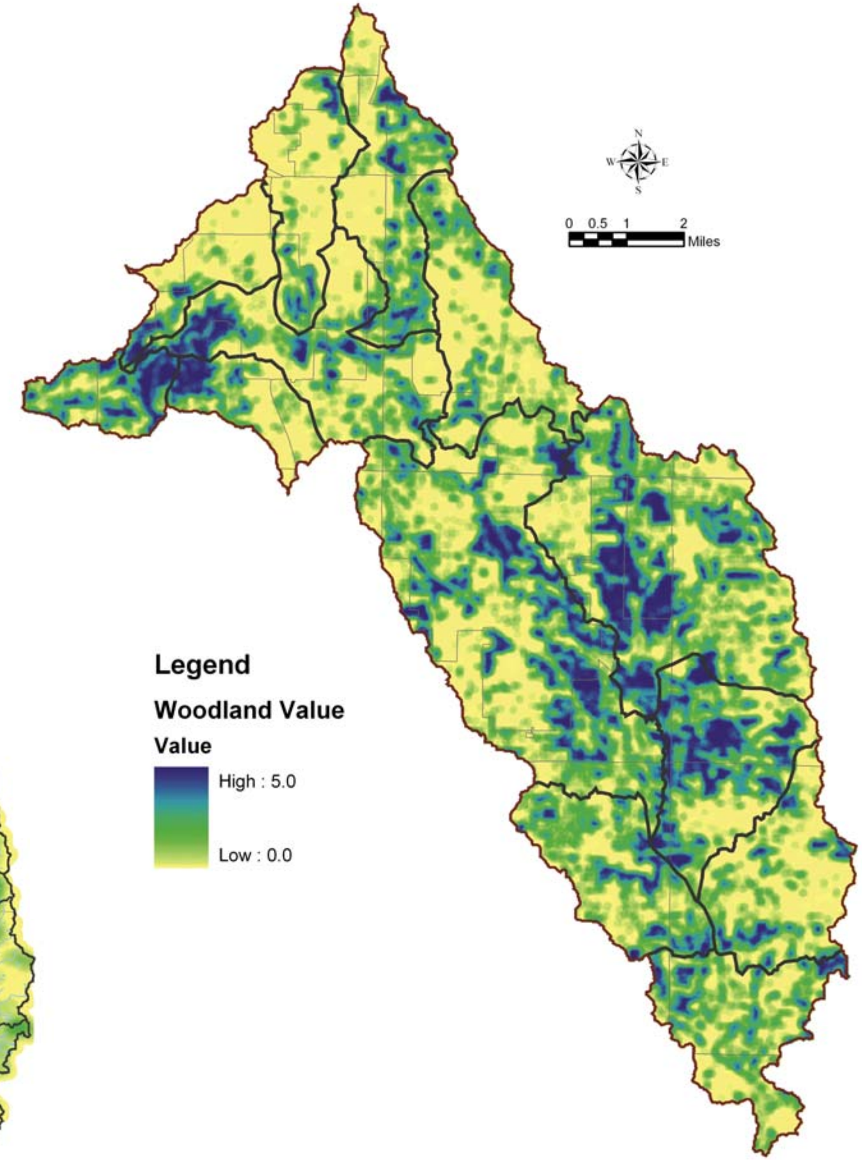
Woodlands and forest cover provide several functions within a watershed system. In addition to providing shelter and habitat for natural species, they may shade portions of a stream, keeping it cooler during the summer months. Cooler water temperatures are generally more supportive of aquatic stream life.

Just as with wetlands, the location and size of woodland areas is important in determining their overall value and benefit to the system. Larger and interconnected woodlands are generally considered more beneficial to the natural system. Like spokes on a wheel, an interconnected system that includes woodlands, waterways and other open space areas may provide "wildlife corridors" and support species that require a larger habitat range for their survival.

Woodland patch areas exist in varying sizes throughout the watershed. Woodland patch areas were mapped with respect to their size. Based on the size of woodland patches, a value was assigned. Woodlands of high value were distributed throughout the watershed, with concentrations near the confluence with the Cuyahoga River, and in proximity to headwater areas of the upper watershed.





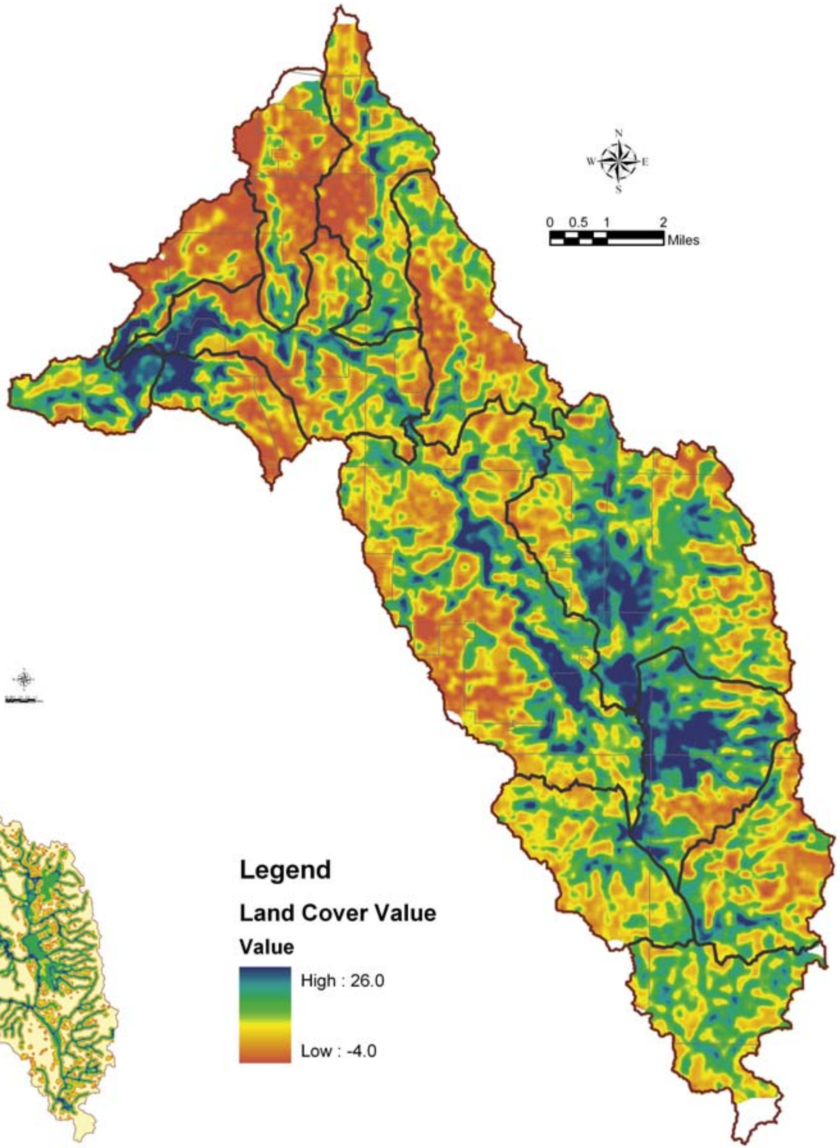


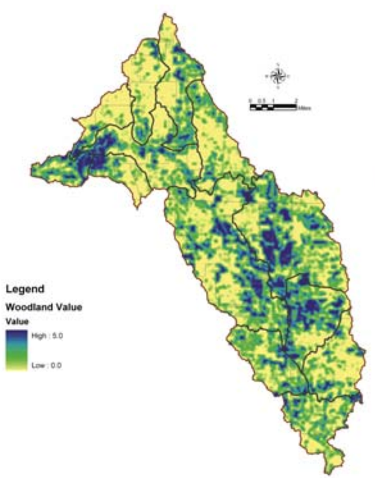
Green Infrastructure Value

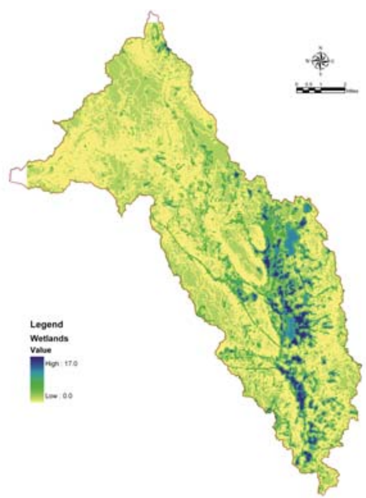
Green infrastructure refers to our natural life support system, comprised of an interconnected network of natural areas and features including wetlands, woodlands, waterways, and wildlife habitat. Green infrastructure provides numerous benefits that contribute to the health of both natural and human systems. The green network supports native species and habitat, maintains natural ecological processes and functions, and sustains air and water resources. In relation to human populations, green infrastructure provides both tangible and intangible benefits that contribute health and quality of life benefits. Recreational opportunities and an improvement in the quality of essential resources such as drinking water and air quality are among the benefits to human populations. In a broad planning sense, green infrastructure addresses both public and private functions through the linkages and building blocks it provides in developing land resources in a sustainable way that provide the most benefit for our environment, economy and communities.

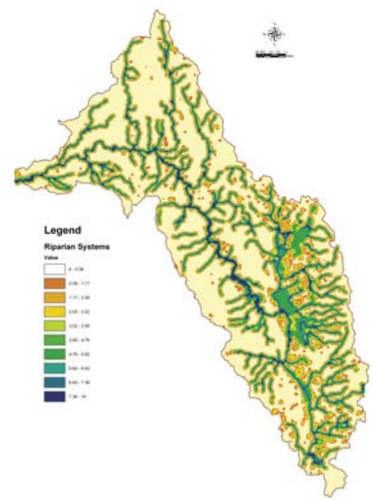
Research has shown the economic benefits to preserving green infrastructure. As an example, in Boulder, Colorado one study estimates that tree cover provides an average of $58/year in energy savings for the average single family detached home. This translates into approximately $1.65 million in annual savings for Boulder's residential areas. Green infrastructure also helps cities address problems with urban heat islands, which are areas of higher temperatures that form over a city at night from the release of daytime heat by impervious (concrete and asphalt) surfaces. Subsequent warm days may lead to higher temperatures in the city, facilitating an increase in ozone and smog production, and contributing to respiratory and other health problems.

Connectivity is important in determining the value of land within the overall green infrastructure system. Woodland, wetland and riparian areas that are larger in size, less fragmented, and more connected provide the most value. Areas that are fragmented, smaller, or isolated are less valuable. Connectivity supports both natural systems and species, allowing for the movement of species and resources, and supporting the overall health of the system. Planning efforts should take into account the connectivity of green areas, with preservation of this connected system as a primary goal. A scored value for green infrastructure was derived by combining the factors of woodlands, wetlands and riparian areas. This allows us to identify areas that are part of the overall interconnected "green infrastructure" system. The resulting map shows a range of values for land within the watershed, derived from their overall connectivity factor.





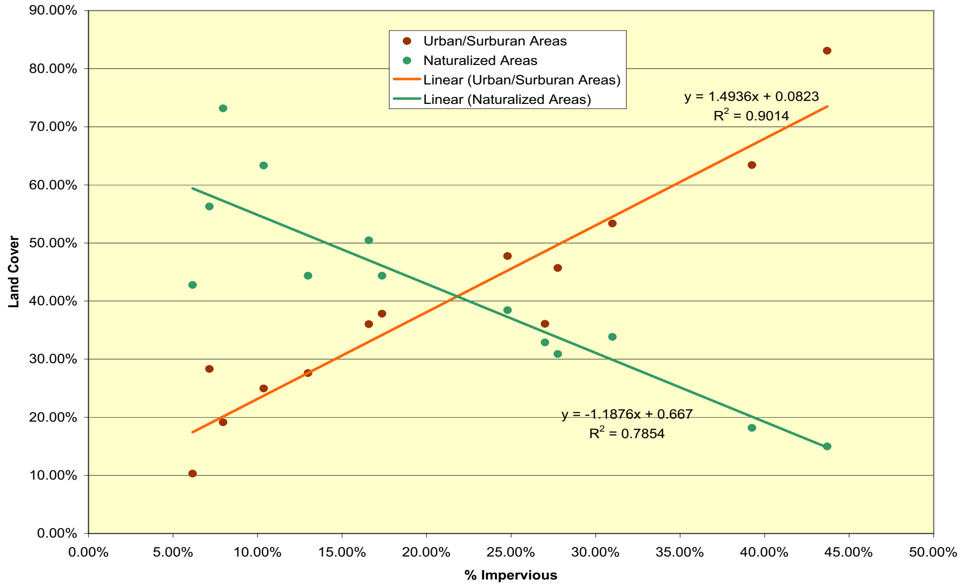


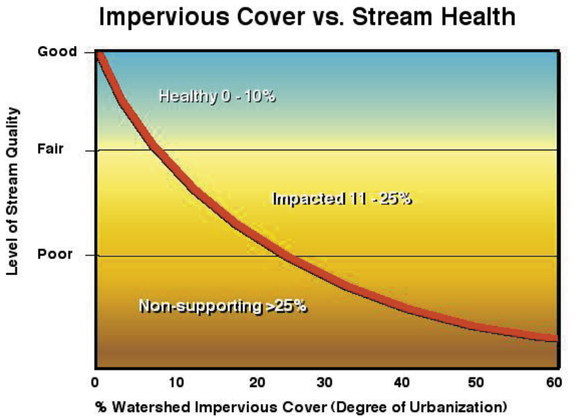


Watershed Influences

Land Cover & Watershed Quality

Research has shown that a direct correlation exists between the amount of impervious cover within a watershed, and stream quality. The Center for Watershed Protection (CWP) has summarized research findings and integrated them into the Impervious Cover Model (ICM), which predicts the average behavior of a group of indicators over a range of impervious cover values. The ICM predicts that most stream quality indicators show a decline as the total impervious cover within a watershed increases. When total impervious cover is 0-10%, streams usually sustain a high quality, and are often typified by stable channels, and healthy biotic communities. The streams may not experience as frequent flash flooding as other urbanized streams. When total impervious cover increases to 11-25%, streams are described as impacted. Watershed urbanization may cause stream degradation and alter the stream geometry as a result of increased storm flow and erosion. Some sensitive species may also disappear from the stream. The ICM predicts that severe degradation occurs when the impervious cover values exceeds 25%. This category of streams may no longer support a diverse biotic community, and the stream channel becomes unstable and may experience severe erosion and stream incision. Biological quality is generally low, and may become dominated by a small variety of pollution tolerant fish and insects. (Source: Center for Watershed Protection)



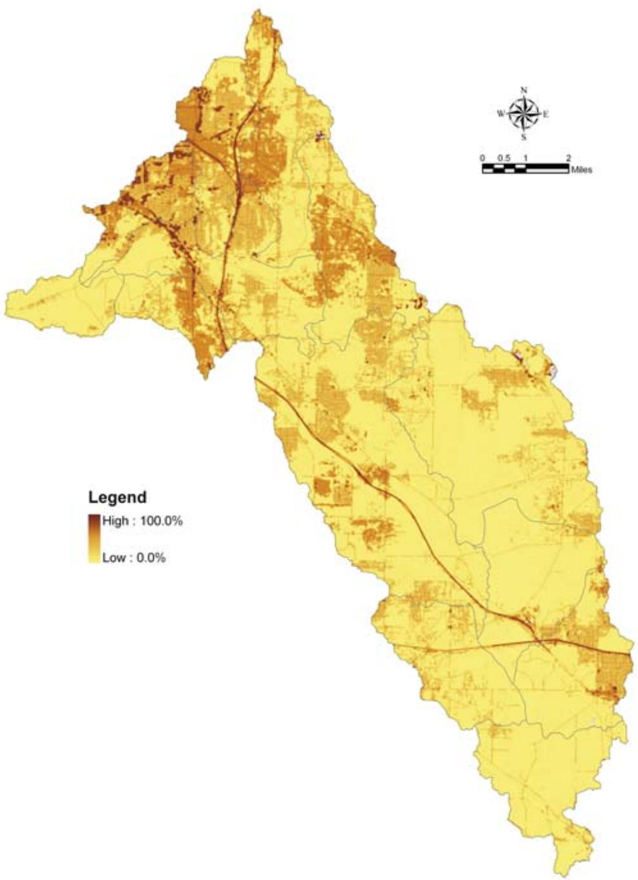


Source: Adapted from Deb Caraco, Rich Claytor, et al., Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds (Elicott city Maryland: Center for Watershed Protection, October 1998).

Increased imperviousness also increases volume and frequency of flooding. Artificial armoring and filling floodplains only exacerbate the problems.

Impervious surfaces send nutrients & pollutants directly to streams creating water quality problems.

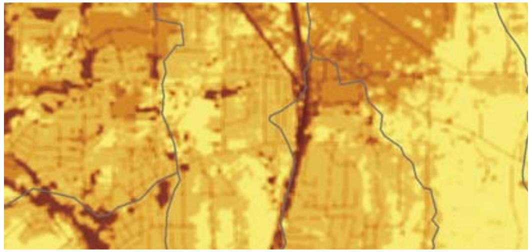
Impervious Cover Model

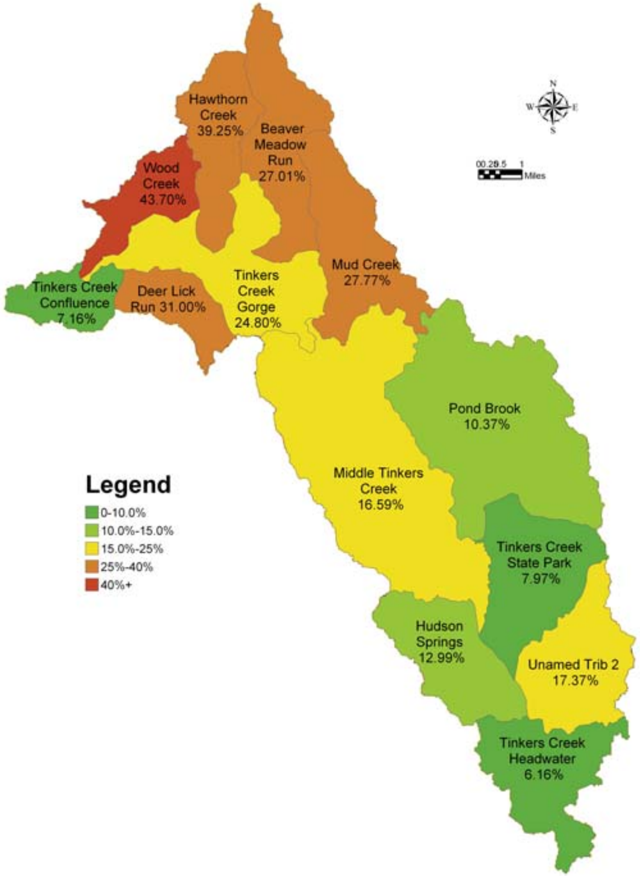


One calculation that can be derived from a classified land use land cover data (LULC) is impervious surface cover. Different land use categories have average impervious ratios. For example urban areas that have dense residential areas, commercial and industrial uses have been found to have impervious ratios around 50% (Source: Prisloe and Giannotti). Impervious surfaces are those which cannot effectively absorb or infiltrate precipitation. Paved surfaces include roads, parking lots and sidewalks, and the roofs of buildings or other structures. These surfaces intercept water and block it from infiltrating into ground surfaces. Impervious surfaces are considered to be a significant factor contributing to an increase in non-point source pollution, runoff, flooding and erosion within a stream system.

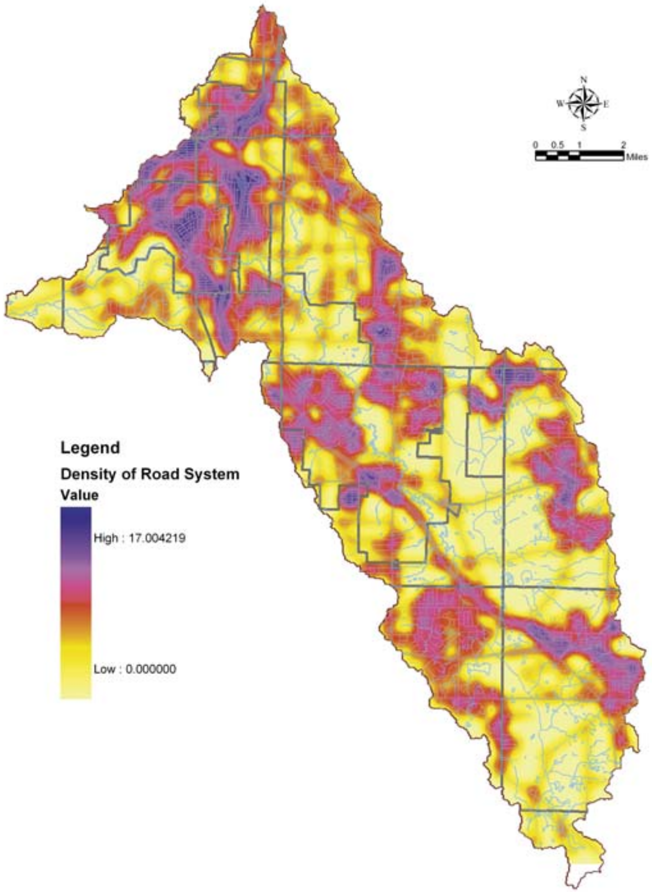
Within the Tinkers Creek watershed, the amount of impervious cover varies greatly. There is a concentration of impervious surfaces in the northern portions of the watershed in Bedford, Bedford Heights, Warrensville Heights. A concentration of impervious cover is also evident in the growing cities of Solon, Hudson and Streetsboro. Tinkers Creek is unique compared to many other watersheds in that it has both undisturbed and ecologically sensitive areas, as well as highly impacted urban areas.

Impervious cover percentages were calculated using land use/land cover (LULC) data. As noted elsewhere, data for some areas may be somewhat dated, and may not fully reflect current conditions in the rapidly developing areas of the watershed.



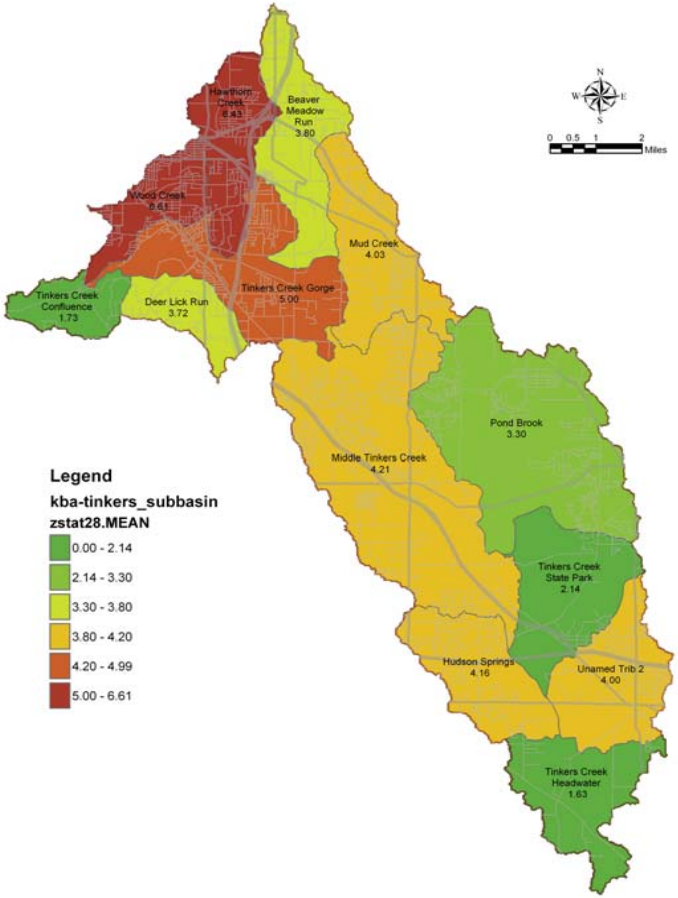


Road Density Model



Roads Density is an indicator of certain land use patterns

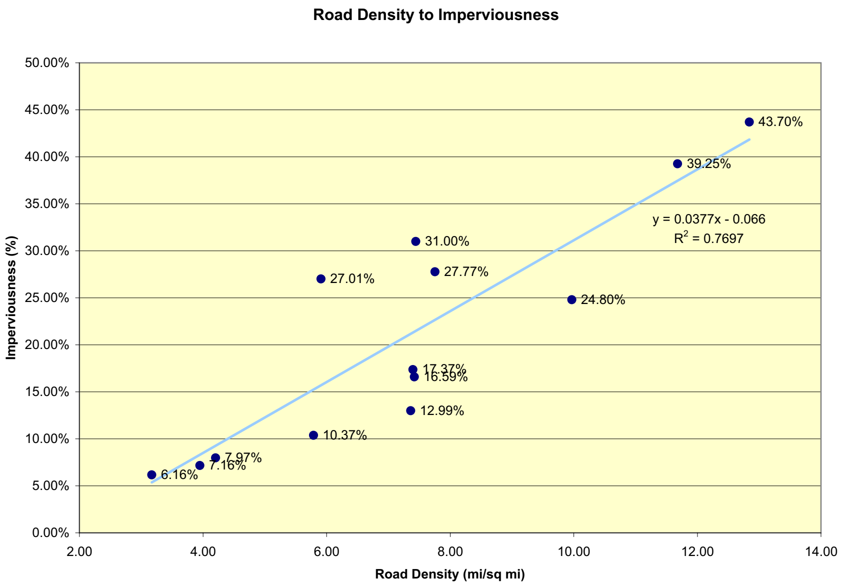
The road density model shows mapped values based on the concentration of road surfaces within the watershed. There appears to be a correlation between road concentrations and other development activities, such as urban or commercial land uses as the roads are related to their function. Accordingly, these areas are also are more likely to have a higher overall concentration of other impervious surfaces in addition to the roads such as buildings, parking areas, and we would expect them to suffer from impacted water quality as a result of impervious surface runoff. As such, areas of the watershed with the lowest concentration of roads were rated highest. The map reflects the range of land values based on road density. One potential shortcoming of this model is that it may not fully take into account large industrial areas, which may have significant impervious surface cover, but few roads.

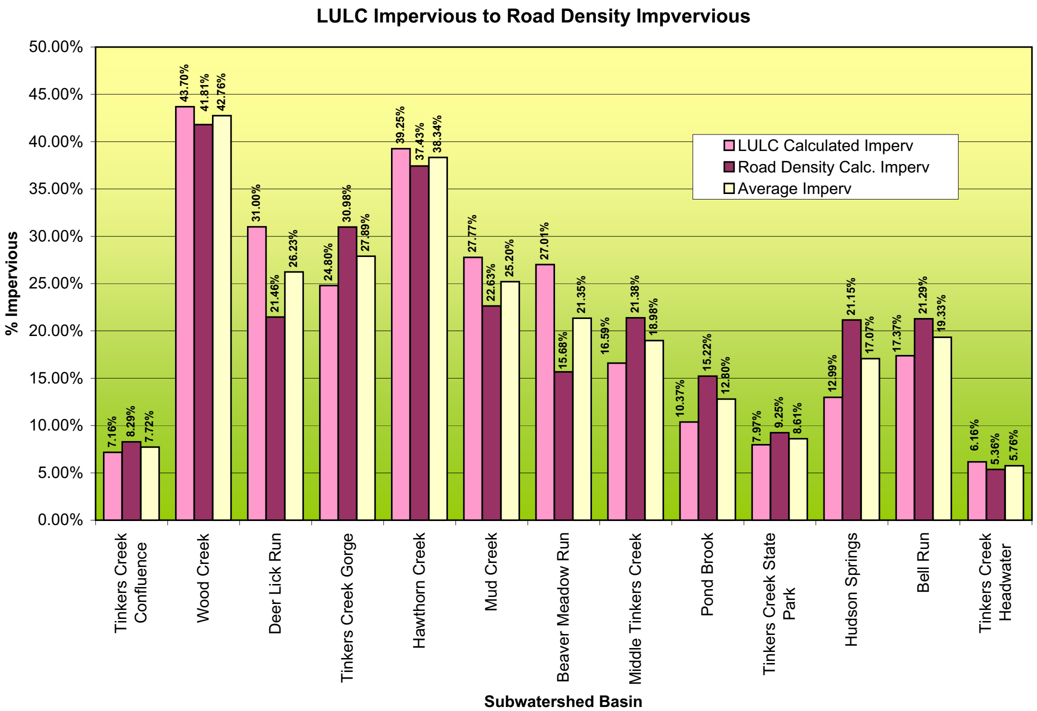


Road Density Model vs ICM

While the impervious cover model uses a traditional LULC as its source, it was recognized that the lack of detailed land cover classifications and age of available data could provide some inaccurate impervious surface calculations. To overcome this possible data deficiency, we looked to available data that was current and accurate. The statistical analysis shows that there appears to be a strong positive correlation between the amount of road density in an area, and the amount of imperviousness or impervious cover. Using this assumption, it would seem logical to assume that road density could be used to predict development density and thus the correlation to the amount of impervious cover. The amount of impervious cover relates directly back to water quality, so this can be used as a predictor of water quality as well. Within the watershed, road density values are highest in the subwatersheds in the north-most portions of the basin which include parts of Solon, Bedford, Beachwood and North Randall. The data suggests that road density and our impervious cover surface model correlate in areas where development has not changed significantly since 1998, the year of the LULC data. Both sets of data were plotted on a scatter graph to calculate a correlation value, which showed a 77% R-factor. Using the corresponding formula, we were able to calculate the projected imperviousness of the subwatersheds. This methodology showed a higher degree of imperviousness in each subwatershed containing more recent development.

A limiting factor on the data should however be noted. While the road cover data should be up to date, this methodology may underestimate large commercial and industrial areas that also have significant impervious areas. This may be especially relevant in some high growth areas of the watershed.



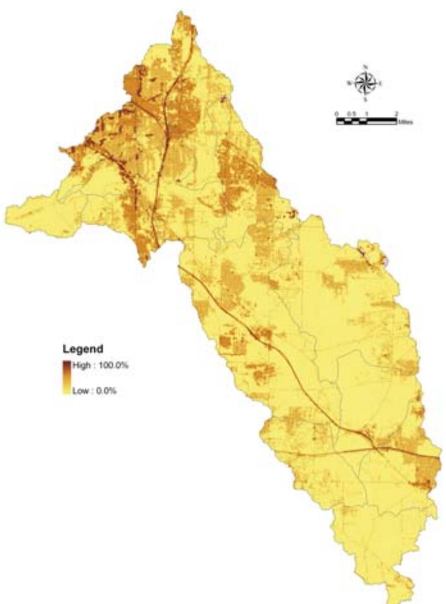


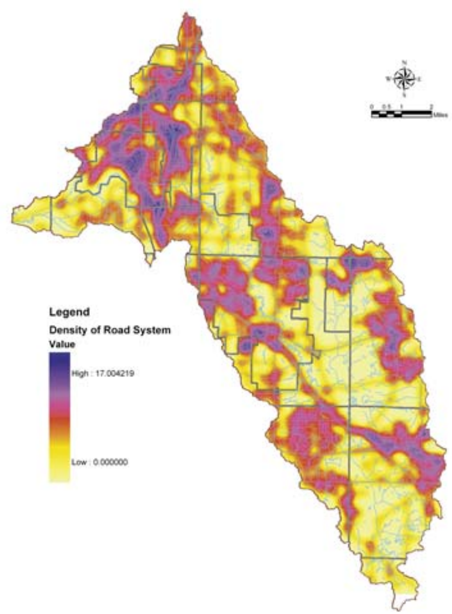
Development Impacts

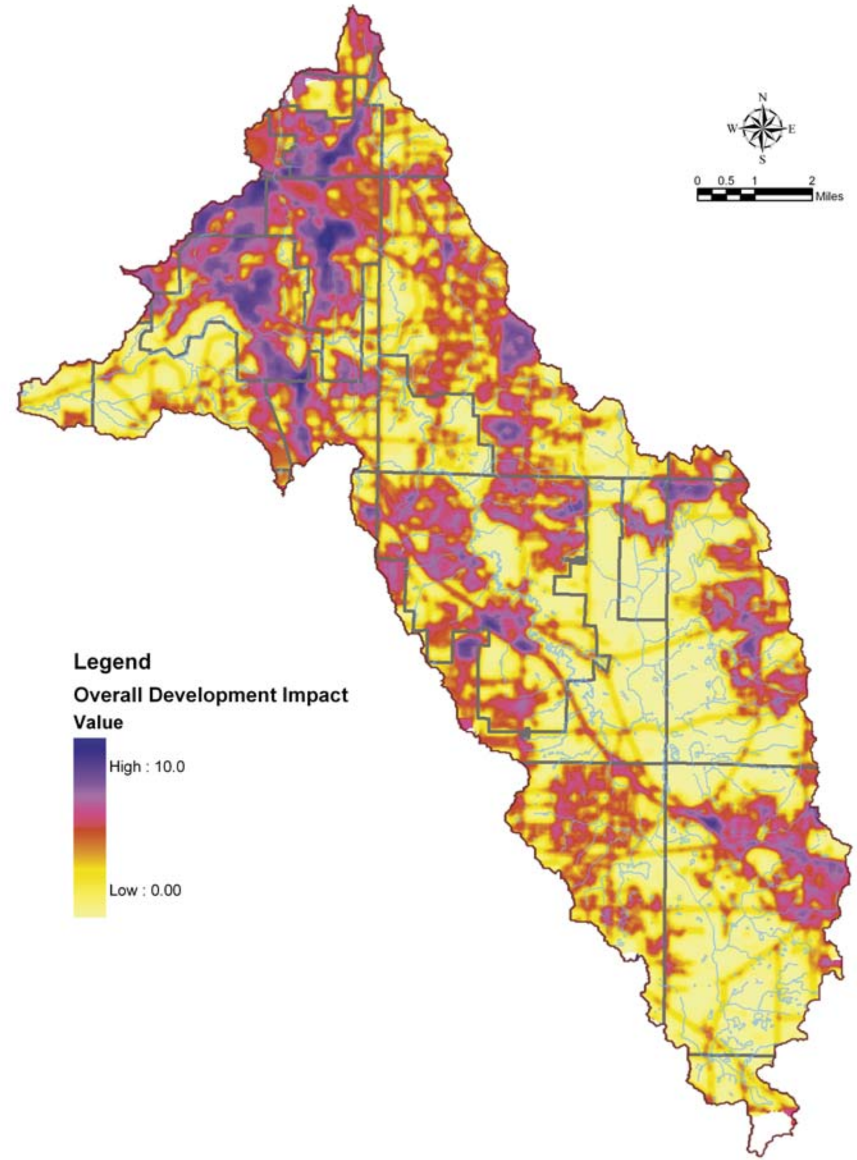
The overall development impact can be estimated by combining road density and impervious cover in one map. Road density and the amount of impervious cover within the watershed exhibit a strong correlation to one another, that is, one can be used to some degree to predict the other. Using this assumption, the amount of impervious cover can be calculated based on the number and size of road surfaces within the watershed. Since the degree of impervious cover itself appears to be correlated with overall water quality, this impervious cover value can be used to derive a value for the overall impact of development in the watershed.

The advantage of using this methodology and analysis is that any shortcomings in the one data set may be offset by the other data set. The most accurate aspects from each of the data sets are combined to be more reflective of current development activities taking place within the watershed.

Values for overall development impact were mapped with a scaled valued of ten (10) representing areas that were highly impacted, and areas where there has been little impact receiving a score of zero (0). Thus, natural areas, where they do occur may not provide a stable or highly valuable ecosystem given the impacts of adjacent development. When these areas are analyzed from a connectedness or adjacency factor, they may not score as high as areas that are farther removed from such impacts.







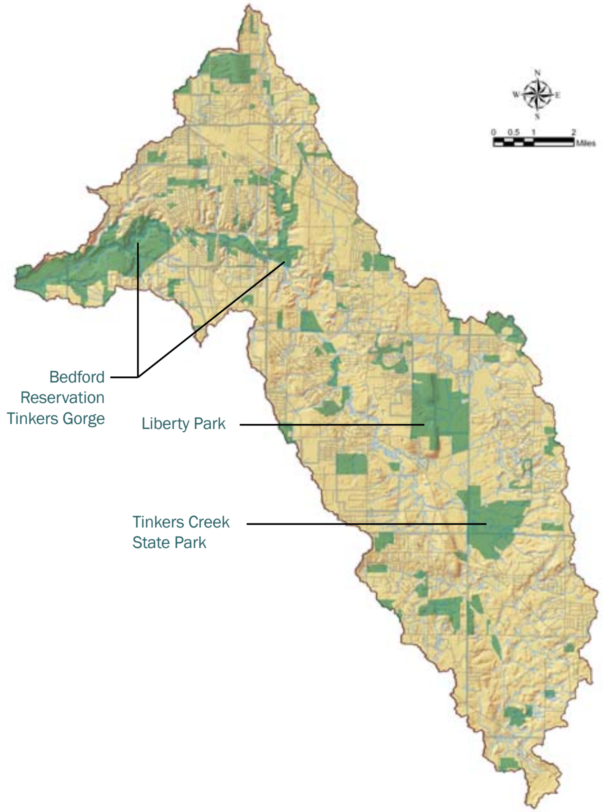
Open Space & Headwater Areas

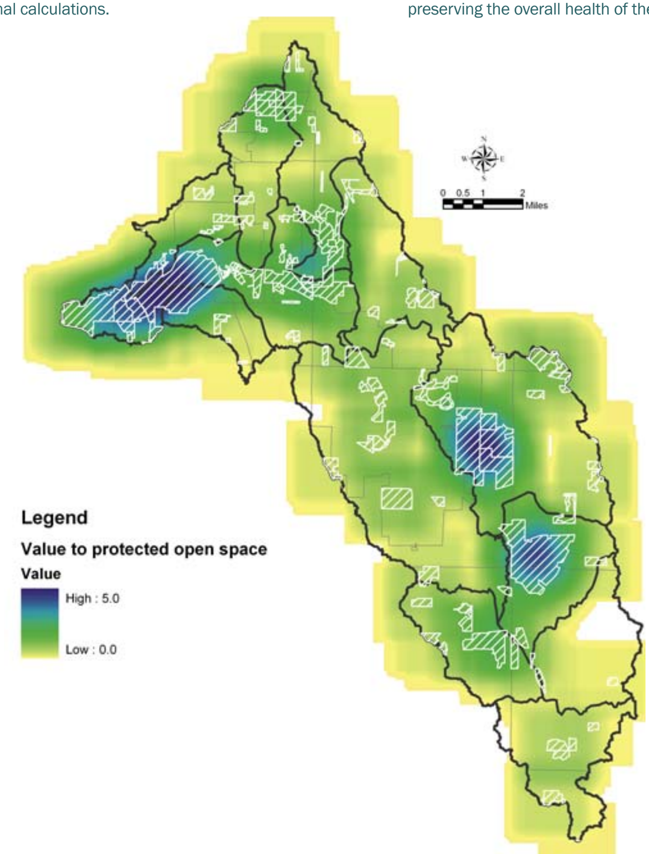
Protected Open Space

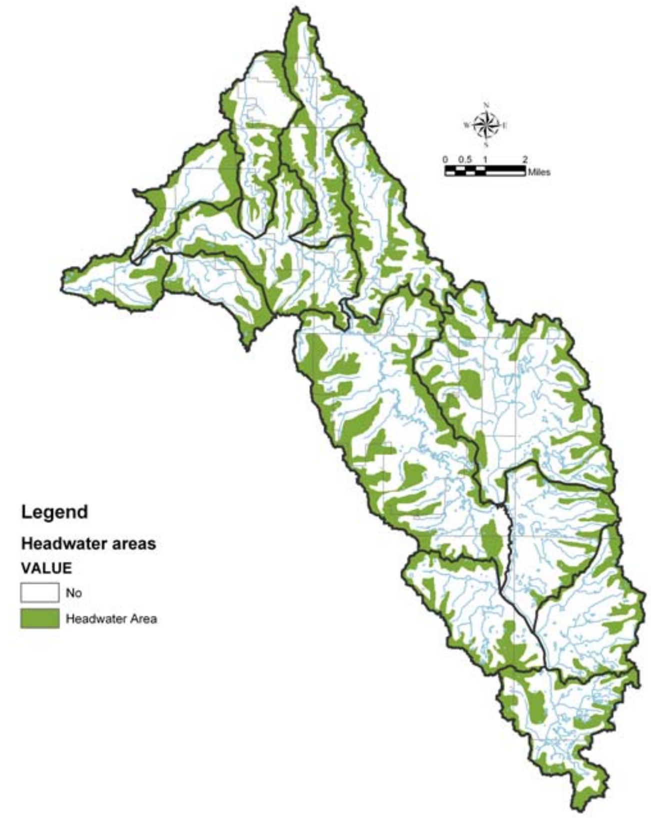
Protected land exists within the watershed in the form of parks, natural areas, land trusts and conservation easements. Through land trusts, currently the Tinkers Creek Land Conservancy protects approximately 300 acres of forest and high quality wetlands in seven (7) preserves within the watershed.. Additional land is protected by the various municipal, county and state entities within the region, whether in parks, or some other form. In total, the amount of land that can be considered protected within the region is approximately 2700 acres. There area four major protected open spaces that contribute the greatest to the watershed. First is the Tinkers Creek Gorge area near the mouth of the river. Second is the Tinkers Creek State Park located in the middle of the watershed. The state park is approximately 786 acres in size, and contains some of the most valuable wetlands in the watershed. A recent addition is Twinsburg's Liberty Park which was purchased by the City of Twinsburg. It's 1400 acres contain both steep exposed rock slopes and important wetlands. The final and most recent addition is the Aurora Wetlands area near the Summit-Portage county line that was purchased by the City of Aurora. Due to the recent nature of its acquisition, it is important to note that this 250 acre wetland was not included in the original calculations.

Subwatershed Headwater Areas

Headwater areas refer to the region where a stream begins, or the upstream source of its flow. Headwaters are significant because in some cases they contribute the largest volume of water to a particular stream. Headwater areas are important for a number of other reasons. They are considered a critical food source for the entire river as they deliver nutrients and organic material to downstream regions, forming the base of the river's food chain. Headwaters also influence downstream conditions. In addition to nutrients, they provide natural sediments, essential to river health. As part of an interconnected system with wetlands and groundwater, headwaters also help to regulate natural river flow. Finally, while headwaters are important for their downstream influences, they are often important in themselves for the rich and varied ecosystems that they support. Headwater areas may contain biologically distinct communities that are not found elsewhere in the watershed. (Source: American Rivers) Tinkers Creek has many small headwater streams and stream segments throughout its watershed. Urbanization and development often covers or eliminates these streams, only to replace them with ditches and other drainage devices. Protecting headwater areas is a critical step in preserving the overall health of the watershed.



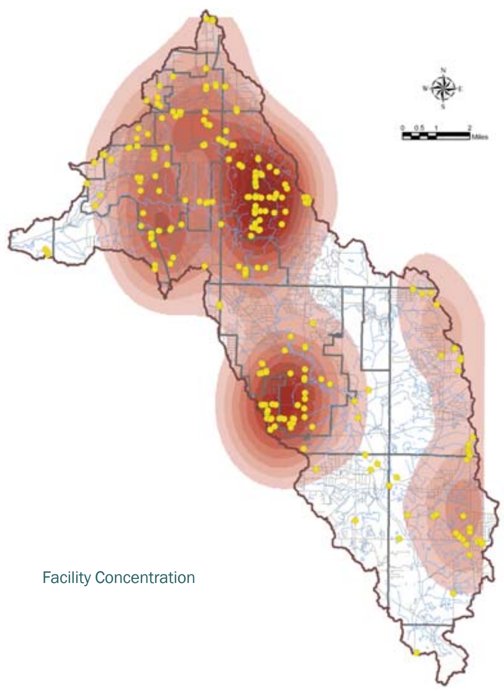




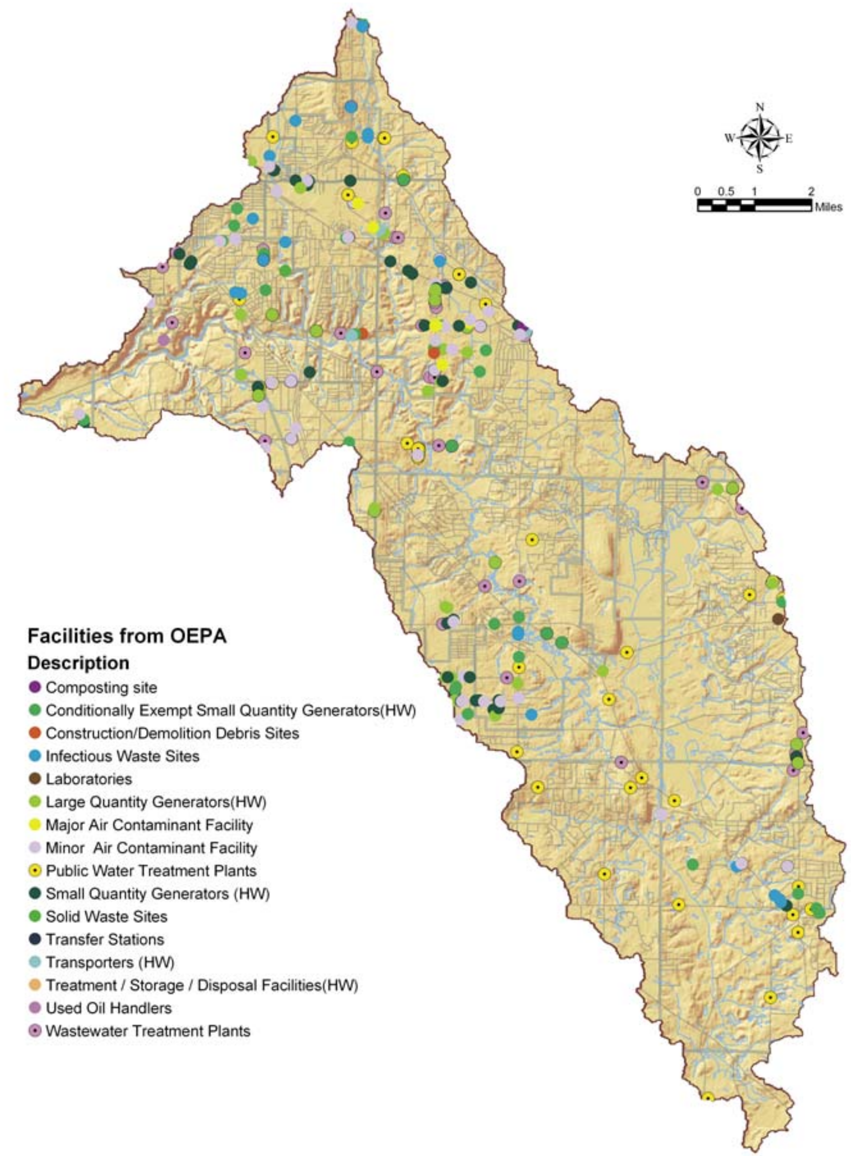
OEPA Permit Facility Locations

The National Pollutant Discharge Elimination System (NPDES) is a program under the Federal Requirements of the Clean Water Act that requires, among other things, operators of small municipal sewer systems and developers of construction sites to implement programs and practices to control polluted storm water runoff. Under the NPDES Phase II Stormwater Rules program, operators of municipal separate storm sewer systems, commonly referred to as MS4s, are required to develop a storm water management program that implements at minimum six different measures that utilize a Best Management Practice (BMP) approach. These six minimum control measures are: 1) public education and outreach; 2) public involvement and participation; 3) elimination of illicit discharges; 4) construction site storm water runoff ordinance; 5) post-construction storm water management ordinance; and, 6) pollution prevention and good housekeeping. The BMP strategies chosen by the MS4 operator must significantly reduce pollutants in urban stormwater compared to existing levels in a cost-effective manner.

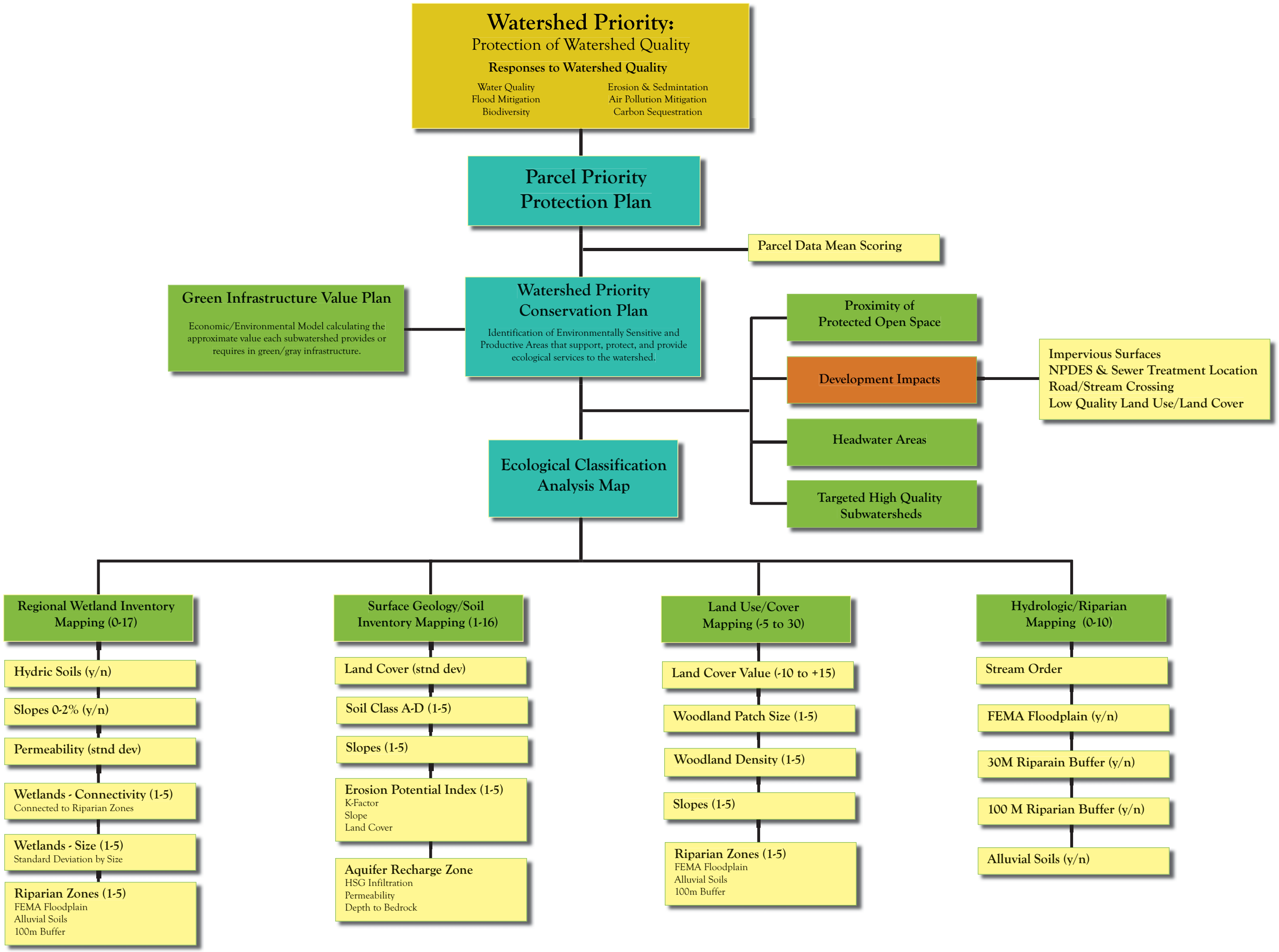
NPDES permit locations within the Tinkers Creek watershed include all MS4 sites operated by cities, and private sites. Sites include both municipal treatment facilities, and commercial/industrial facilities that produce effluent or are required to have a permit due to site size and stormwater runoff.



Facility Concentration



Watershed Assessment



Scoring Methodolgy:

This study will use a geographic information system (GIS) based system to map and analyze the watershed. GIS is a computer-based tool for mapping and analyzing land. The GIS system can accurately map natural features in the watershed, as well as man-made aspects such as current land uses, growth patterns, property values and other characteristics. Features such as topography, vegetation, soils, wildlife and riparian area, and cultural or man-made characteristics such as land use, growth patterns and property values can all be taken into account. GIS allows you to integrate and analyze these maps, and prioritize areas for conservation. The GIS analysis facilitates looking at a system as a whole, by taking complex data and making it visual. This allows you to consider features and the impact that they might have on the entire system, and to test different theories in regard to the relationships between variables in the model. For effective watershed protection this is important, as critical areas may spread across multiple jurisdictions. (Source: Trust for Public Land)

Data used in the study will be a combination of secondary source data, remote sensing imagery, low-altitude aerial photographs, and other sources as the base to use for analysis. Limited field reconnaissance activities were also conducted. The data came primarily from secondary information sources, given the scope and budget of the project. It is important to note that since the data is derived from secondary sources, the quality and quantity of the data available may be subject to some variance. Where applicable, any limitations to the data will be duly noted. Individual maps will list the sources of data from which they were derived. A complete listing of the data sources utilized is listed in the appendices.

The analysis will use an operational model, which is also referred to as a ranking system. This type of model uses data to generate indices or qualitative rankings. The model integrates a wide variety of data and information such as topography, slopes, soil types and land use, to produce GIS data layers. This allows mapping to identify high priority sites for protection or conservation. When this information is used in combination with local knowledge, and field verification, the priority lists can be very useful tools in guiding decision-makers. Using GIS analysis, values were assigned for the individual characteristics or qualities being examined on each map. The values had a range for each characteristic being examined.

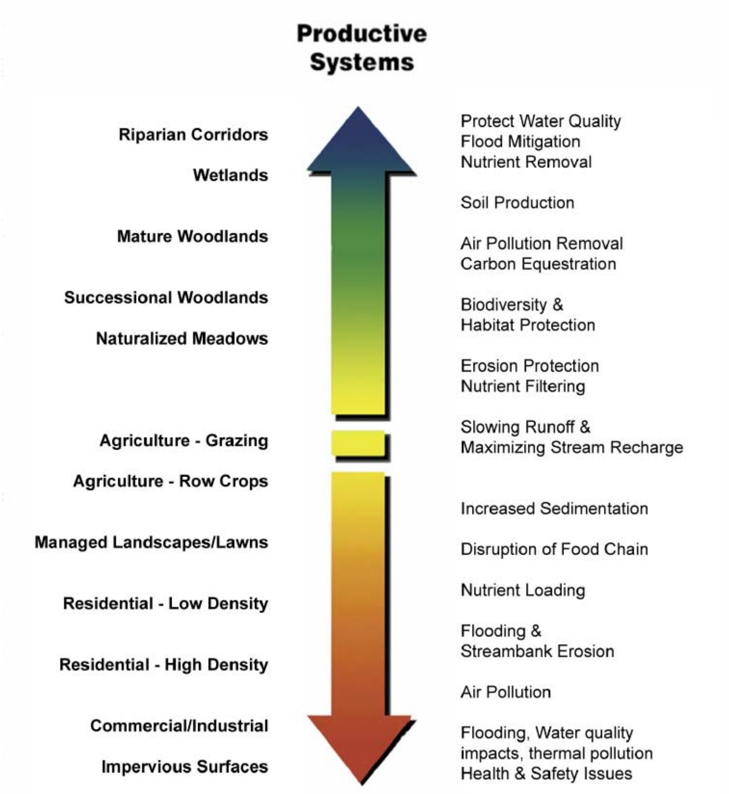
Priority Plan

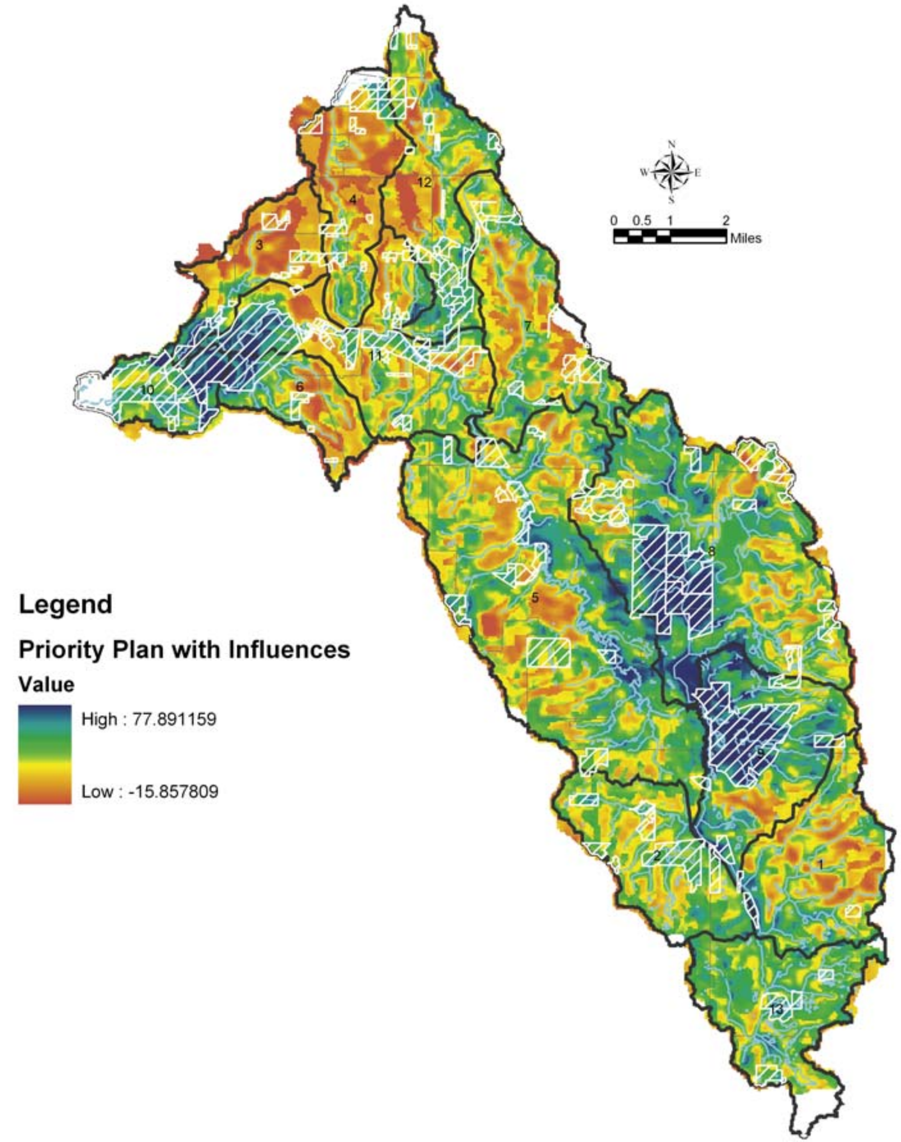
Tinkers Creek Watershed Land Conservation Priority Plan

The priority plan combines and scores various GIS data layers, and integrates them together in order to produce an overall score based upon the weighted factors in the data layers. The weighted value of the factors is outlined in the Project Methodology chart. Visually, this information is displayed in pixels or cells, that is, the "dots" that make up an overall picture. The individual cells in our mapped data represent an actual area on the ground surface that is approximately 30 meters by 30 meters in size.

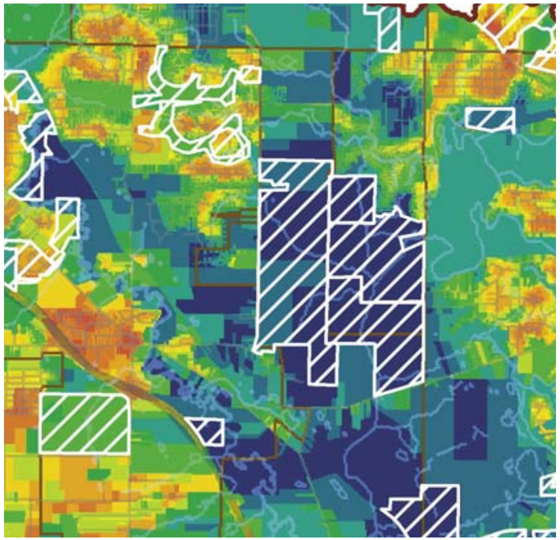
The scoring represents a range of values, allowing us to identify the most land are in terms of "Ecological System Value". Land cover values range from those that represent productive systems, to those associated with consumptive systems. Land with impervious cover, or commercial/industrial uses are part of a consumptive system, contributing to air pollution, flooding, and water quality impacts. Land uses representing productive systems include riparian corridors, woodlands, and wetlands, and contribute to flood mitigation and pollution removal.

It should be emphasized that our model identifies the most valuable land parcels based on ecosystem value and is not a risk assessment model. A GIS model that identifies land based on the existence of potential pollution sources to determine where restoration activities might be needed is an example of a risk assessment model. (Source: Trust for Public Land)





Priority Parcel Plan

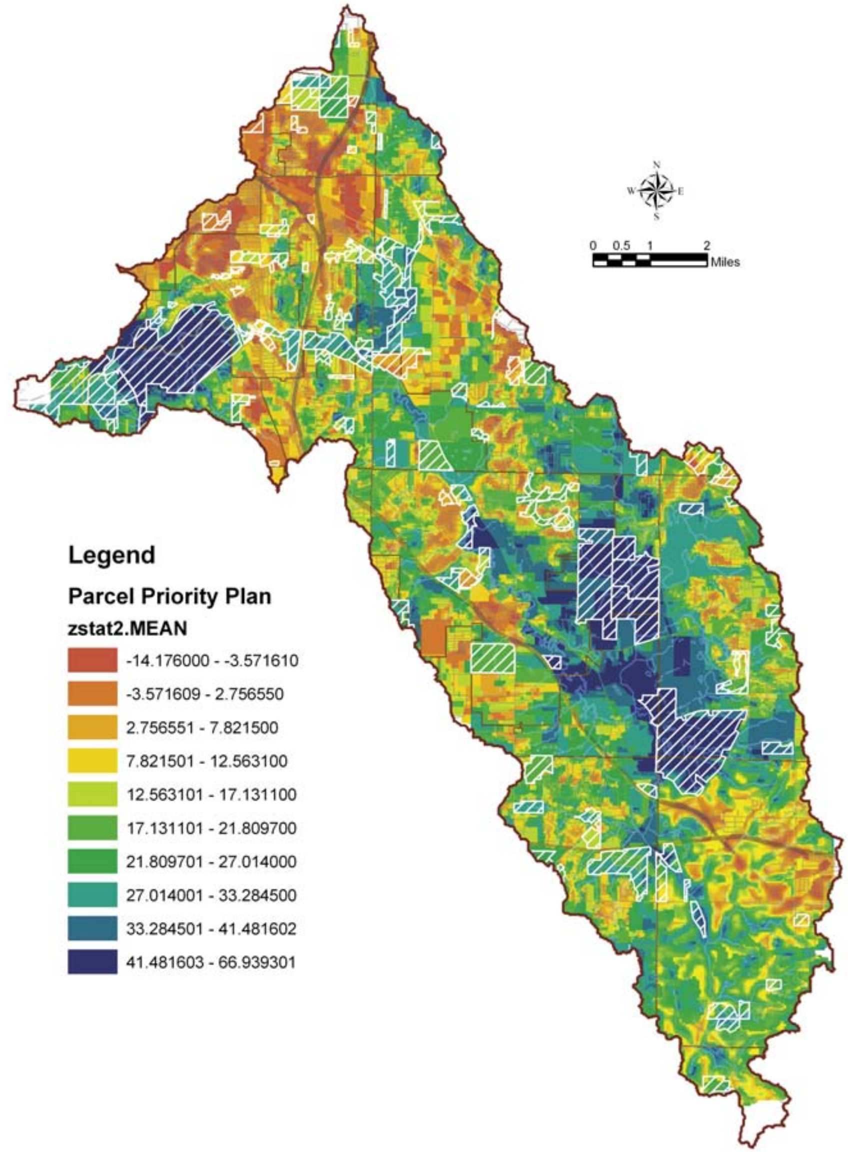


Enlargement of the Parcel Plan identifing the mean score for each parcel

Parcel Plan overlayed on the aerial.

The priority parcel plan takes the derived cell scores, and assigns them to individual land parcels. Utilizing this methodology, individual land parcels are assigned a score based upon the scored value of the cells that correspond to their location. An average (mean) score is then assigned to the entire land parcel.

The disadvantage of using this method is that an assumption is made that the entire land parcel has the same use as the average value, which may not be the case. A limitation to the data should also be noted. Parcel level data is currently not available for all of the counties within the watershed. At this time, only Cuyahoga and Summit counties have parcel level data available. The top fifty (50) land parcels that scored highest are identified on page 37.

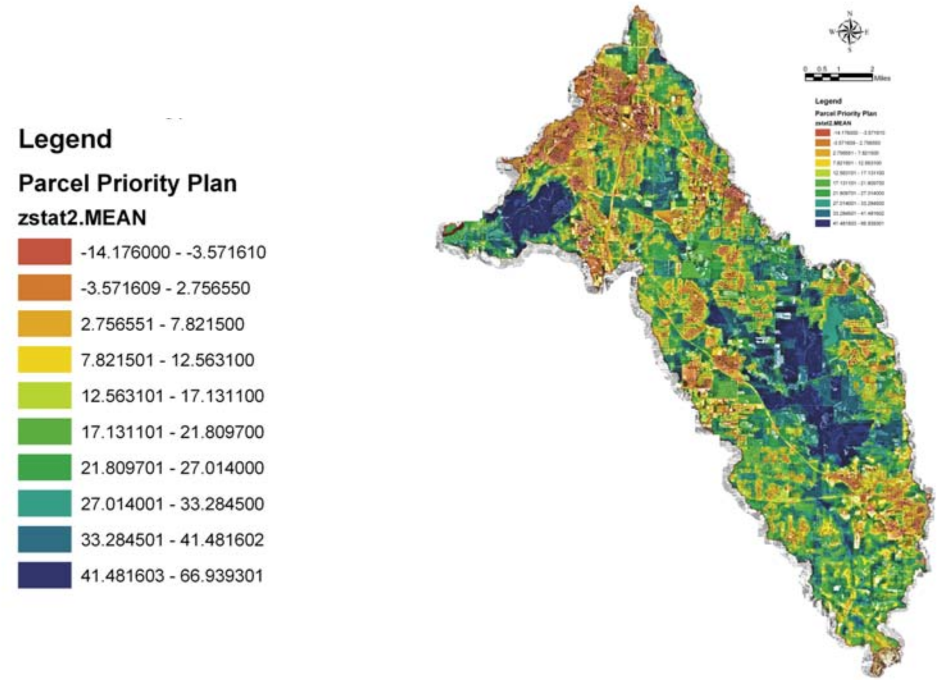


Top Parcels

Rank	MEAN SCORE	RECORD ACRES	CALC ACRES	ADDR	PARID	CLASS	LUC	OWN1	OWNADDR1	CITYNAME	OWNZIP 1
1	**62.92**	50.95	50.95	LIBERTY RD	6600257	A	100	BOARD OF COMMISSIONERS OF METRO	975 TREATY LINE RD	AKRON	44313
2	**58.89**	118.46	118.46	LIBERTY RD	6408644	A	100	CITY OF TWINSBURG	9701 BROOKPARK RD	CLEVELAND	44129
3	**58.55**	33.85	33.85	8579 RAVENNA RD	6200894	A	101	ODEN VICTOR J & VICTOR L	8579 RAVENNA RD	TWINSBURG	44087
4	**58.32**	56.95	56.95	MILL RD	6201065	E	610	STATE OF OHIO	705 OAKWOOD ST	RAVENNA	44266
5	**58.03**	30.05	30.05	AURORA RD	6200733	A	100	POND BROOK DEVELOPMENT INC	32145 OLD S MILES RD	SOLON	44139
6	**56.66**	29.08	29.08	8613 RAVENNA RD	6200893	A	101	JOHNSON CHRISTINE L & PIAZZA MARCIA J	8207 STOW RD	HUDSON	44236
7	**55.96**	88.34	95.23	LIBERTY RD	6408642	A	100	CITY OF TWINSBURG	9701 BROOKPARK RD	CLEVELAND	44129
8	**55.93**	0.00	0.86	SHADELAND ST	6500413	R	500	COOPER HOLDINGS LLC	15288 VIA PINTO	LOS GATOS	95030
9	**55.87**	23.03	23.03	3973 E AURORA RD	6200197	R	599	BOARD OF COMMISSIONERS OF METRO	975 TREATY LINE RD	AKRON	44313
10	**55.71**	25.11	25.11	RAVENNA RD	6200383	A	100	3279 OLD MILL ROAD LLC	6360 ROTHERBY CIRCLE	HUDSON	44236
11	**55.69**	108.00	108.00	AURORA RD	6200730	A	100	POND BROOK DEVELOPMENT INC	32145 OLD S MILES RD	SOLON	44139
12	**55.37**	18.16	18.16	RAVENNA RD	6200384	A	100	3279 OLD MILL ROAD LLC	6360 ROTHERBY CIRCLE	HUDSON	44236
13	**55.20**	0.00	5.96	RAVENNA RD	6201274	U	840	WHEELING & LAKE ERIE RAILWAY COMPANY			
14	**54.57**	46.74	46.74	LIBERTY RD	6600258	A	100	BOARD OF COMMISSIONERS OF METRO	975 TREATY LINE RD	AKRON	44313
15	**54.30**	0.00	327.28	LIBERTY RD	6601041	E	680	BD OF COMMISSIONERS OF METRO PARKS	975 TREATY LINE RD	AKRON	44313
16	**54.12**	0.23	0.23	8944 RAVENNA RD	6201250	R	500	BALOGH JAMES C & MARY BETH	8944 RAVENNA RD	TWINSBURG	44087
17	**53.72**	11.00	11.00	LIBERTY RD	6600256	R	500	BOARD OF COMMISSIONERS OF METRO	975 TREATY LINE RD	AKRON	44313
18	**53.49**	59.10	55.64	AURORA RD	6408643	A	100	CITY OF TWINSBURG	9701 BROOKPARK RD	CLEVELAND	44129
19	**53.44**	0.00	40.00	STONEWATER CT	6205495	R	500	PULTE HOMES OF OHIO LLC	30575 BAINBRIDGE RD SUITE 1	SOLON	44139
20	**52.88**	0.00	0.43	SHADELAND ST	6500119	R	500	GORDON WILLIAM L	1396 ANTLER ALLEY	JAMESTOWN	16134
21	**51.76**	0.00	8.60	HERRICK RD	6201275	U	840	WHEELING & LAKE ERIE RAILWAY COMPANY			
22	**51.70**	0.00	0.43	SHADELAND ST	6500039	R	500	COLLURA CHERYL		AURORA	44202
23	**51.69**	56.95	56.95	MILL RD	6201065	E	610	STATE OF OHIO	705 OAKWOOD ST	RAVENNA	44266
24	**51.65**	0.00	0.29	CONNECTICUT ST	6500208	R	500	COOPER HOLDINGS LLC	15288 VIA PINTO	LOS GATOS	95030
25	**51.63**	23.32	23.32	RAVENNA RD	6200449	A	100	HILLVIEW COMPANY ETAL	C/O STEVE MARTON	CHAGRIN FALLS	44022
26	**51.60**	11.18	11.18	RAVENNA RD	6201650	R	500	PAPESCH BONITA J & ROBERT J	8954 RAVENNA RD	TWINSBURG	44087
27	**51.56**	0.00	0.86	EAST BLVD	6500120	R	500	DIERSING RAYMOND F & MARCELLA	3500 CANNON RD	TWINSBURG	44087
28	**51.32**	60.82	60.82	E AURORA RD	6200731	A	100	POND BROOK DEVELOPMENT INC	32145 OLD S MILES RD	SOLON	44139
29	**50.91**	0.86	0.86	MAY AVE	6500301	R	500	COLLURA CHERYL		AURORA	44202
30	**50.69**	0.00	0.29	GEORGIA ST	6500202	R	500	COOPER HOLDINGS LLC	15288 VIA PINTO	LOS GATOS	95030
31	**50.64**	0.00	42.79	RAVENNA RD	6205380	A	100	WOLSTEIN SCOTT A TRUSTEE	C/O STEVE MARTON	CHAGRIN FALLS	44022
32	**50.61**	12.50	12.50	3575 ANTHONY LN	6200015	R	510	FREELAND DALE E & TAYLOR JAMETTA	3575 ANTHONY LANE	TWINSBURG	44087
33	**50.58**	26.90	26.90	RAVENNA RD	6200450	A	100	HILLVIEW COMPANY ETAL	C/O STEVE MARTON	CHAGRIN FALLS	44022
34	**50.52**	22.31	22.31	E AURORA RD	6200196	A	100	BOARD OF COMMISSIONERS OF METRO	975 TREATY LINE RD	AKRON	44313
35	**50.43**	24.46	24.46	E AURORA RD	6200200	E	640	CITY OF AURORA TWINSBURG TOWNSHIP			
36	**50.39**	0.00	0.32	3663 SEA RAY COVE	6600332	R	510	POT JAMES A	3663 SEA RAY COVE	AURORA	44202
37	**50.38**	11.21	11.21	9020 RAVENNA RD	6400693	A	199	ENSTEN LOUIS H		TWINSBURG	44087
38	**50.38**	96.01	96.01	3210 HUDSON AURORA RD	3003549	A	120	TENBROECK ELSIE M TRUSTEE	3210 AURORA RD	HUDSON	44236
39	**50.15**	7.51	7.51	HERRICK RD	6200363	R	500	WOLSTEIN SCOTT A TRUSTEE	C/O STEVE MARTON	CHAGRIN FALLS	44022
40	**49.92**	0.00	0.86	EAST BLVD	6500289	R	500	COLLURA CHERYL		AURORA	44202
41	**49.85**	228.84	228.84	9577 LIBERTY RD	6408640	A	101	CITY OF TWINSBURG	9701 BROOKPARK RD	CLEVELAND	44129
42	**49.81**	0.00	0.29	GEORGIA ST	6500334	R	500	PARKER WILLIAM R	904 LAUREL GLENS DR	MEDINA	44256
43	**49.78**	0.00	31.18	RAVENNA RD	6205379	A	100	TINKER CREEK LAND CONSERVANCY	PO BOX 805	TWINSBURG	44087
44	**49.71**	0.00	0.17	CONNECTICUT ST	6500213	R	500	COOPER HOLDINGS LLC	15288 VIA PINTO	LOS GATOS	95030
45	**49.59**	0.00	0.86	EAST BLVD	6500355	R	500	SAVIC ALEKSANDER SR TRUSTEE	7300 BROMPTON ST	HOUSTON	77025
46	**49.53**	0.00	0.86	EAST BLVD	6500315	R	500	NOVAK LOUIS A & IRENE N	2080 HERITAGE DR	TWINSBURG	44087
47	**49.36**	31.77	31.55	9372 LIBERTY RD	6406444	A	120	TWINSBURG TWO LLC	1718 PREYER AVE	CLEVELAND	44118
48	**49.26**	0.00	0.29	CONNECTICUT ST	6500002	R	500	ABELT RICHARD M AND CHARLOTTE R	4755 BLYTHIN RD	CLEVELAND	44125
49	**49.03**	0.00	1.10	ABRAMS DR	6408451	R	500	ABRAMS FARMS COMMUNITY ASSOCIATION INC	9345 RAVENNA RD	TWINSBURG	44087
50	**48.99**	23.99	23.99	E AURORA RD	6200199	A	100	BOARD OF COMMISSIONERS OF METRO	975 TREATY LINE RD	AKRON	44313

*Parcel Data includes Cuyahoga & Summit County, Portage and Geauga County Data is not available.

Subwatersheds



Subbassin	Name	Size (acres)	Size (Sq. MI)	Stream Length (MI) (4-7)	Stream Crossings	Projected Population	Population Density (#/SQ MI)	Percent population of watershed	Road Length miles	Road Density (mi/sq.mi)	Calc. Road Density Ratio	ICM (Imprv Cover)	Calculated Impvr (road density)	Population/ Road Mile	Road/Stream Crossings Density (#/SQ MI)
WTRSHED	**TINKERS CREEK**	63,672	99.49	553.91	1497	109,199	1,098	100.00%	705.03	7.09			20.12%	154.9	2.02
1	Tinkers Creek Confluence	1,825	2.85	20.78	20	1,243	436	1.14%	11.26	3.95	1.73	7.16%	8.29%	110.4	1.78
2	Wood Creek	2,302	3.60	6.03	62	12,903	3,587	11.82%	46.19	12.84	6.61	43.70%	41.81%	279.3	1.34
3	Deer Lick Run	2,018	3.15	14	48	2,106	668	1.93%	23.47	7.44	3.72	31.00%	21.46%	89.7	2.05
4	Tinkers Creek Gorge	5,451	8.52	51.86	144	13,248	1,555	12.13%	84.90	9.97	5.00	24.80%	30.98%	156.0	1.70
5	Hawthorn Creek	3,277	5.12	11.42	79	15,032	2,936	13.77%	59.80	11.68	6.63	39.25%	37.43%	251.4	1.32
6	Mud Creek	4,459	6.97	22.29	107	7,508	1,078	6.88%	54.02	7.75	4.03	27.77%	22.63%	139.0	1.98
7	Beaver Meadow Run	5,152	8.05	16.65	75	6,226	773	5.70%	47.58	5.91	3.80	27.01%	15.68%	130.9	1.58
8	Middle Tinkers Creek	12,459	19.47	73.26	310	23,684	1,217	21.69%	144.47	7.42	4.21	16.59%	21.38%	163.9	2.15
9	Pond Brook	10,139	15.84	67.18	315	11,492	725	10.52%	91.70	5.79	3.30	10.37%	15.22%	125.3	3.44
10	Tinkers Creek State Park	4,527	7.07	195.58	57	3,495	494	3.20%	29.74	4.20	2.14	7.97%	9.25%	117.5	1.92
11	Hudson Springs	3,830	5.98	18.84	109	5,628	940	5.15%	44.05	7.36	4.15	12.99%	21.15%	127.8	2.47
12	Bell Run	4,096	6.40	26.85	137	5,113	799	4.68%	47.35	7.40	4.00	17.37%	21.29%	108.0	2.89
13	Tinkers Creek Headwater	4,137	6.46	29.17	34	1,521	235	1.39%	20.50	3.17	1.63	6.16%	5.36%	74.2	1.66

1- Tinkers Creek Confluence

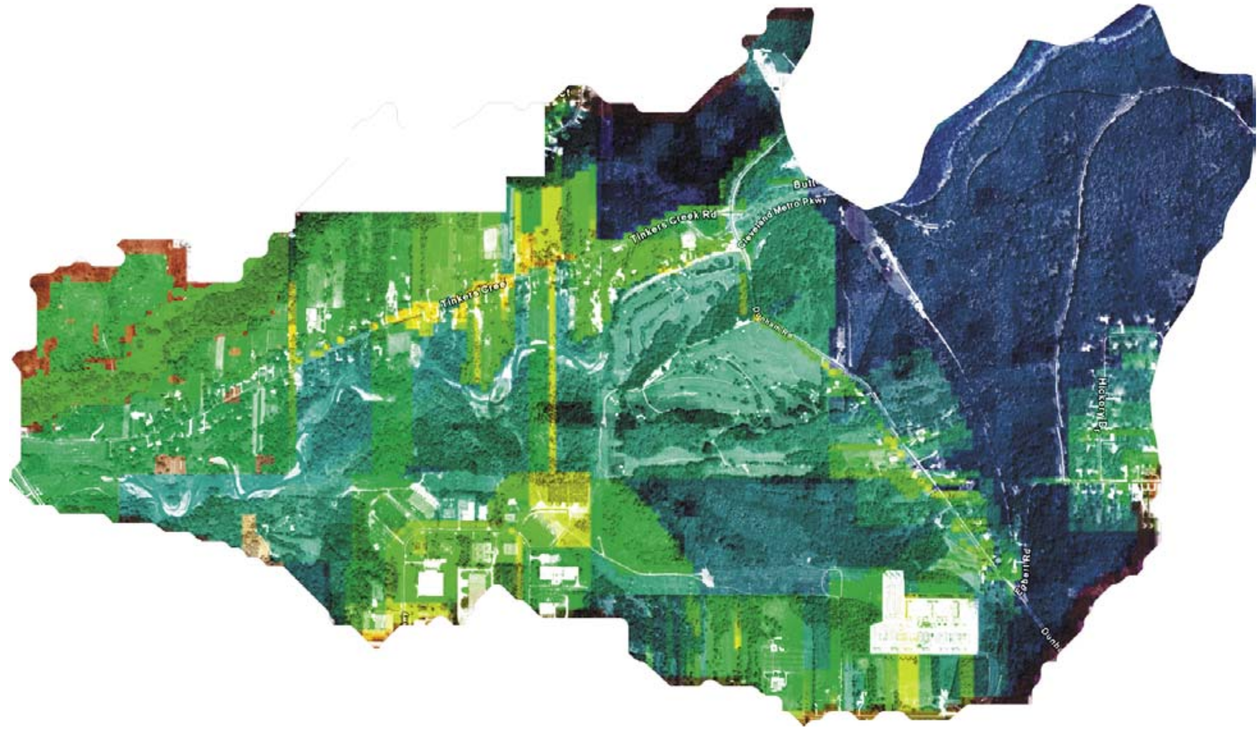
Tinkers Creek Watershed Land Conservation Priority Plan

Subwatershed Statistics

Subwatershed Size:	**2.85 sq mi. / 1,825 Acres**
Stream Name:	**Tinkers Creek**
Stream Length	**20.78 miles**
Stream/Road Crossing	**20 times**
Population Density:	**2,593 people/square mile**
Projected Population:	**2,941**
% Population of watershed:	**2.17 %**
Public Road Length:	**11.26 miles**
Road Density:	**3.95 mi/sq mi.**
Population/Road Mile	**656.84 people/mile**
Imperviousness:	**7.16%**

Land Use Classifications

Urban/Impervious	**203 ac.**	**11.15%**
Suburban	**313 ac.**	**17.18%**
Grass/Meadow	**362 ac.**	**19.88**
Forested	923 ac.	50.60%
Water	6 ac.	.33%
Barren	**68 ac.**	**3.73%**
Shrub	**44 ac.**	**2.41%**
Wetland	53.76 ac	2.95%



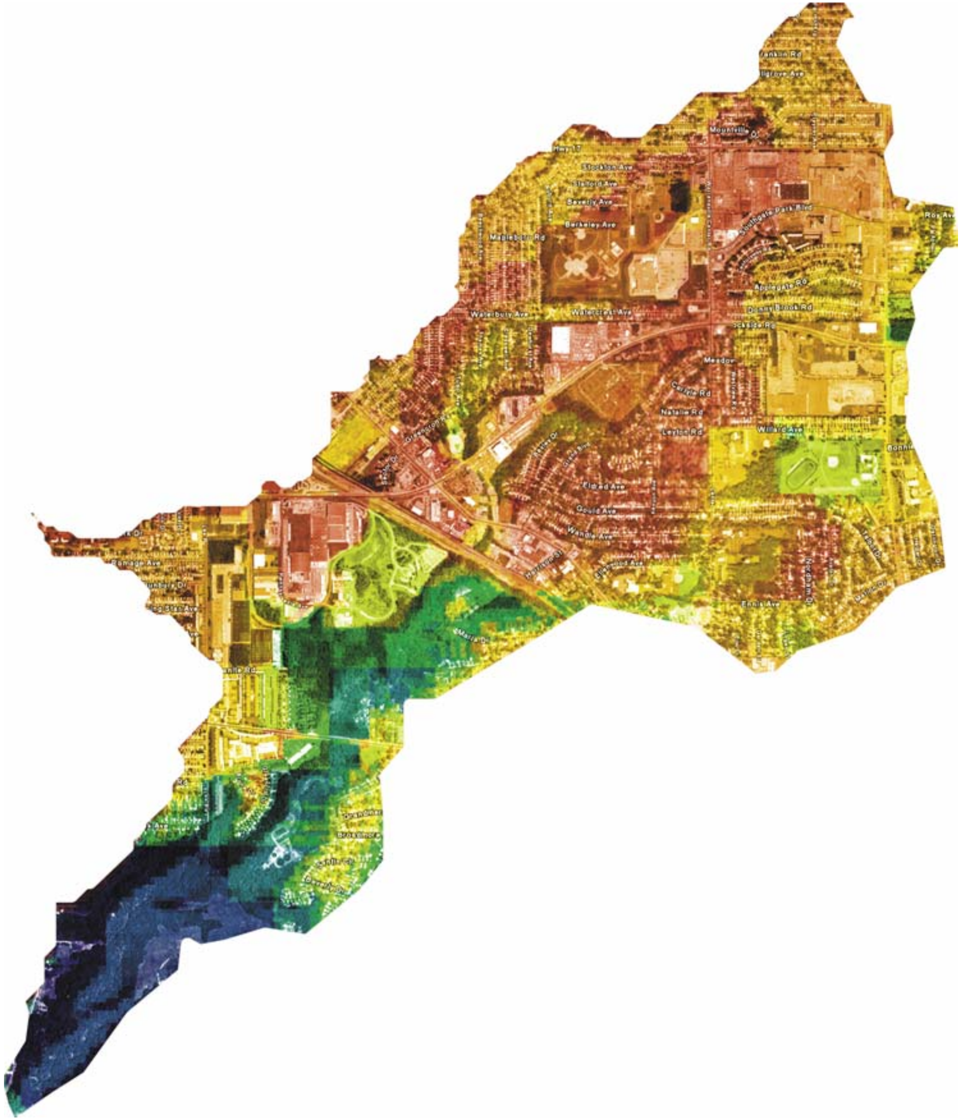
2- Wood Creek

Subwatershed Statistics

Subwatershed Size:	3.60 sq mi. / 2302 Acres
Stream Name:	Wood Creek
Stream Length	6.03 miles
Stream/Road Crossing	62
Population Density:	10,533 people/square mile
Projected Population:	12,314
% Population of watershed:	11.13 %
Public Road Length:	46.19 miles
Road Density:	12.84 mi/sq mi.
Population/Road Mile	820 people/mile
Imperviousness:	43.70%

Land Use Classifications

Urban/Impervious	1,261 ac.	54.79%
Suburban	651 ac.	28.31%
Grass/Meadow	189 ac.	8.23
Forested	319 ac.	13.88%
Water	1.55 ac	0.07%
Barren	24 ac.	1.08%
Shrub	16 ac.	0.72%
Wetland	7.19 ac.	0.31%



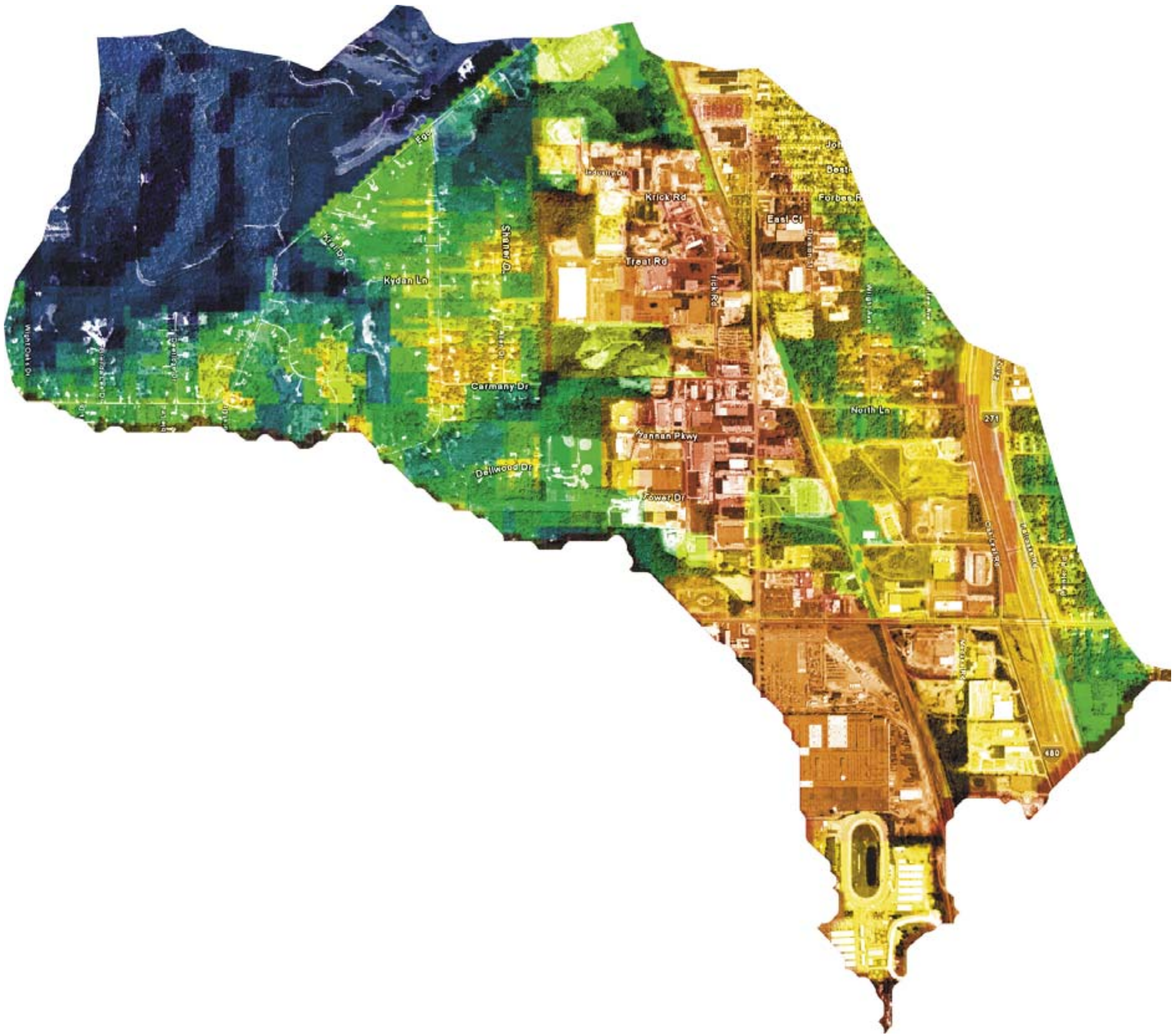
3- Deer Lick Run

Subwatershed Statistics

Subwatershed Size:	3.15 sq mi. / 2,018 Acres
Stream Name:	Deer Lick Run
Stream Length	14 miles
Stream/Road Crossing	48
Population Density:	4,102 people/square mile
Projected Population:	4,711
% Population of watershed:	3.80%
Public Road Length:	23.47 miles
Road Density:	7.44 mi/sq mi.
Population/Road Mile	551 people/mile
Imperviousness:	31.0%

Land Use Classifications

Urban/Impervious	817 ac.	40.50%%
Suburban	259 ac.	12.86%
Grass/Meadow	287 ac.	14.24
Forested	618 ac.	30.65 %
Water	1.93 ac.	0.10% %
Barren	51 ac.	2.54%
Shrub	15.30 ac.	0.76%
Wetland	46.89 ac.	2.32 %



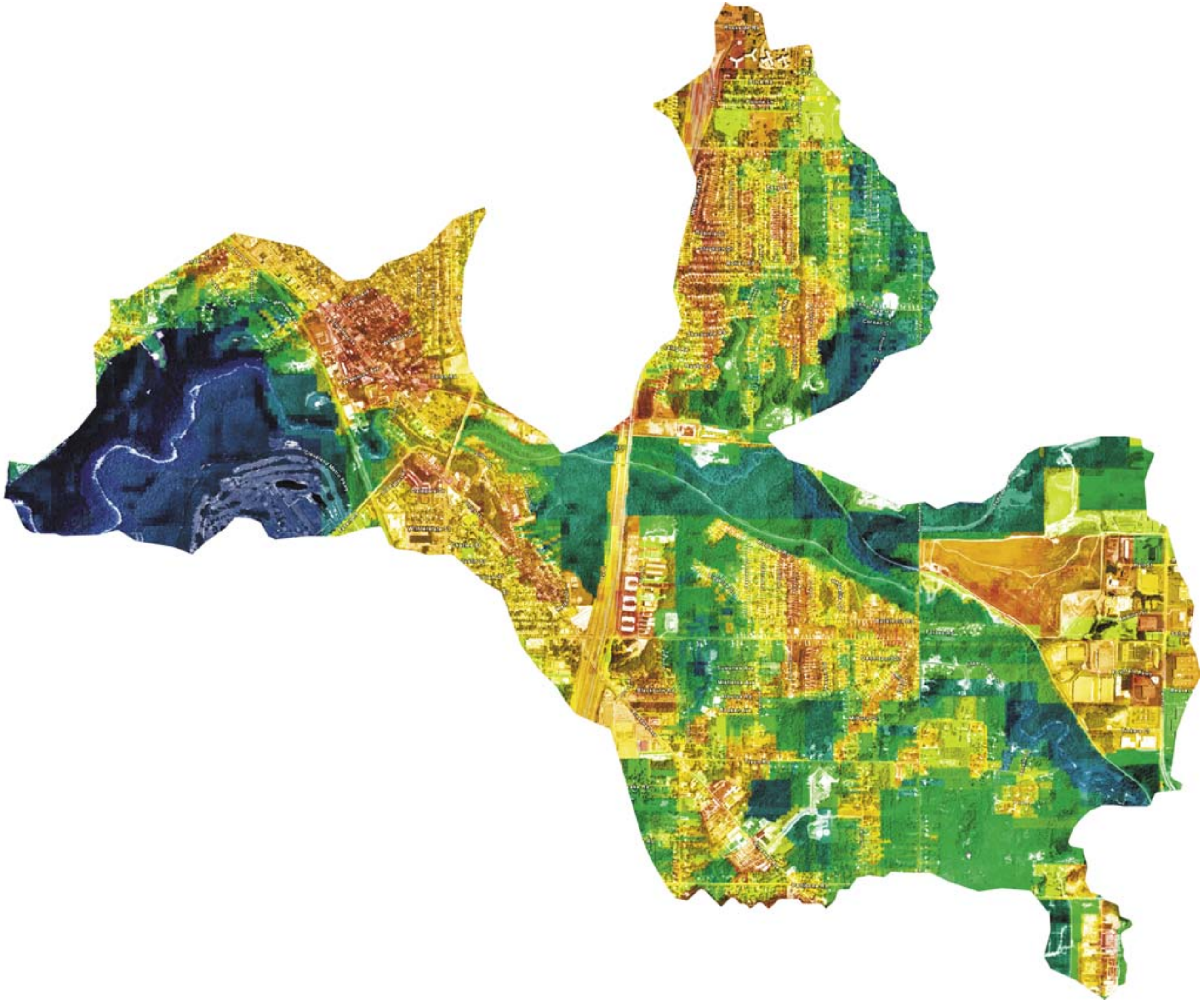
4- Tinkers Creek Gorge

Subwatershed Statistics

Subwatershed Size:	8.52 sq mi. / 5,451 Acres
Stream Name:	Tinkers Creek
Stream Length	51.86 miles
Stream/Road Crossing	144
Population Density:	4,660 people/square mile
Projected Population:	6,526
% Population of watershed:	11.66%
Public Road Length:	84.9 miles
Road Density:	9.97 mi/sq mi.
Population/Road Mile	467.55 people/mile
Imperviousness:	24.80%

Land Use Classifications

Urban/Impervious	1795 ac.	32.93%
Suburban	807 ac.	14.82%
Grass/Meadow	854 ac.	15.68
Forested	1,868 ac.	34.28%
Water	19.33 ac.	0.35%
Barren	150.72	2.77%
Shrub	80. 79 ac.	1.48%
Wetland	126 ac.	2.31%



5- Hawthorn Creek

Subwatershed Statistics

Subwatershed Size:	5.12 sq mi. /3,277 Acres
Stream Name:	Hawthorn Creek
Stream Length	11.42 miles
Stream/Road Crossing	79
Population Density:	6,474 people/square mile
Projected Population:	8,033
% Population of watershed:	9.74%
Public Road Length:	59.8 miles
Road Density:	11.68 mi/sq mi.
Population/Road Mile	554 people/mile
Imperviousness:	39.25%

Land Use Classifications

Urban/Impervious	1,616 ac.	49.33%
Suburban	461 ac.	14.08%
Grass/Meadow	439 ac.	13.42%
Forested	533 ac.	16.29 %
Water	2.71 ac.	0.08%
Barren	55.02 ac.	168%
Shrub	23.44 ac.	0.72%
Wetland	35.74 ac	1.09%

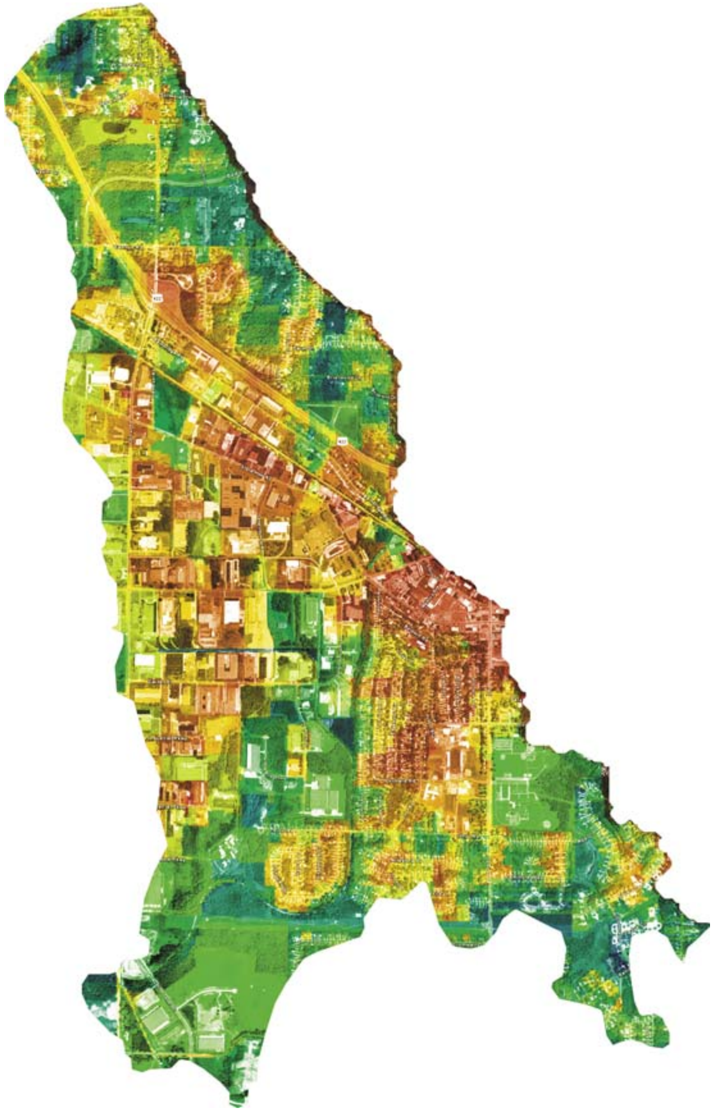
6- Mud Creek

Subwatershed Statistics

Subwatershed Size:	6.97 sq mi. / 4,459 Acres
Stream Name:	Mud Creek
Stream Length	22.29 miles
Stream/Road Crossing	107
Population Density:	2,685 people/square mile
Projected Population:	3,565
% Population of watershed:	5.50%
Public Road Length:	54.02 miles
Road Density:	7.75 mi/sq mi.
Population/Road Mile	346.35 people/mile
Imperviousness:	27.77%

Land Use Classifications

Urban/Impervious	1,528 ac.	34.29%
Suburban	508 ac.	11.41%
Grass/Meadow	848 ac.	19.04%
Forested	1,135 ac.	25.48%
Water	22.86 ac.	0.51%
Barren	88 ac.	1.97%
Shrub	92.41 ac.	2.07%
Wetland	126 ac.	2.83%



7- Beaver Meadow Run

Subwatershed Statistics

Subwatershed Size:	8.05 sq mi. /5,152 Acres
Stream Name:	Beaver Meadow
Stream Length	16.65 miles
Stream/Road Crossings	75
Population Density:	2,585 people/square mile
Projected Population:	3,564
% Population of watershed:	6.12%
Public Road Length:	47.58 miles
Road Density:	5.91 mi/sq mi.
Population/Road Mile	437.45 people/mile
Imperviousness:	27.01%

Land Use Classifications

Urban/Impervious	1,446 ac.	28.08%
Suburban	411.29 ac.	7.98
Grass/Meadow	762 ac.	14.80%
Forested	1,419 ac.	27.55 %
Water	8.75 ac.	0.17%
Barren	75.36 ac.	1.46%
Shrub	54.44 ac.	1.06%
Wetland	211 ac.	4.11%

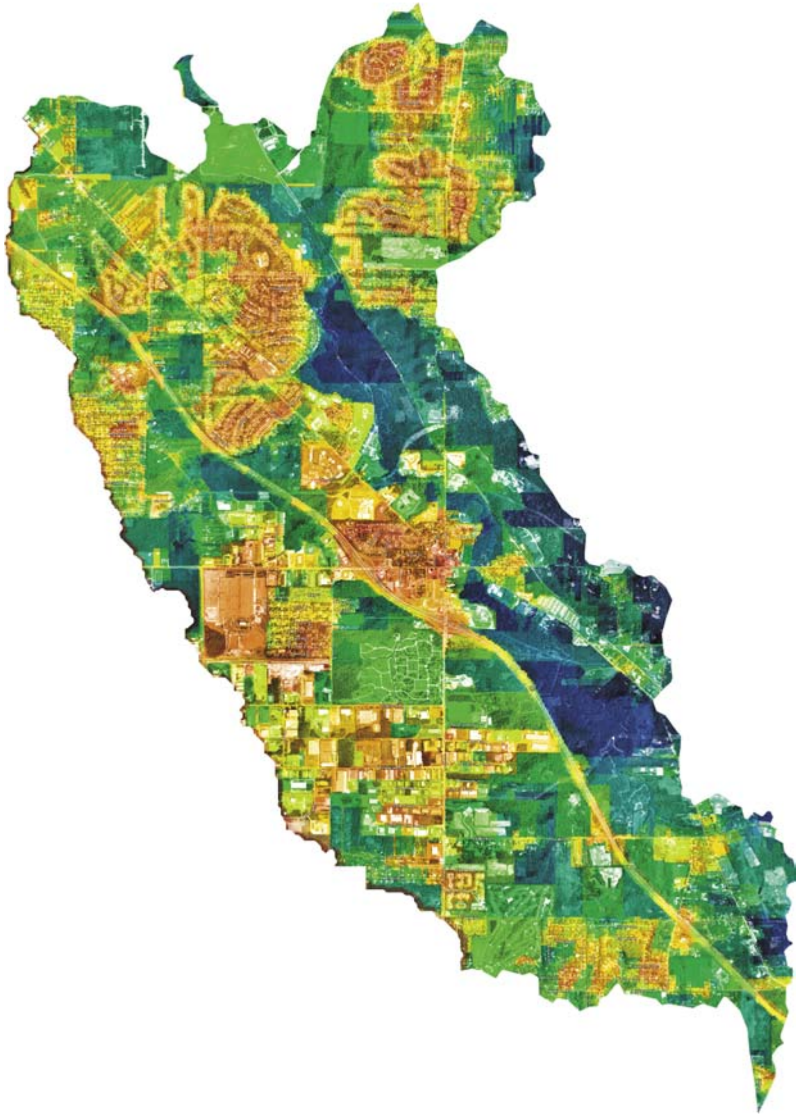
8- Middle Tinkers Creek

Subwatershed Statistics

Subwatershed Size:	19.47 sq mi. / 12,459 Acres
Stream Name:	Tinkers Creek
Stream Length	73.26 miles
Stream/Road Crossing	310
Population Density:	3,178 people/square mile
Projected Population:	6,088
% Population of watershed:	18.18%
Public Road Length:	144.47 miles
Road Density:	7.42 mi/sq mi.
Population/Road Mile	428 people/mile
Imperviousness:	16.59%

Land Use Classifications

Urban/Impervious	2829 ac.	22.71%
Suburban	1657 ac.	13.30%
Grass/Meadow	2504 ac.	20.10%
Forested	5,056 ac.	40.58%
Water	49.51 ac.	0.40%
Barren	280 ac.	2.25%
Shrub	205 ac.	1.65%
Wetland	974 ac.	7.82%



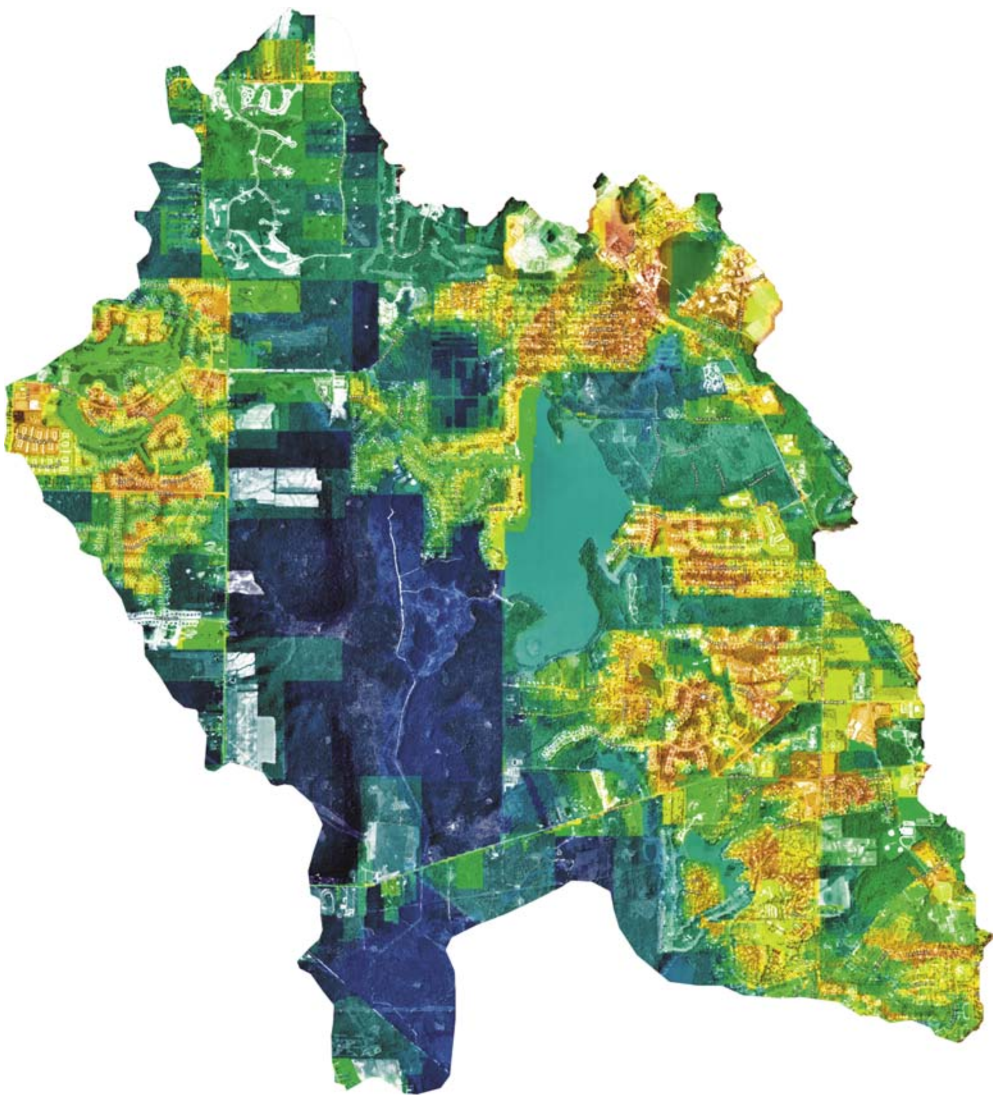
9- Pond Brook

Subwatershed Statistics

Subwatershed Size:	15.84 sq mi. /10,139 Acres
Stream Name:	Pond Brook
Stream Length	67.18 miles
Stream/Road Crossing	315
Population Density:	2,531 people/square mile
Projected Population:	4,416
% Population of watershed:	11.78%
Public Road Length:	91.70 miles
Road Density:	5.79 mi/sq mi.
Population/Road Mile	437.34 people/mile
Imperviousness:	10.37%

Land Use Classifications

Urban/Impervious	1,558 ac.	15.37%
Suburban	970 ac.	9.57%
Grass/Meadow	1713 ac.	16.90%
Forested	5,029 ac.	49.61%
Water	405 ac.	4%
Barren	178 ac.	1.76%
Shrub	127 ac.	1.26%
Wetland	858 ac.	8.47%



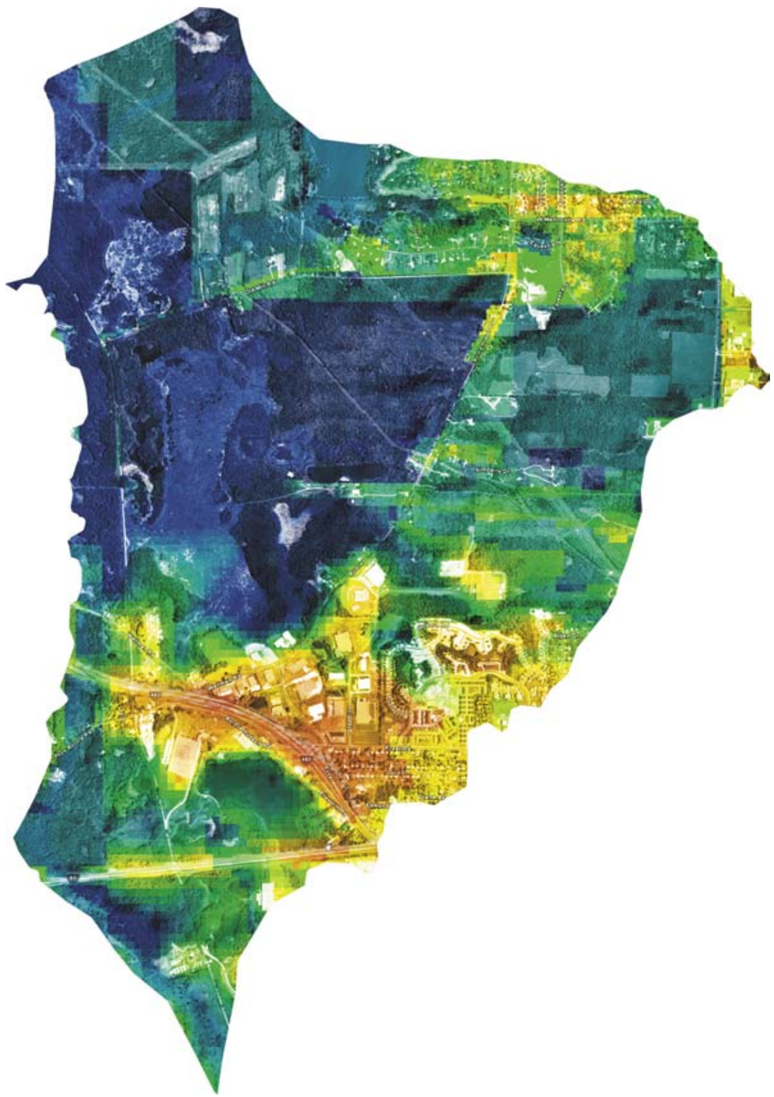
10- Tinkers Creek State Park

Subwatershed Statistics

Subwatershed Size:	7.07 sq mi. /4,527 Acres
Stream Name:	Tinkers Creek
Stream Length	195.58 miles
Stream/Road Crossing	57
Population Density:	2,400 people/square mile
Projected Population:	3,199
% Population of watershed:	4.99%
Public Road Length:	29.74 miles
Road Density:	4.20 mi/sq mi.
Population/Road Mile	570.95 people/mile
Imperviousness:	7.97%

Land Use Classifications

Urban/Impervious	562 ac.	12.43%
Suburban	303 ac.	6.70%
Grass/Meadow	609 ac.	13.47%
Forested	2,714 ac.	59.97%
Water	155.74 ac.	3.44%
Barren	98 ac.	2.17%
Shrub	102 ac.	2.27%
Wetland	338 ac.	7.49%



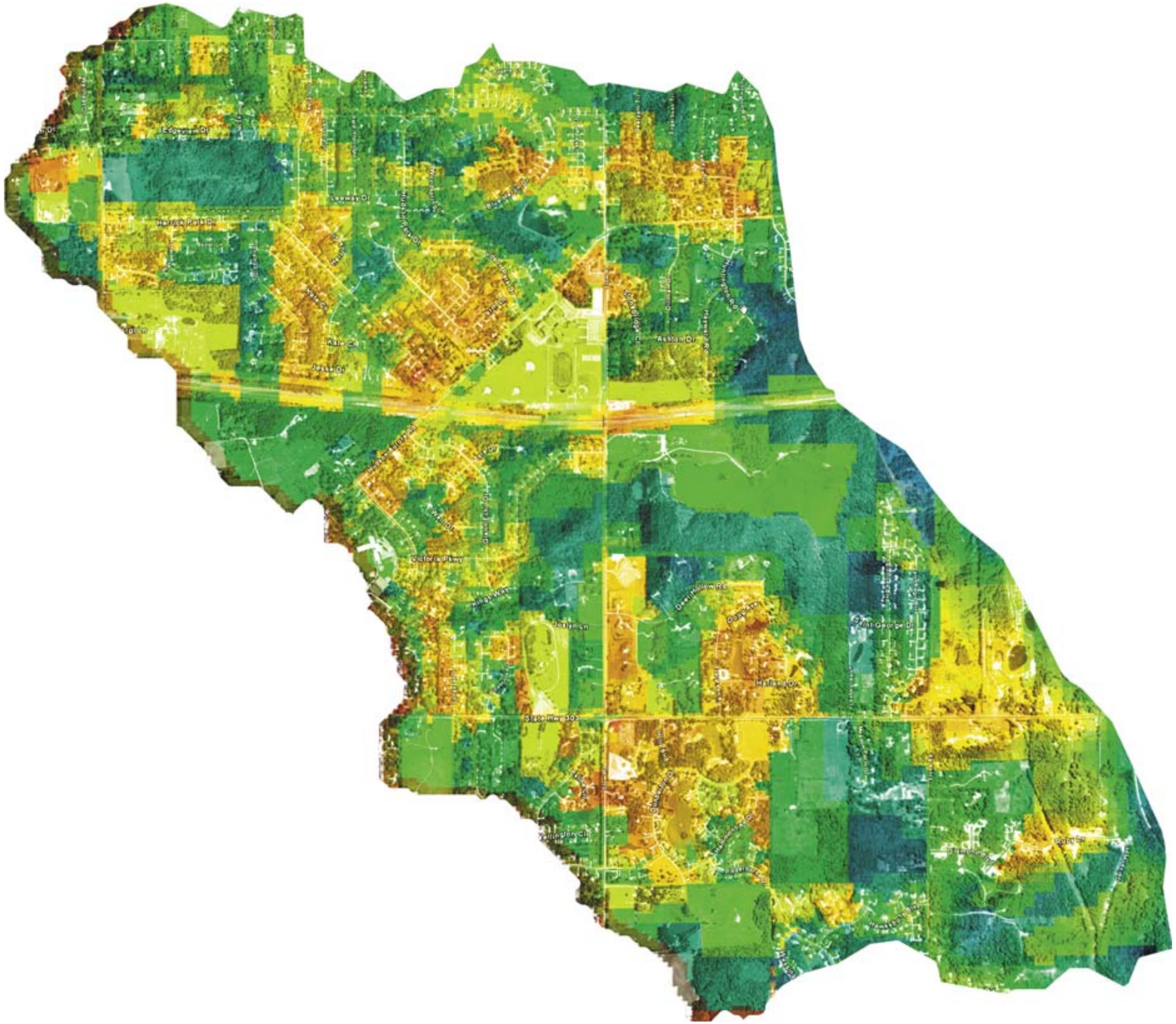
11- Hudson Springs

Subwatershed Statistics

Subwatershed Size:	**5.98 sq mi. / 3,830 Acres**
Stream Name:	**Tinkers Creek**
Stream Length	**18.84 miles**
Stream/Road Crossing	**109**
Population Density:	**2,808 people/square mile**
Projected Population:	**3,598**
% Population of watershed:	**4.94%**
Public Road Length:	**44.05 miles**
Road Density:	**7.36 mi/sq mi.**
Population/Road Mile	**381.54 people/mile**
Imperviousness:	**12.99%**

Land Use Classifications

Urban/Impervious	**407 ac.**	**10.65%**
Suburban	**648 ac.**	**16.94%**
Grass/Meadow	**1,117 ac.**	**29.18%**
Forested	**1,439 ac.**	**37.60%**
Water	**74.86 ac.**	**1.95%**
Barren	**96 ac.**	**2.51%**
Shrub	**74 ac.**	**1.95%**
Wetland	**109 ac.**	**2.85%**



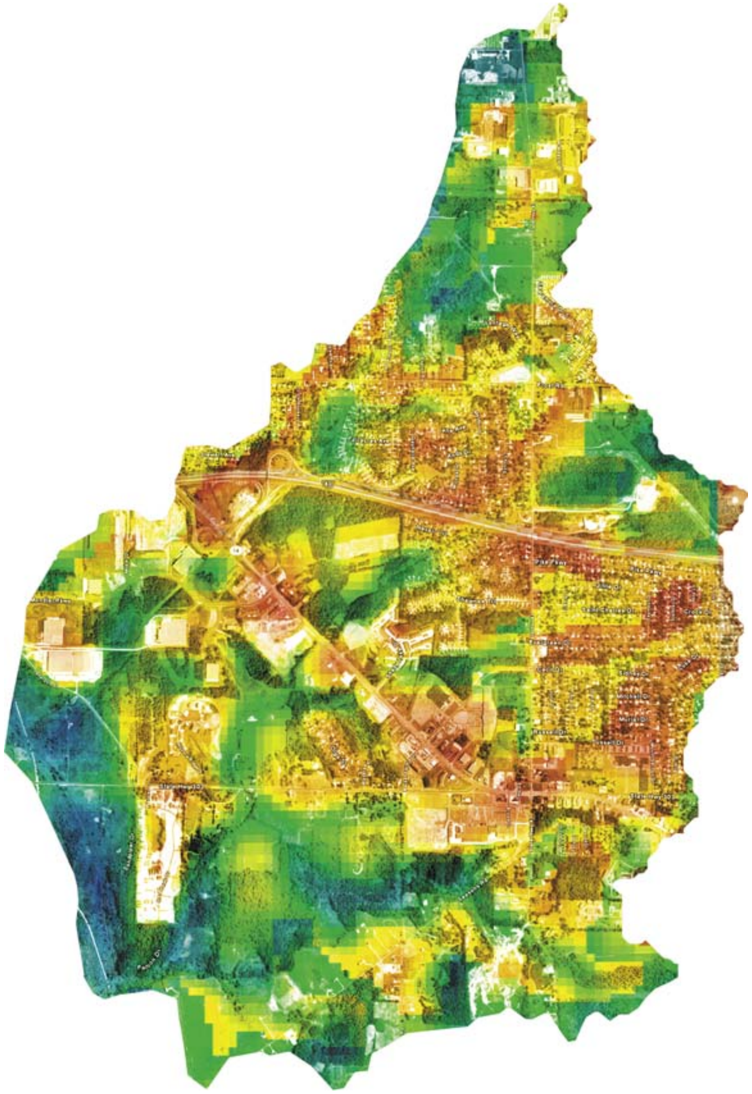
12- Bell Run

Subwatershed Statistics

Subwatershed Size:	6.40 sq mi. / 4,096 Acres
Stream Name:	Tinkers Creek
Stream Length	26.85 miles
Stream/Road Crossing	137
Population Density:	2,872 people/square mile
Projected Population:	3,736
% Population of watershed:	540%
Public Road Length:	47.35 miles
Road Density:	7.40 mi/sq mi.
Population/Road Mile	388.19 people/mile
Imperviousness:	17.37%

Land Use Classifications

Urban/Impervious	1,091 ac.	26.66%
Suburban	457 ac.	11.17%
Grass/Meadow	975 ac.	23.81%
Forested	1,212 ac.	29.61%
Water	25 ac.	0.63%
Barren	1104 ac.	26.96%
Shrub	118 ac.	2.89%
Wetland	459.47	11.22%



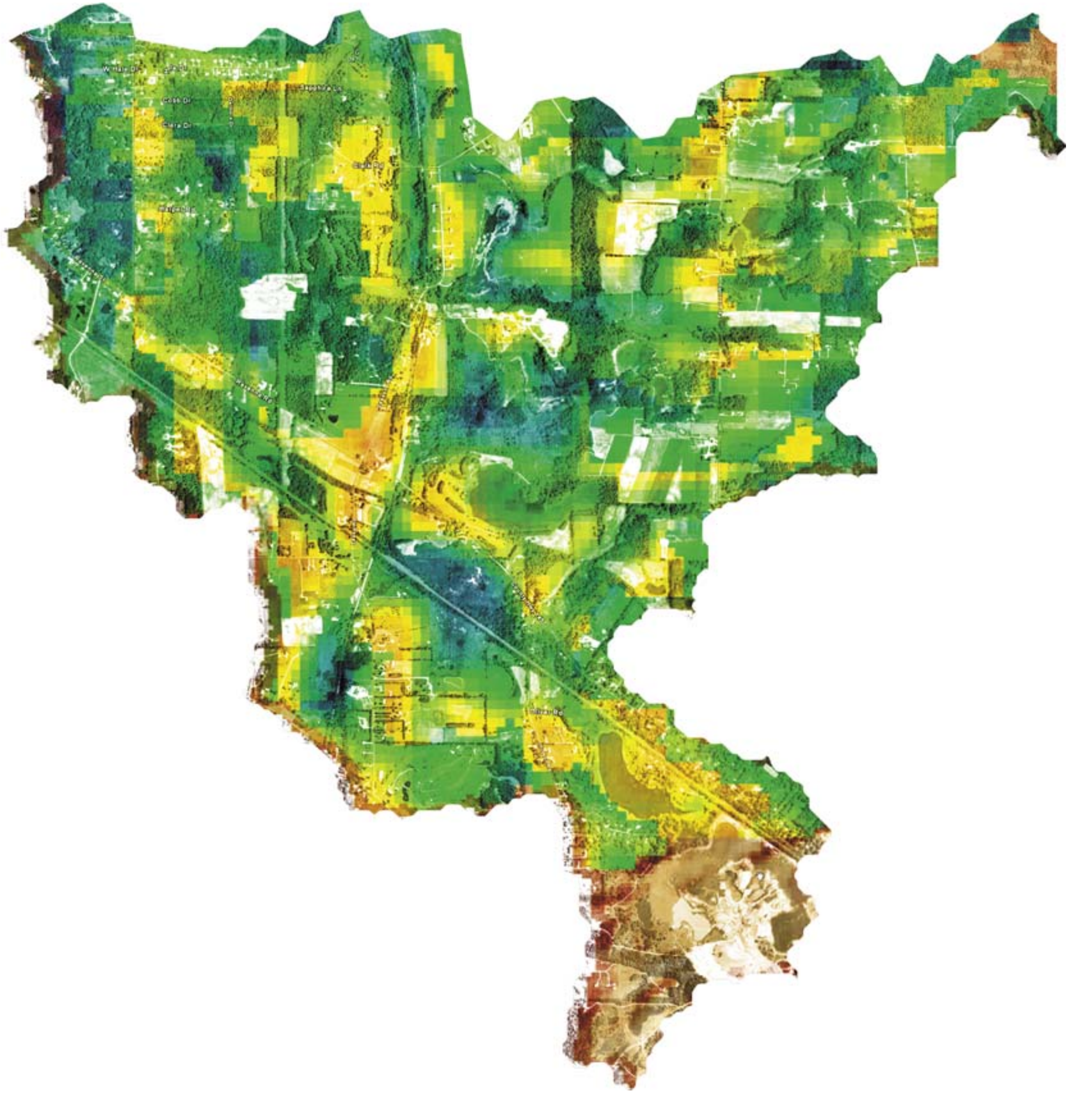
13- Tinkers Creek Headwaters

Subwatershed Statistics

Subwatershed Size:	6.46 sq mi. / 4,137 Acres
Stream Name:	Tinkers Creek
Stream Length	29.17 miles
Stream/Road Crossings	34
Population Density:	2,408 people/square mile
Projected Population:	3,140
% Population of watershed:	4.57%
Public Road Length:	20.50 miles
Road Density:	3.17 mi/sq mi.
Population/Road Mile	759 people/mile
Imperviousness:	6.16%

Land Use Classifications

Urban/Impervious	180 ac.	4.37%
Suburban	245 ac.	5.93%
Grass/Meadow	1321 ac.	31.93%
Forested	1,407 ac.	34.03%
Water	88 ac.	2.13%
Barren	67.97 ac.	1.64%
Shrub	241 ac.	5.84%
Wetland	32 ac.	0.79%



Appendices

Data Sources & References

Data layer	Original Gis Data Source	Original Data Source Location	Original file name	Tinker Area
Census data, Ohio Block (population, etc.)	United States Census Bureau	U.S. Census Bureau	Ohblkgrp.shp	kba-tinkers_ census
Congressional Districts	United States Census Bureau	U.S. Census Bureau	conDist1	Viewed as is - not converted
Contours	US Geologic Survey Obtained Via:http:// dept.kent.edu/soars	(http://www.kent.edu/ SOARS).	contours.shp	kba-tinker_ contours
Counties (Cuyahoga, Summit, Portage, and Geauga)	Magic 2001 Data CD (ESRI, NOACA,OEPA)	Magic 2001 Data CD from ESRI	7cbnd.shp	no data
Elevation Layer: DEM_ NED	USGS Seamless Data Distribution System; obtained via: SOARS 2003 (Kent State University)	(http://www.kent.edu/ SOARS).	DEM_NED.jpeg	clip to data frame
FloodPlain - 100 Year	SOARS 2003 (Kent State University)	http://www.kent.edu/ SOARS	flood_100yr	kb-tinkers_ floodplain
Headwaters	SOARS 2003 (Kent State University)	Original, other sources, Headwaters	Shapefile: C:\Documents and Settings\All Users\ Documents\0411-Tinkers Creek Mapping\Original Data\Others Sources\ Headwaters\tinkers_ headwaters	kba-tinkers_ headwaters
Lakes	Magic 2001 Data CD (ESRI, NOACA,OEPA)	Magic 2001 Data CD from ESRI	"county"00lake.shp	kba-tinkers_ lakes
Land Cover	OhioView Consortium Obtained via:Kent State University	http://www.kent.edu/ SOARS	Obtained via: OhioView Consortium	kba-tinker_ 070601land
NPDES	Ohio Environmental Protection Agency	http:// www.epa.state.oh.us/ pic/facts/npdes.html	Tinkers_NPDES.shp	kba-tinkers_ NPDES
Open Space	Gary Ellsworth-CLE-metroparks GIS Manager	email--	8 county open space sp nad83 2	kba-tinker_ openspace
Parks	Magic 2001 Data CD (ESRI, NOACA,OEPA)	Magic 2001 Data CD from ESRI	7cpark.shp	
Parcels- (summit, Cuyahoga, Aurora)	Summit County, Cuyahoga, Portage Geographic Information Services	Summit County CD, Origianl Data on Server	Parcel_Summit.shp;Parcel_ Regions.shp;Parcel_ new3.shp	kba_tinker_ parcel
Political Boundaries (municipalities)	Magic 2001 Data CD (ESRI, NOACA,OEPA)	Magic 2001 Data CD from ESRI	cu97muni.shp, (ge, po, su97muni)	kba-tinkers_
Rail Roads	Magic 2001 Data CD (ESRI, NOACA,OEPA)	Magic 2001 Data CD from ESRI	cu98rail.shp (ge, po, su98rail)	No tinkers
Roads	ESRI- Census 2000 TIGER data Obtained via: http//dept.kent.edu/soars/2003	http//dept.kent.edu/ soars/2003	Roads (Vector-Transportation	kba-tinkers_ roads-all
Satellite Imagery	EROS Data Center, Sioux Falls S.D. Obtained via:SOARS Kent State University	(http://www.kent.edu/ SOARS).	L7_081002	No data
School Districts	United States Census Bureau	U.S. Census Bureau	sn39_doo	kba-tinkers_
Soils	SOARS 2003 (Kent State University)	(http://www.kent.edu/ SOARS).	reprosoil.shp	kba-tinkers_ soils
Streams OEPA	Ohio Environmental Protection Agency	www.epa.state.oh.us	tinkers creek streams.shp	kba-tinkers_ streams.shp
Tinkers Subbasin	http://www.cuyahogariverrap.org/	http://www.cuyahogari verrap.org/	tinkerscreek.shp	kba-tinkers_ LULC
USGS -Topographic maps	US Geologic Survey Obtained Via:http:// dept.kent.edu/soars	(http://www.kent.edu/ SOARS).	basemap_ NW(SW,SE,NE).jpeg	USGS
Water	ESRI- Census 2000 TIGER data Obtained via: http//dept.kent.edu/soars/2003	http://dept.kent.edu/ soars/2003	tinkerscreek.shp	kba-tinkers_ streams.shp
Wetlands	Summit County Geographic Information Services	Summit County CD	wetland_drg	kba-tinker_ wetlands
Woodlands/Land Use Land Cover	SOARS 2003 (Kent State University)	http//dept.kent.edu/ soars/2003	tinkerscreek.shp	kba-tinkers_ woodland

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Trust for Public Land. Source Protection Handbook – Using Land Conservation to Protect Drinking Water Supplies.

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USGS. Streamflow statistics for Tinkers Creek at Bedford, Ohio. Stream gage identification: USGS 04207200

Glossary of Terms

Abiotic: The non-living components of an ecosystem, such as soil, climate, and hydrology.

Aggradation: To fill and raise the level of the bed of a stream by deposition of sediment.

Alluvial: 1) Deposits of silts, sands, gravels and similar detrital material which have been transported by running water. 2) Composed of sediment deposited by flowing water.

Ambient: Surrounding.

Anthropogenic: Something that is human induced or influenced.

Aspect: A particular direction, such as south.

Attenuation: The reduction in strength, force, or amount.

Bank: The lateral boundary of a stream confining water flow; the bank on the left side of a channel looking downstream is called the left bank.

Bankfull discharge: The discharge corresponding to the stage at which the natural channel is full.

Bankfull line: Maximum fill line at which a stream's natural banks end, and water rising beyond that becomes part of overflow or flood water.

Bar: An elongated deposit of alluvium within a channel or across its mouth.

Base flow: The flow contribution to a creek that comes from groundwater. During dry periods, base flow may constitute the majority of stream flow.

Bedload: The material moved by a river, exclusive of water, e.g., silt, sand, gravel, cobbles, and boulders.

Bench: A horizontal surface or step in a slope.

Best Management Practice (BMP): A structural or non-structural device designed to temporarily store or treat stormwater runoff in order to mitigate flooding, reduce pollution, and provide other amenities.

Biodiversity: The variety and abundance of species, their genetic composition, and the natural communities, ecosystems, and landscapes in which they occur.

Bioengineering: The integration of living woody and herbaceous materials along with organic and inorganic materials to increase the strength and structure of soil.

Biogeography: The study of the spatial distribution of life forms.

Brownfield: Abandoned or under-used industrial and commercial sites where future expansion or redevelopment can be directed after site remediation for possible contamination.

Build-out: The total percentage of development in a watershed based on current zoning.

Carbon sequestration: The ability of forests or other natural systems to "sink" or store carbon, thereby preventing it from collecting in the atmosphere as CO2. Forests absorb carbon when they break down CO2 during photosynthesis.

Channelization: The excavation, deepening, and straightening of stream channels to convey flows at a greater rate.

Chaparral: Vegetation consisting mainly of shrubs and small trees.

Canopy: The overhead branches and leaves of vegetation.

Community (Plant): A particular assembling of plant species reflecting the prevailing environment, soil type and management.

Concentrated flow: Flowing water that has been accumulated into a single, fairly narrow stream, increasing its potential for erosion.

Correlation: A statistical measure referring to the relationship between two or more variables, events, or occurrences. A correlation between two variables suggests some causal relationship (cause and effect) between these variables.

Cubic feet per second (CFS): A standard unit of measurement for water discharge. One cubic foot per second is equal to the discharge of a stream of rectangular cross section, 1 foot wide and 1 foot deep, flowing water an average velocity of 1 foot per second.

Degradation: The process by which stream beds lower in elevation; the opposite of aggradation.

Detrital: A collective term for loose rock and mineral material worn off or removed by mechanical means from pre-existing rock structures.

Deposition: The settlement of suspended material out of water.

Drainage basin: A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Dredging: Removal of mud from the bottom of water bodies. This can disturb the ecosystem and causes silting that kills aquatic life. Dredging of contaminated mud can expose biota to heavy metals and other toxics. Dredging activities may be subject to Federal regulation under Section 404 of the Clean Water Act.

Easement: An interest in land owned by another that entitles its holder to a specific limited use or enjoyment. A right, such as a right of way, afforded a person to make limited use of another's real property.

Effluent: Wastewater, treated or partially treated, that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Environmentally critical area: Any area recognized as a valuable environmental resource because of its outstanding scenic, cultural, ecological, natural, or geologic significance. Critical areas can include those valuable for their cultural or scenic quality, such as woodlands, farms, waterfalls, or scenic views. Critical habitat areas can include vernal pools, headwaters areas, wetlands, swamps, and riparian areas. They may be alternatively referred to as an "environmentally sensitive area".

Ephemeral Stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

Erosion: Removal of surface soils and rocks by action of water, wind, frost, ice and extreme sun/heat; internal erosion leads to change of the earth structure and piping; closed vegetation is the best safeguard against erosion.

Erosion and accretion: Loss and gain of land, respectively, by the gradual action of a stream in shifting its cannel by cutting one bank while it builds on the opposite bank; property is lost by erosion and gained by accretion.

Erosion control: Vegetation, such as grasses and wildflowers, and other materials such as straw, fiber, stabilizing emulsion, protective blankets, etc., placed to stabilize areas disturbed by grading operations, to reduce the loss of soil due to the action of water or wind, and prevent water pollution.

Eutrophication: 1) The process of water quality degradation caused by the presence of excessive dissolved nutrients in a water body. This can lead to excessive plant growth and algae, and deplete dissolved oxygen levels in the water, impacting fish and other organisms. 2) The process whereby a body of water becomes rich in dissolved nutrients through natural or man-made processes. This often results in a deficiency of dissolved oxygen, producing an environment that favors plant over animal life.

Exurban: Increased out-migration from urban and suburban areas, more land consumption per capita, and edge city formation around the periphery of central cities have led to more complicated patterns of settlement in which the distinction between suburban and rural has become increasingly blurred. A new type of development that is neither fully suburban nor fully rural has emerged, sometimes referred to as the "exurbs." Exurbs are located at greater distances from urban centers than suburban developments and are comprised of a different mix of land uses and population. Exurbs are areas that may appear to be in transition from a traditional rural setting to something more urban.

Floodplain: Areas adjacent to a stream or river that are subject to flooding or inundation during storm events and periods of increased runoff. (often called a 100-year floodplain, it would include the area or flooding that occurs, on average, once every 100 years.) 2) The lowland bordering a stream, which floods when the stream overflows its banks.

Fluvial geomorphology: The study of landforms created by and pertaining to the action of flowing water process such as rivers or streams.

Glossary of Terms

Geology: The physical make-up of the earth's surface in relation to rocks and other inorganic material, and the science that examines the structures and patterns formed by these materials.

Gradient (slope): The rate of ascent or descent expressed as a percent or as a decimal as determined by the ratio of the change in elevation to the length.

Groundwater: Water that is stored underground, such as in an aquifer, and does not readily flow freely. This water may be accessed/released through a well, spring or other means.

Groundwater recharge: The process through which surface water is infiltrated through the ground and joins underground aquifers. Recharge rates vary according to season, land cover type, and soil type, among other factors.

Herbaceous plants: Non-woody vegetation

Headwater area: The source or the upstream waters of a stream are referred to as the headwater area.

Hydraulics: The science and technology of the behavior of fluids.

Hydric Soils: Soils are characterized by frequent, prolonged saturation and low oxygen content, which lead to anaerobic chemical environments (oxygen-lacking conditions) that support the growth and regeneration of hydrophytic vegetation (plants specialized to grow in water or in soil too waterlogged for most plants to survive). This term is part of the legal definition of a wetland included in the Food Security Act of 1985.

Hydrograph: A graph showing stage, flow, velocity, or other properties of water with respect to time.

Hydrologic cycle: A convenient term to denote the circulation of water from the sea, through the atmosphere, to the land; and thence, with many delays, back to the sea by overland and subterranean routes, and in part by way of the atmosphere; also the many short circuits of the water that is returned to the atmosphere without reaching the sea. The cycle of water movement from the atmosphere to the earth and its return to the atmosphere through various stages or processes, such as precipitation, interception, runoff, infiltration, storage, evaporation, and transpiration.

Impervious cover: Any surface in the landscape that cannot effectively absorb or infiltrate rainfall. In the context of watershed planning and issues, impervious surfaces commonly discussed include paved or concrete areas such as parking surfaces, roads and sidewalks, and surfaces that are covered over by structures such as buildings.

Incised channel: Those channels which have been cut relatively deep into underlying formations by natural processes. Characteristics include relatively straight alignment and high, steep banks such that overflow rarely occurs, if ever.

Incision: The downward cutting of a channel into its streambed; also known as degradation.

Infiltration: The passage of water through the soil surface into the ground.

Instream Cover: Areas of shelter in a stream channel that provide aquatic organisms protection from predators or competitors and/or a place in which to rest and conserve energy due to a reduction in the force of the current.

Meander: In connection with streams, a winding channel usually in an erodible, alluvial valley; a reverse or S-shaped curve or series of curves formed by erosion of the concave bank, especially at the downstream end, characterized by curved flow and alternating shoals and bank erosions; meandering is a stage in the migratory movement of the channel, as a whole, down the valley.

MS4: This designation under the NPDES program refers to a municipal separate storm sewer system. This definition does not include combined sewer systems.

NOX: Stands for nitrogen oxides, which are a chief component of air pollution produced by fossil fuel burning, including gasoline and coal. Nitrogen oxide reacts with other compounds in the atmosphere to form smog, and is a major component of acid rain.

Non-Point Source Pollution: Variable, unpredictable, and dispersed pollution sources from agriculture, silviculture, mining, construction, saltwater intrusion, waste deposition and disposal, and pollution from urban-industrial development areas. A source of water pollution that is difficult to trace because it does not come from one specific place. This occurs when water runs over land or through the ground, picks up pollutants, and deposits them in surface waters or introduces them into the ground.

NPDES: An acronym for the National Pollutant Discharge Elimination System. Established by Section 402 of the Clean Water Act, this federally mandated system is used for regulating point source and stormwater discharge. The program includes Phase II Storm Water rules, which mandates that operators of small municipal sewer systems and developers of construction sites to implement programs and practices to control polluted storm water runoff.

Ordinary high water mark: The line on the shore established by the fluctuation of water and physically indicated on the bank (1.5+ years return period).

Open Space: Land which is permanently set aside for public or private use and will not be developed with homes or commercial businesses. The space may be used for passive or active recreation, or may be reserved to protect or buffer natural areas.

Palustrine: A type of wetland that is a shallow freshwater system, such as a marsh or pond.

Peak flow: Maximum momentary stage or discharge of a stream.

Perennial Stream: A stream that maintains water in its channel throughout the year.

Permeability: The property of soils which permits the passage of any fluid. Permeability depends on grain size, void ratio, shape and the arrangement of pore spaces.

Physiographic: The physical features of the land, in particular its slope, elevation, and geologic features and make up.

Point Source Pollution: Steady, predictable, and concentrated pollution from through "end of pipe" discharges from manufacturing and water treatment plants.

Pool: Deeper, still areas in a flowing stream that provide a good habitat for fish and other aquatic organisms.

Reach: The length of a channel uniform with respect to discharge, depth, area, and slope; more generally, any defined length of a river or drainage course.

Revegetation: Planting of indigenous plants to replace natural vegetation that has been damaged or removed. This work includes provisions for irrigation.

Riffle: 1) A shallow area in a stream with rapids. 2) The steeper portions of stream channels, typically where water flows quickly and is shallow.

Riparian: Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water. Land related to the banks of a stream. Land specifically delineated by the transition between the aquatic ecosystem and the adjacent terrestrial ecosystem and defined by soil characteristics and distinctive vegetation communities that require free and unbound water. Areas include stream channels, lakes, wetlands, and adjacent floodplains and riparian ecosystems.

River: A large stream, usually active when any streams are flowing in the region.

Riverine: Associated with a river system, e.g., a riverine wetland,

Runoff: 1) The surface waters that exceed the soil's infiltration rate and depression storage; 2) The portion of precipitation that appears as flow in streams; 3) Drainage or flood discharge which leaves an area as surface flow or a pipeline flow, having reached a channel or pipeline by either surface or subsurface routes.

Saltation: Small pieces of gravel and sand that bounce along the riverbed in a series of short hops as the river picks them up then drops them again because they are too heavy or large to be suspended in the water.

Sand: Granular soil coarser than silt, but finer than gravel, generally ranging from 0.05 to 5mm in diameter.

Sandstone: A coarse-grained sedimentary rock formed when sand sized particles (usually rich in quartz) are cemented together. Compared to shale it is lower in fertility, coarser in texture, and more permeable. This results in a deeper soil profile.

Scour: The process by which a channel is deepened through the action of moving water. The result of erosive action of running water, primarily in streams, excavating and carrying away material from the bed and banks; wearing away by abrasive action.

Glossary of Terms

Sediment: Fragmentary material that originates from weathering of rocks and is transported by, suspended in, or deposited by water. Fragmental material that originates from the weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

Sedimentation: The process whereby sediment particles are washed from the land to eventually be deposited at the bottom of a waterway. May be used interchangeably with the term siltation.

Seepage: Groundwater emerging from the face of a streambank; flow of water in the pores of soil under influence of gravity or capillary action.

Shale: A fine-grained, detrital, sedimentary rock, formed by the compaction and lithification of clay, silt, or mud. It has a finely laminated (composed of layers) structure, that gives it a fissility, or tendency to split along bedding planes.

Sheet erosion: Erosion of thin layers of soil by sheets of flowing water.

Sheet flow: Any flow spread out and not confined; i.e. flow across a flat open field.

Shrub: Woody growth whose main and side shoots form multiple branches from main stock baseline or form below-ground side shoots or on which, instead of only one stem (main stem), several stems are grown.

Silt: 1) Waterborne sediment. Detritus carried in suspension or deposited by flowing water, ranging in diameter from 0.005 to 0.05 mm. The term is generally confined to fine earth, sand, or mud, but is sometimes both suspended and bedload. 2) Deposits of waterborne material, as in a reservoir, on a delta, or on floodplains.

Siltation: Generally refers to the accumulation of soil that has eroded from another source and been carried into a body of water by storm water runoff. May be used synonymously with the term sedimentation.

Sinuosity: The ratio of the length of the river thalweg to the length of the valley proper. The ratio of channel length between two points on a channel to the straight line distance between the same two points.

Slope: 1) Gradient of a stream; 2) Inclination of the face of an embankment, expressed as the ratio of horizontal to vertical projection; or 3) The face of an inclined embankment or cut slope. In hydraulics it is expressed as percent or in decimal form.

Soil bioengineering: Use of live, woody vegetative cuttings to repair slope failures and increase slope stability; the cuttings serve as primary structural components, drains, and barriers to earth movement.

SOX: Stands for sulfur dioxide, a chief component of air pollution formed during the incineration of fossil fuels. Sulfur dioxide is a major component of acid rain.

Spoils: The material removed from channels and canals by dredging.

Sprawl (Urban Sprawl): A pattern of growth and development that is unplanned and uncontrolled. It is characterized by significant land consumption, low population densities in comparison with older communities, automobile dependence by the residents, and limited or fragmented open space.

Stream: Water flowing in a channel or conduit, ranging in size from small creeks to large rivers.

Stakeholder: Any agency, organization, or individual that is involved in, affected by, or interest in a particular activity or set of activities.

Stream Buffer: Defined as a minimum area of land directly adjacent to and on either side of a river or stream, designated as 'no-build' where disturbance is not allowed. The primary purpose of the stream buffer is to preserve or enhance natural vegetation in order to provide adequate filtration of pollutants and improve water quality.

Stream Order: A system used to classify (and analyze) streams. Also, a method of numbering streams as part of a drainage basin network. The smallest unranked mapped tributary is called first order, the stream receiving the tributary is called second order, and so on. The main stream is always the highest order with a particular system.

Substrate: 1) The mineral and organic material that is from the bed of the stream; 2) The layer of earth or rock immediately below the soil surface. 3) The mineral and/or organic material that forms the bed of the stream.

Subwatershed: A subdivision of a watershed based on hydrology, generally corresponding to the area drained by a small tributary, as opposed to a major river.

Surface runoff: The movement of water on the earth's surface, whether flow is overland or in a channel.

Surface water: Water that is stored in an above ground state, such as in a lake, river, marsh or stream.

Suspended load: Sediment that is supported by the upward components of turbulent currents in a stream and that stay in suspension for an appreciable amount of time.

Swale: A shallow, gentle depression in the earth's surface. This tends to collect the waters to some extent and is considered in a sense as a drainage course, although waters in a swale are not considered stream waters. A swale may be seasonally wet or marshy, is usually heavily vegetated with marsh grasses and is normally without flowing water

Taxa: Plural for groups and kinds of organisms, e.g., families of plants.

Temperate: Refers to zones located between the subtropics and the polar circles, which experience distinct seasons. Temperature ranges can be extreme within these climates, and precipitation occurs throughout the year.

Thalweg: A longitudinal line that follows the deepest part of the channel of a stream.

Topography: The shapes, patterns and physical configuration of the surface of the land, including its relief (local differences in elevation) and the positions of natural and man-made features.

Total Maximum Daily Load (TMDL): Maximum amount of pollutant or sediment a waterbody can receive and still satisfy water quality standards.

Transport: To carry solid material in a stream in solution, suspension, saltation, or entrainment.

Trophic: Of or pertaining to nutrition, or the level of feeding in an ecosystem.

Turbidity: a) Relative water clarity. b) A measurement of the extent to which light passing through water is reduced due to suspended materials. c) Cloudiness caused by the presence of suspended solids in water, an indicator of water quality.

Undermining: The removal of lateral support at the base of a slope by scour, piping, erosion, or excavation.

Vegetation: A plant cover formed of many different plant types; the whole of the plant species of one area.

Watershed: An area of land that drains into a particular river, lake, or ocean, usually divided by topography. All the land which contributes runoff to a particular point along a waterway. Also called catchment area, drainage area, or basin.

Wetland: Areas inundated by water at or near the surface of the land or covered by shallow water. Wetlands can be scientifically delineated by the presence of hydric soils, hydrophyllic plants, and water.

Zoning: A set of regulations and requirements that govern the use, placement, spacing, and size of buildings and lots within a specific area or in a common class (zone).

100 Year Flood Event: A flood event of a magnitude expected to be equaled or exceeded once on the average during any 100-year period. The term "100 year flood" does not mean that a flood will only occur once every 100 years, but rather that there is a 1% chance in any given year that a flood might occur. Thus, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood is the standard used by most state and federal agencies, including the Federal Emergency Management Agency (FEMA) and by the National Flood Insurance Program (NFIP) in determining the need for flood insurance.