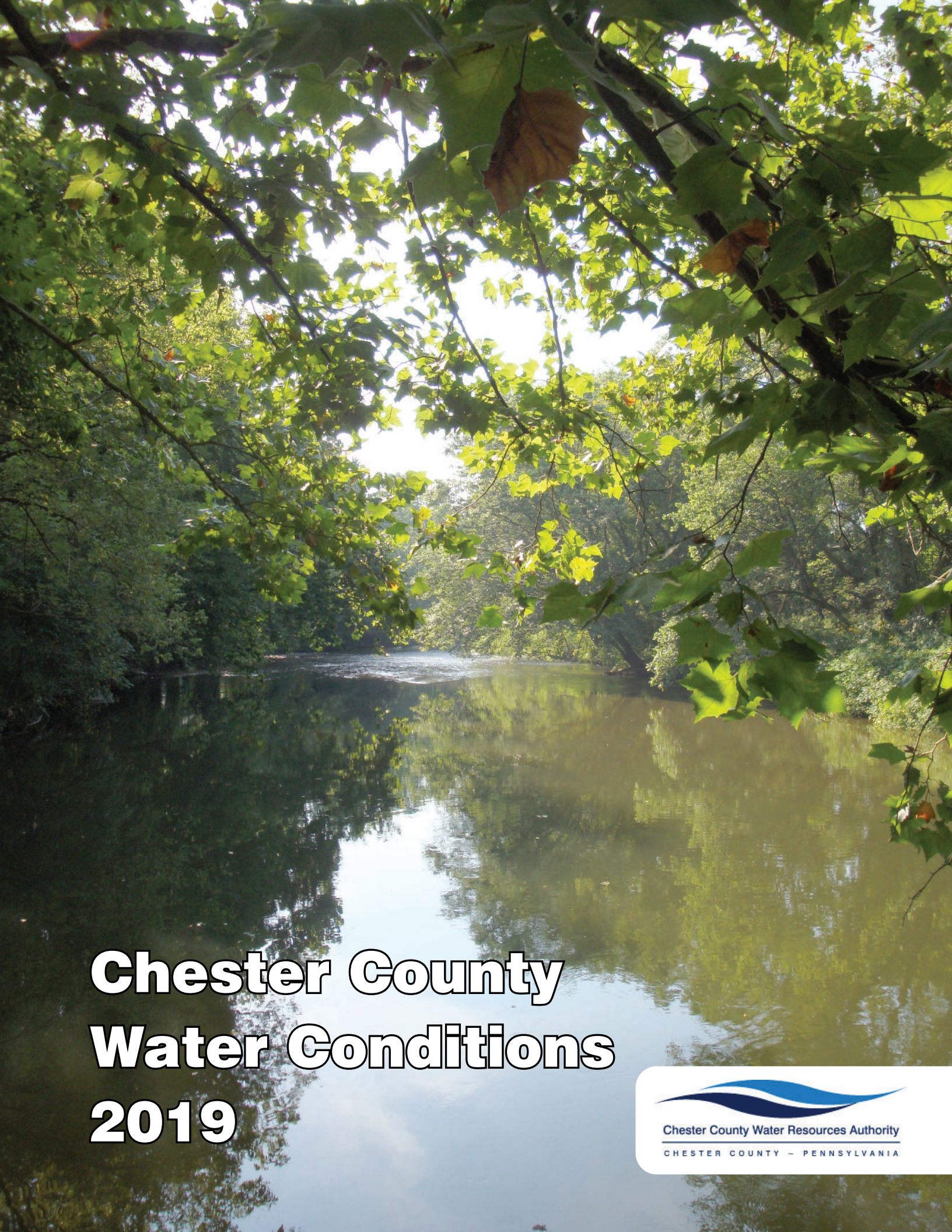


Chester County Water Conditions 2019

Chester County Water Resources Authority

CHESTER COUNTY – PENNSYLVANIA

Contents

Acknowledgments

The Chester County Water Resources Authority and Chester County gratefully acknowledge the technical and financial support provided by the U.S. Geological Survey (USGS) for the Chester County-USGS cooperative water monitoring program.

USGS
science for a changing world
https://www.usgs.gov/centers/pa-water

Sources Online: Data sources and references are available on the CCWRA web site at www.chesco.org/4471/Chester-County-Water-Conditions-Report--

On the Cover: West Branch Brandywine Creek, Newlin Township, Chester County

Published: 11/23/2020

Summary of 2019 Water Conditions

A review from CCWRA's Executive Director, Dr. Seung Ah Byun

The annual Water Conditions report presents a snapshot of Chester County's water resources in 2019 and highlights select long-term water quality trends over the last 20 years. The Chester County-USGS cooperative water quality monitoring program supports the mission of the Chester County Water Resources Authority (CCWRA) to provide flood protection, sustainable water supply, and water science, information and planning for our communities and natural ecosystems.

Several of the water quality parameters monitored through the cooperative program increased in 2019; however, these results must be viewed within the context of the the County's seasonal precipitation levels. A few of the highlights from data collected in 2019 are summarized below:

- After a record-setting year for precipitation in 2018, groundwater levels and stream flows were well above average at the start of 2019. Overall, the County received nearly 54.9 inches of rainfall, 7.9 inches above average.
- High groundwater and stream levels from a record-setting wet year in 2018 were sustained through much of 2019 by elevated spring and summer rainfall.
- The County-wide average biodiversity score continued to gradually increase. Over the past two decades, the average score from the County's 18 fixed sampling sites has increased by more than 20%, rising from 54.0 in 1999 to 66.6 in 2019.
- Eleven of the 18 annual sampling sites saw an increase in total nitrogen concentration, however the average concentration across all sites remained relatively unchanged from 2018.
- While annual phosphorus concentrations vary widely at some sites, levels increased at most sites in 2019. These increases may partially be explained by lower stream flows during the 2019 sampling period when compared to 2018. Overall, phosphorus levels have decreased over the last two decades.
- Chloride concentrations were greater at 14 of the 18 annual sites, with a mean increase of 5.1% across all sampling sites.

While the results from a single year of monitoring data provides a momentary perspective of the County's water resources, long-term data collection offers a more complete story and provides context to annual variations. This report summarizes a few of the water quality trends seen across Chester County over the past 20 years.

The management and protection of the County's water resources are the work of our entire community. CCWRA has partnered with several other agencies and organizations to help maintain and improve our valuable water resources for public health, flood protection, recreation, and aquatic habitat. The health of our waterways continues to support vital ecosystem services and shape the landscape of Chester County.

Seung Ah Byun, PhD, PE

Dr. Seung Ah Byun was appointed to serve as the Executive Director for the Chester County Water Resources Authority in August 2020. She brings to Chester County more than 20 years of extensive water resources experience in nonprofit, government, academia and private consulting. Her collective work in water resources has ranged from water supply availability to stormwater management to local policy-based initiatives for water quality improvement.

Chester County Water Resources Authority
CHESTER COUNTY ~ PENNSYLVANIA

About the Chester County Water Resources Authority

The mission of the Chester County Water Resources Authority is to provide flood protection, reservoir water supplies, and water science, information and planning to the citizens of Chester County so that they may live in safe, healthy and prosperous communities that sustain the natural quality, quantity and biodiversity of the County's water resources.

WHO WE ARE

The Chester County Water Resources Authority is a municipal authority that was established by the Chester County Board of Commissioners in 1961 to provide flood protection and water supply resources in the Brandywine Creek Watershed and to provide water resources management, science, information, planning, and monitoring services for Chester County. The Authority is comprised of a nine member Board of Directors, each appointed by the Chester County Board of Commissioners. Its staff includes a team of five administrative and water resources professionals.

OUR PROGRAMS

Stormwater and Pollution Reduction

- Provide technical tools, information, analyses, and guidance to municipalities and partners to support watershed-based planning, to reduce stormwater impacts, and to address stormwater regulations.
- Maintain county-wide water quality and flow monitoring networks.
- Deliver informational products to the general public and to public and private decision-makers to aid in their understanding of the importance of protecting water resources.

Water Resources Management

- Provide reservoir management, operation, and raw water supplies to support the greater Coatesville regional public water supply system.
- Collaborate with the USGS to provide real-time instream flow and groundwater monitoring to support water supply withdrawal management and maintain the county-wide water quality monitoring network.
- Provide interpretive information to support the protection of sources of water supplies.
- Provide technical information and assistance to water suppliers and their source water protection efforts.

Flood Protection

- Own and manage four regional flood control facilities in the Brandywine Creek watershed.
- Provide dam safety oversight, emergency preparedness planning, flood preparedness, and floodplain management coordination and information to municipalities and the public.
- Provide real-time flood conditions monitoring and flood mitigation information for the public, emergency responders, municipalities, and local emergency coordinators.

Water Awareness and Information

- Provide science-based information and educational products through various media outlets and public events describing the character and conditions of Chester County's water resources.
- Increase awareness among the public, residents, businesses, and property owners of the importance of the County's waters and the vulnerability of those resources to the impacts of pollution and erosion from surface runoff.
- Collaborate with the public, municipalities, businesses, and property owners to inform them of ways they can reduce pollution and protect the County's water resources.

The Importance of Monitoring

Understanding impacts to public health and economic livelihood.

THE IMPORTANCE OF WATER QUALITY MONITORING

In December 2019, the Chester County Water Resources Authority (CCWRA) released a report summarizing results from selected physical and chemical water resources parameters collected by CCWRA and the U.S. Geological Survey (USGS) from monitoring stations located across Chester County. This current report builds upon the previous version by including County-wide monitoring results through the end of 2019.

The conditions of Chester County's water resources impact the lives of every resident. Clean streams and groundwater aquifers are essential to sustaining healthy and vibrant communities and maintaining the bucolic character of our stream corridors. Long-term monitoring of these parameters helps us understand the current state of Chester County's water resources and identify long-term trends in water quality.

USGS Hydrologic Technician making a discharge measurement during a rainfall event.

HOW WERE THE DATA COLLECTED?

The majority of the data presented in this report were collected through the Chester County/USGS Cooperative Water Resources Program, which is jointly funded by the County of Chester and the U.S. Geological Survey. This partnership supports stream gaging stations throughout the County that provide stage and streamflow data and 28 observation wells that are used to measure groundwater levels. Eleven of the stream gage stations monitor one or more additional water quality parameters, including temperature, turbidity, specific conductance, pH, and dissolved oxygen. Data used to measure biotic diversity and water quality parameters such as nitrogen, phosphorus, and chloride levels are collected each fall at 18 separate long-term monitoring sites. Information on surface water withdraws for public water systems was obtained from the Pennsylvania Department of Environmental Protection.

HOW ARE THE DATA USED?

CCWRA uses the data collected to provide guidance and technical assistance to municipalities, water suppliers, industrial dischargers, watershed and conservation organizations, state and Federal agencies, river basin commissions, and members of the general public. These data are also used by other County agencies, such as the Planning Commission, Health Department, and Conservation District, in conducting their programs and activities and planning for future growth.

The conditions of Chester County's water resources impact the lives of every resident. Long-term monitoring helps us identify trends in water quality across the County's streams.

Precipitation

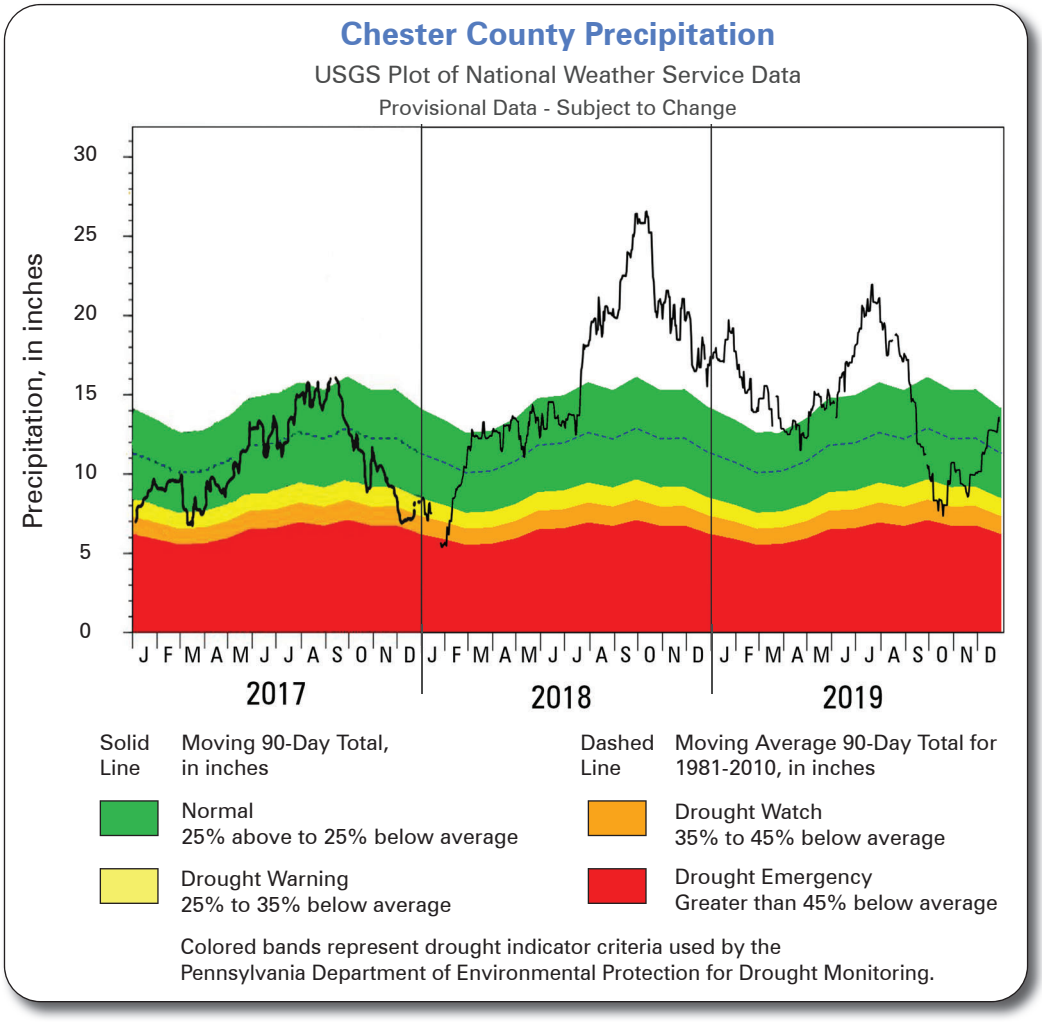
Rain and snow are the foundation of the water resources in the County.

Chester County received 54.9 inches of precipitation in 2019, which was 7.8 inches, or 17%, above the County's historic average of 47.1 inches.

BACKGROUND

CCWRA closely monitors precipitation trends because precipitation levels exert a substantial influence on both the quantity and quality of surface waters and groundwater. Since rainfall patterns vary, and it is common to have periods of weeks with little to no rainfall, precipitation is often evaluated using cumulative rainfall over the preceding 90-days, measured in inches. Data collected by the National Weather Service (NWS) are used to determine if recent precipitation amounts are within normal levels, or if the region is entering a drought watch, warning, or emergency.

Recent variability in precipitation patterns illustrate the uncertainty in future local rainfall trends. This uncertainty highlights the need for adaptive stormwater and floodplain management and planning that considers the potential for more variability in precipitation amounts, stormwater runoff, and groundwater table levels, as noted by several studies (Maimone et al. 2019 & Shortle et al. 2015).



KEY FINDINGS

- For the second year in a row, precipitation levels in Chester County were above average.
- According to the NWS, Chester County received 54.9 inches of precipitation in 2019, which is 7.8 inches above the historic County average of 47.1 inches per year.
- From January through July, the County received 37.4 inches of rain, which was 10.5 inches, or 39%, above the normal value for this time period.
- The 90-day precipitation total peaked at just over 21 inches in late July.
- Wet conditions persisted across the County through July, but dry conditions in September and October resulted in the 90-day precipitation total dipping to Drought Watch levels.
- The County received 17.5 inches of precipitation from August to December, which was 2.6 inches, or 13%, below normal precipitation levels for this time period.

Monthly Precipitation for Chester County, in inches

Month	Chester County Monthly Total	3-Month Total	Monthly Departure from Normal	3-Month Departure from Normal
January 2019	4.3	19.2	0.9	8.2
February 2019	3.1	13.9	0.4	3.9
March 2019	5.4	12.8	1.4	2.7
April 2019	3.7	12.2	- 0.2	1.6
May 2019	6.4	15.5	2.2	3.4
June 2019	7.3	17.4	3.3	5.3
July 2019	7.2	20.9	2.5	8.0
August 2019	2.8	17.3	-1.0	4.8
September 2019	1.1	11.1	-3.6	-2.1
October 2019	7.0	10.9	3.0	-1.6
November 2019	1.8	9.9	-1.9	-2.5
December 2019	4.8	13.6	0.9	2.0
Total for 2019	**54.9**	**n/a**	**7.9**	**n/a**
Total for 2018	69.8	n/a	22.7	n/a
Total for 2017	42.7	n/a	-4.3	n/a
Total for 2016	40.7	n/a	-6.5	n/a
Total for 2015	45.7	n/a	-1.4	n/a

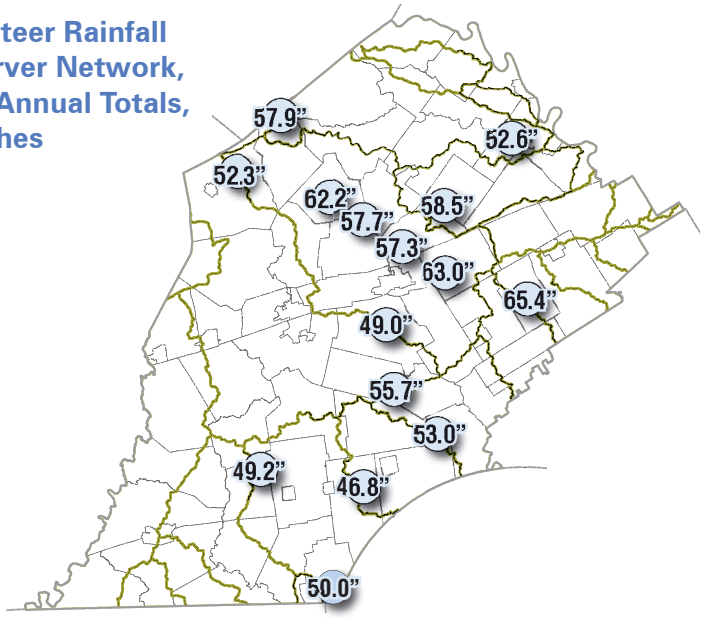
Source: National Weather Service's Middle Atlantic River Forecast Center

CHESTER COUNTY VOLUNTEER RAINFALL OBSERVER NETWORK

Chester County is fortunate to have a network of 15 volunteers who report monthly rainfall totals through the Chester County Volunteer Rainfall Observer Network. These data supplement the data collected by the National Weather Service and help to identify patterns of precipitation distribution across the County.

The Volunteer Network began in the late 1970's. This program collects precipitation data that provide a relative index of rainfall across the County to provide information regarding severe weather events. The volunteer observers keep track of daily rainfall and snowfall totals and submit their report at the end of each month to CCWRA.

Volunteer Rainfall Observer Network, 2019 Annual Totals, in inches



Groundwater

Groundwater sustains the base flow of streams throughout the County. Approximately 40% of County residents rely on private groundwater wells for their water supply.

Groundwater levels remained elevated throughout the year at most monitoring sites, with levels peaking in the spring.

BACKGROUND

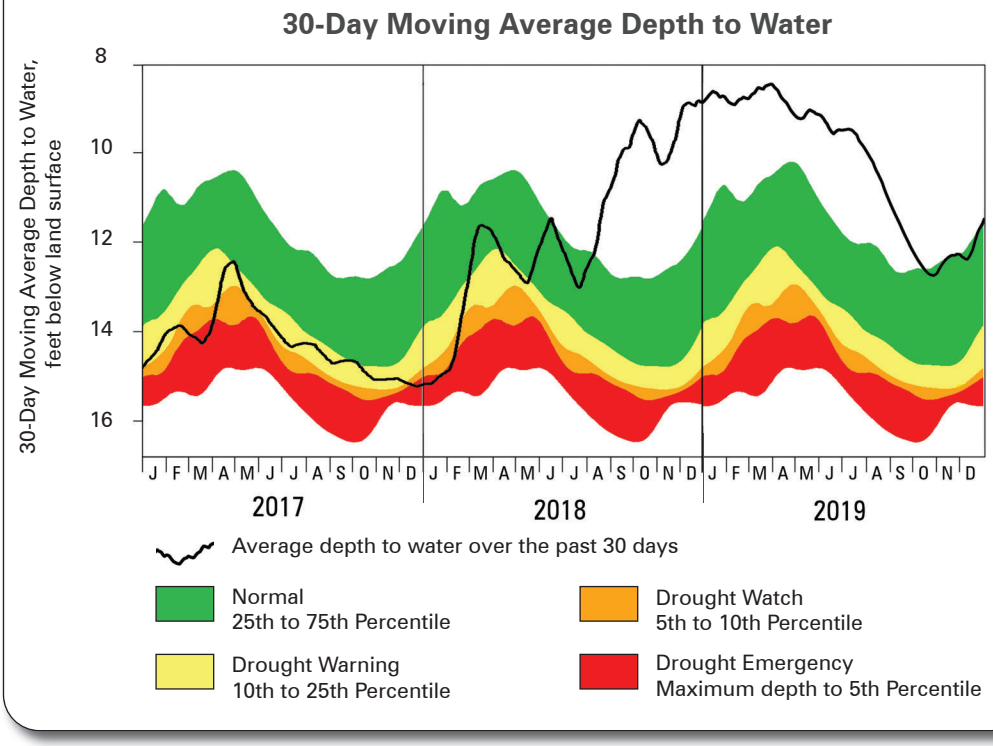
Groundwater is water located beneath the ground's surface that occupies the pore spaces and fractures between soil particles and rocks. Depth to groundwater can vary significantly based on slope, geology, elevation, and location on the landscape. Long-term monitoring of groundwater levels provides information on normal conditions and typical annual variations. Deviations from normal levels may indicate less groundwater is available to sustain stream flows and groundwater-based drinking water supplies.

High groundwater levels can result in the emergence of new springs and seeps on valley walls and in low-lying areas or areas along the base of slopes. These springs and seeps can impact agricultural production by reducing suitable cropland areas or delaying harvests, can interfere with septic fields or spray application of wastewater disposal, and can present difficulties in mowing or maintaining residential areas. High groundwater levels can also result in more frequent basement flooding during rain events.

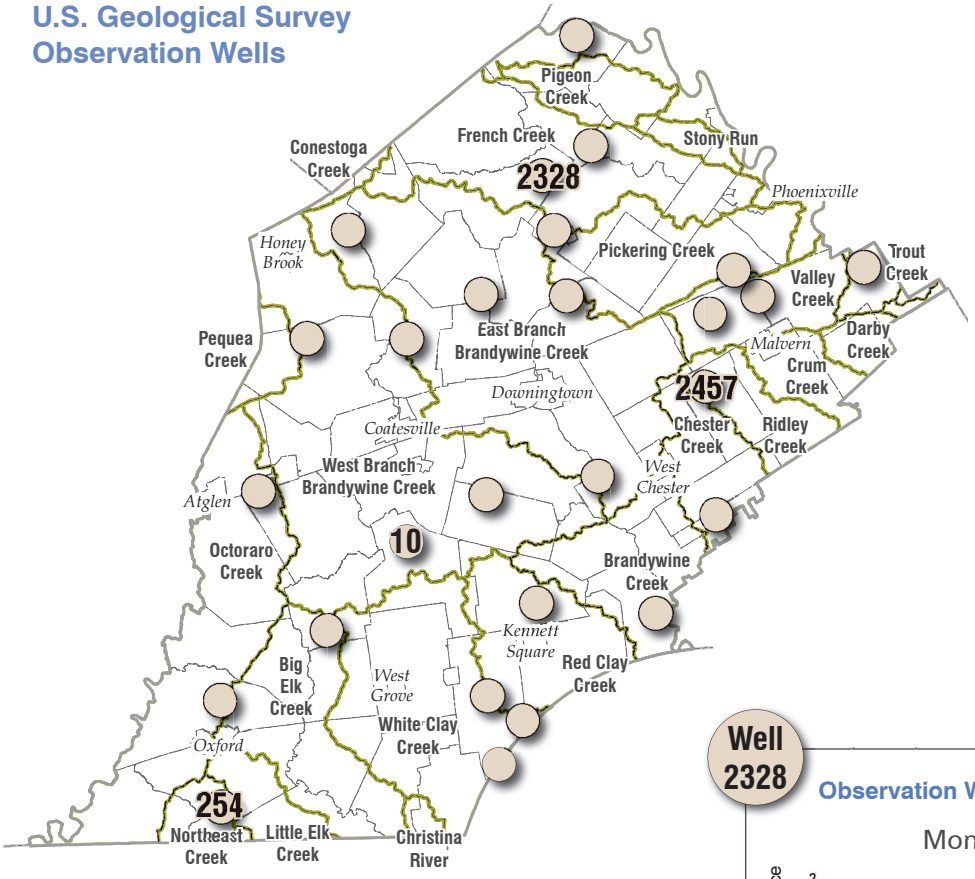
Groundwater levels throughout the County are monitored monthly at 27 observation wells and hourly at one well (Observation Well CH 10).

Well 10

Observation Well CH 10: West MarlboroughTownship



U.S. Geological Survey Observation Wells



The four wells with well IDs are graphed.

Legend

- Monthly Measured Water Level
- Above Normal — Above 75th Percentile
- Normal — 25th to 75th Percentile
- Drought Warning — 10th to 25th Percentile
- Drought Watch — 5th to 10th Percentile
- Drought Emergency — Maximum depth to 5th Percentile

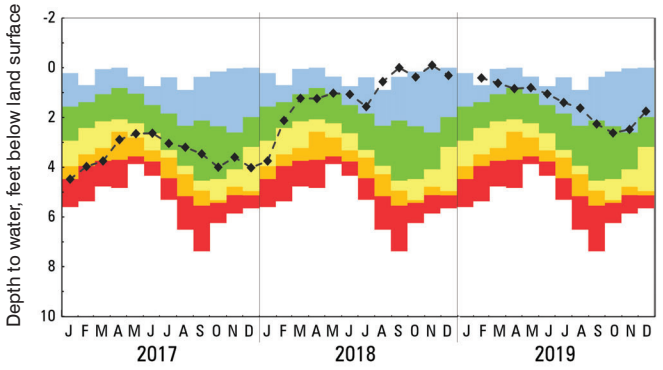
KEY FINDINGS

- Following several months of above-average rainfall in the summer and fall of 2018, groundwater levels rose to above average conditions at wells throughout the County in late-2018 and early-2019.
- Water levels at Observation Well CH 10 peaked during the spring.
- Above-average groundwater levels persisted through the first nine months of 2019.
- As precipitation levels dropped to below average in August and September, groundwater dropped to within the upper range of seasonal averages and generally remained above normal through the end of the year.

Well 2328

Observation Well CH 2328: East Nantmeal Township

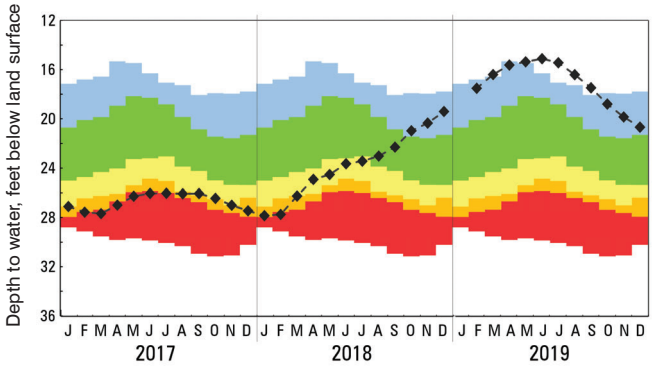
Monthly Measured Water Level



Well 254

Observation Well CH 254: East Nottingham Township

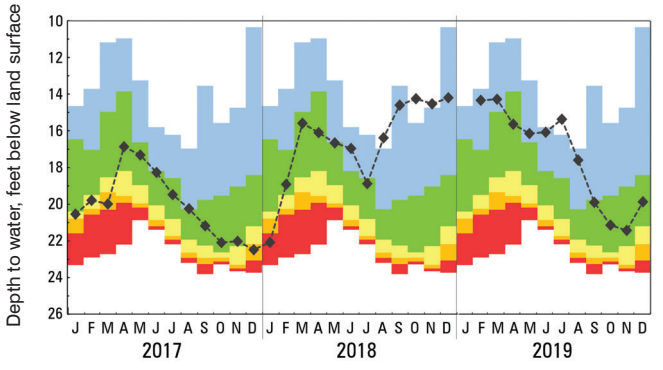
Monthly Measured Water Level



Well 2457

Observation Well CH 2457: East Goshen Township

Monthly Measured Water Level



Stream Flows

Stream flows closely reflect local groundwater levels.

Stream flows across Chester County were well above average at the beginning of 2019, but returned to within the range of normal variability during the fall.

BACKGROUND

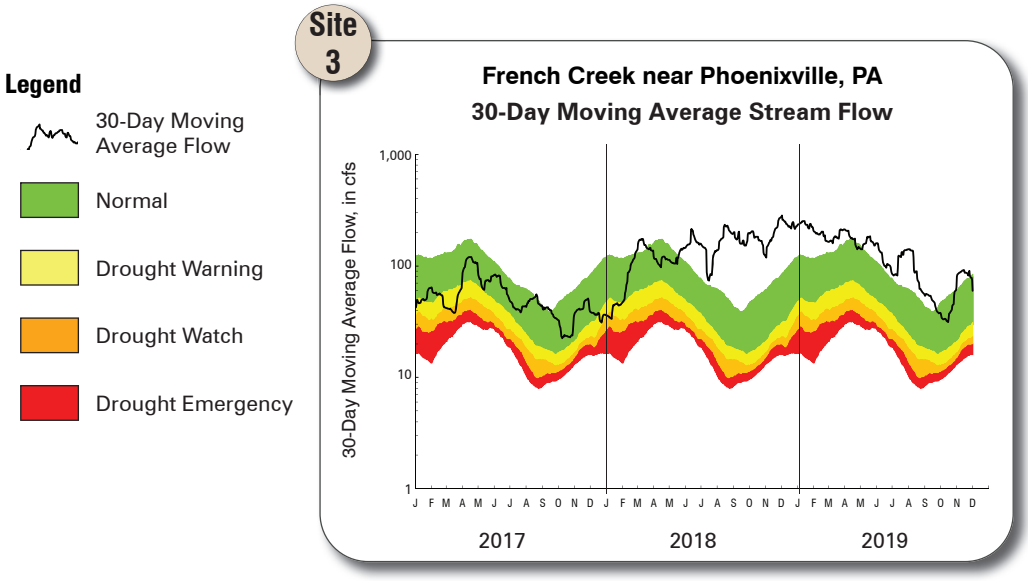
Chester County has over 2,300 miles of streams across 21 watersheds. Water flowing in these streams originates from the precipitation that falls upon the landscape, which makes its way to streams either from overland runoff (after rainfall events) or from groundwater contributing to the streams' base flow (between rainfall events). Water quality is closely linked to stream flow; higher flows from storm runoff can result in increased instream sediment loads (by generating greater streambank erosion and bed scour) and other pollutants. When the stream flows are not a result of storm runoff, the water quality in the stream is more representative of groundwater conditions.

Stream flows are monitored at 27 USGS continuous-record gaging stations in and around Chester County. These stations provide hourly updates, which can be found on the USGS stream flow website for Pennsylvania.

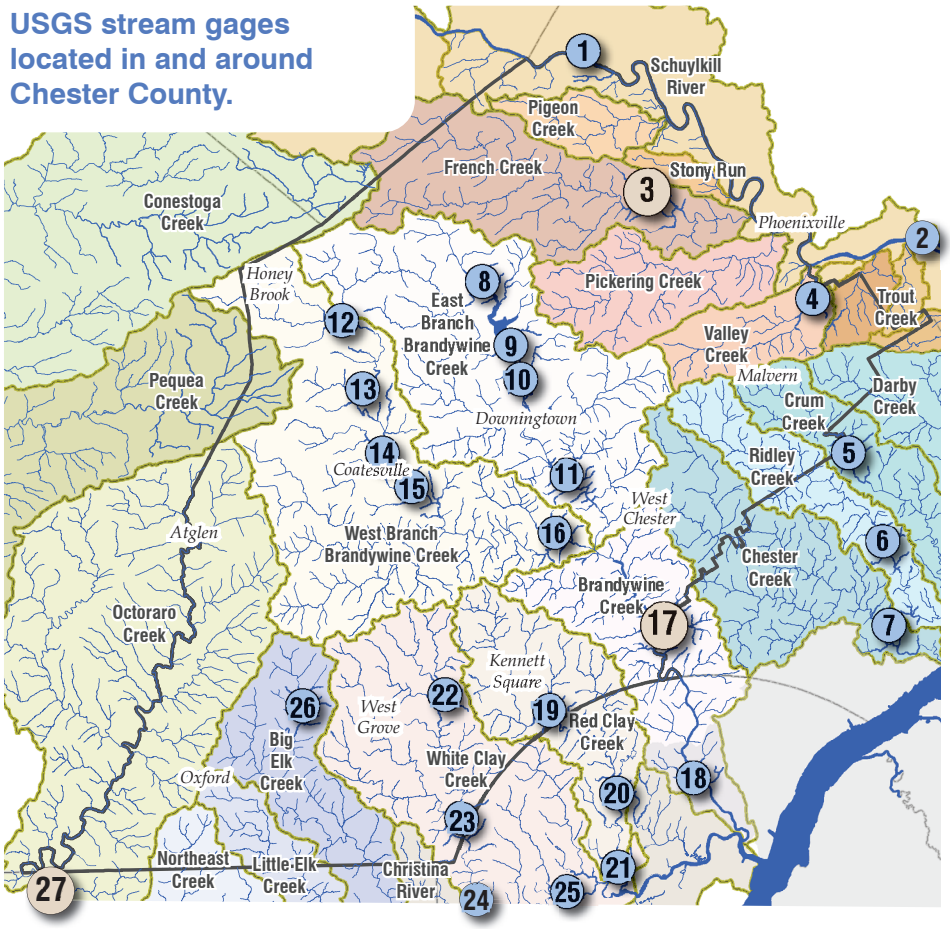
KEY FINDINGS

- Stream flows at the beginning of 2019 were well above seasonal average levels.
- While precipitation levels briefly returned to within their normal range in the spring of 2019 (see graph on page 4), stream flows remained elevated due to high groundwater levels.
- High stream flows persisted through August 2019, when decreasing precipitation and groundwater levels allowed streams to return to near normal levels.
- Stream flows at the end of 2019 were within seasonal normal levels.

30-Day Moving Average Stream Flows compared to drought ranges



USGS stream gages located in and around Chester County.



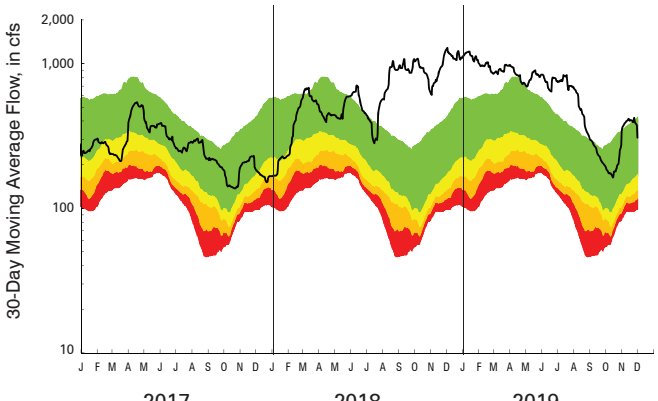
The three stations with over-sized, tan markers are graphed.

Map ID	Location
1	Schuylkill River at Pottstown, PA
2	Schuylkill River at Norristown, PA
3	French Creek near Phoenixville, PA
4	Valley Creek at Pa Turnpike Bridge near Valley Forge, PA
5	Crum Creek near Newtown Square, PA
6	Ridley Creek at Media, PA
7	Chester Creek near Chester, PA
8	Marsh Creek near Glenmoore, PA
9	Marsh Creek near Downingtown, PA
10	East Br Brandywine Creek near Downingtown, PA
11	East Br Brandywine Creek below Downingtown, PA
12	West Br Brandywine Creek near Honey Brook, PA
13	Birch Run near Wagontown, PA
14	West Branch Brandywine Creek at Coatesville, PA
15	West Branch Brandywine Creek at Modena, PA
16	Broad Run at Northbrook, PA
17	Brandywine Creek at Chadds Ford, PA
18	Brandywine Creek at Wilimington, DE
19	Red Clay Creek near Kennett Square, PA
20	Red Clay Creek at Wooddale, PA
21	Red Clay Creek near Stanton, DE
22	East Branch White Clay Creek at Avondale, PA
23	White Clay Creek near Strickersville, PA
24	White Clay Creek at Newark, DE
25	White Clay Creek near Newark, DE
26	East Branch Big Elk Creek at Forrestville, PA
27	Octoraro Creek near Richardsmere, MD

Site 17

Brandywine Creek at Chadds Ford, PA

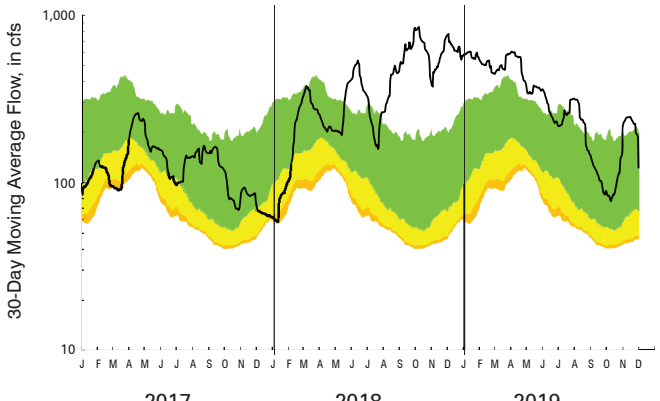
30-Day Moving Average Stream Flow



Site 27

Octoraro Creek near Richardsmere, MD

30-Day Moving Average Stream Flow



Note: Octoraro Creek at Richardsmere does not have statistics for the drought emergency threshold (5th percentile).

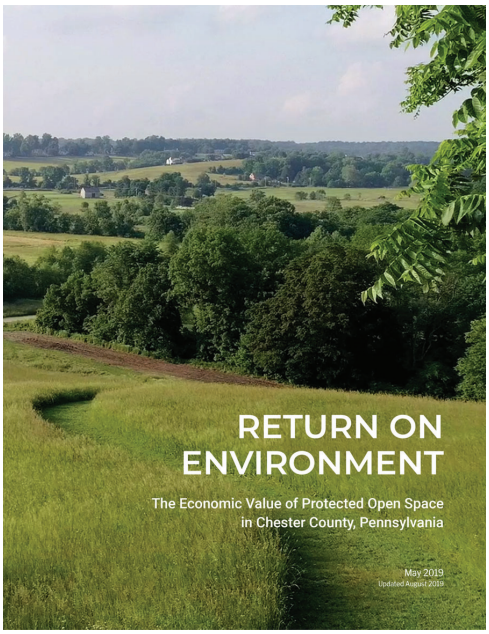
Spotlight: *Return on Environment* Study

Exploring the economic benefits of Chester County's preserved open space.

Preserved open space in Chester County provides more than $97 million in annual environmental services costs savings and economic gains.

BACKGROUND

From the forested hills of the Hopewell Big Woods to the meandering stream corridors of the Brandywine Valley, Chester County's scenic landscapes are a vital component of the County's character. County residents recognized the importance of preserving these scenic landscapes, and in 1989, they overwhelmingly approved a ballot referendum that allocated funds specifically for open space preservation. Over the past 30 years, this initiative helped to foster the protection of nearly 140,000 acres of open space.



For the report, executive summary, a short video and other reseources, visit chescoplanning.org/openspace/roe.cfm

The ecosystem services provided by these protected areas impart significant economic benefits on Chester County and its citizens. Chester County's *Return on Environment* report (2019) used established research and new analyses to place a dollar value on several types of ecosystem services provided by protected open space: replenishing water supply, water quality improvement, flood mitigation, wildlife habitat, air pollution removal, and carbon sequestration and storage. Together, these represent ecosystem functions that, if lost, would require costly measures to replicate.

Protected open space also mitigates the impacts of stormwater runoff by avoiding increases in the volume of runoff created by new development and the associated pollutants that stormwater carries. This reduces the burden placed on communities and their stormwater infrastructure to manage the volume of runoff and pollutant loads, thereby avoiding both capital and long-term maintenance expenditures, as well as improving ecological habitats, recreational resources, and sources of current and future public water supplies.

Photos on this and facing page credited to the *Return on Environment* report.

SUMMARY OF ECOSYSTEM SERVICES

Stormwater Runoff and Pollution Mitigation

Because protected lands are largely undeveloped, they generate much less stormwater runoff than the surrounding developed lands, which helps to avoid erosion, pollution, and flooding. If all the County's protected open space within the Brandywine Creek watershed were developed at the same extent and density as nearby unprotected developed lands, and there were no requirements for conservation plans on protected agricultural lands, the annual volume of surface runoff would increase by nearly 2.1 billion gallons per year. Protected open space in the Brandywine Creek Watershed alone avoids an estimated $263 million of one-time capital cost for stormwater infrastructure construction.

Water Supply

The soil of undeveloped land absorbs water that replenishes streams, reservoirs, and aquifers. This natural system provides for the continuous recharge of the County's groundwater and streams. Chester County realizes nearly $40 million in annual cost savings from natural water supply services on protected open space.

Water Quality

Natural landscapes, forests and wetlands in particular, provide a natural protective buffer between human activities and water bodies. Chester County receives $8.2 million in annual economic benefit from open spaces' natural protection of water quality.

Flood Mitigation

Many natural landscapes serve as a buffer protecting people and properties from destructive natural events, such as flooding. Protected open space helps to mitigate the risk of flooding during storm events by slowing, trapping, and absorbing rainfall that would otherwise become floodwaters. The total annual benefit provided by natural flood mitigation services is estimated to be $18.3 million.

Wildlife Habitat

Chester County's protected open space serves as habitats for a diverse array of plants and animals, including several threatened and endangered species. Intact forests and wetlands harbor valued species important to the ecosystem. Wildlife habitat on the County's open space has an estimated annual value of $13.1 million.

Tree planting at wetlands at Embreeville.

Air Pollution Removal

Trees mitigate significant amounts of air pollution through respiration. An analysis of regional satellite imagery revealed that protected open space in Chester County contains more than 47,000 acres of tree canopy. It is estimated that trees on protected open space provide $13.5 million in air pollution removal services annually.

Carbon Sequestration and Storage

Trees mitigate the impacts of excess atmospheric carbon by absorbing and storing carbon from carbon dioxide. Trees on Chester County's protected open space store nearly 1.7 million tons of carbon, which avoids $120 million in damages that would result from this increase in carbon emissions.

Protected open space in the Brandywine Creek Watershed captures and infiltrates stormwater, helping to avoid $263 million in long-term stormwater infrastructure capital costs.

Photo courtesy of the USGS,

Average biodiversity scores across the County continued to steadily rise, with the average score increasing by just over 2%.

Biotic Diversity

The diversity of insects living in streams is an indicator of water quality.

BACKGROUND

The presence or absence of certain species of stream insects, called benthic macroinvertebrates, such as mayflies, stoneflies, and caddisflies, can be used as an indicator of water quality and habitat. Biotic diversity is used to calculate a score between 1 and 100, with higher scores representing benthic communities that indicate higher water quality. Chester County's Index of Biotic Integrity was specifically developed by USGS scientists using benthic macroinvertebrate samples collected within Chester County.

In Chester County, benthic macro-invertebrates are sampled through a cooperative program between Chester County and USGS. Eighteen long-term sites located throughout the County are monitored annually, and nine additional flexible sites are selected each year.

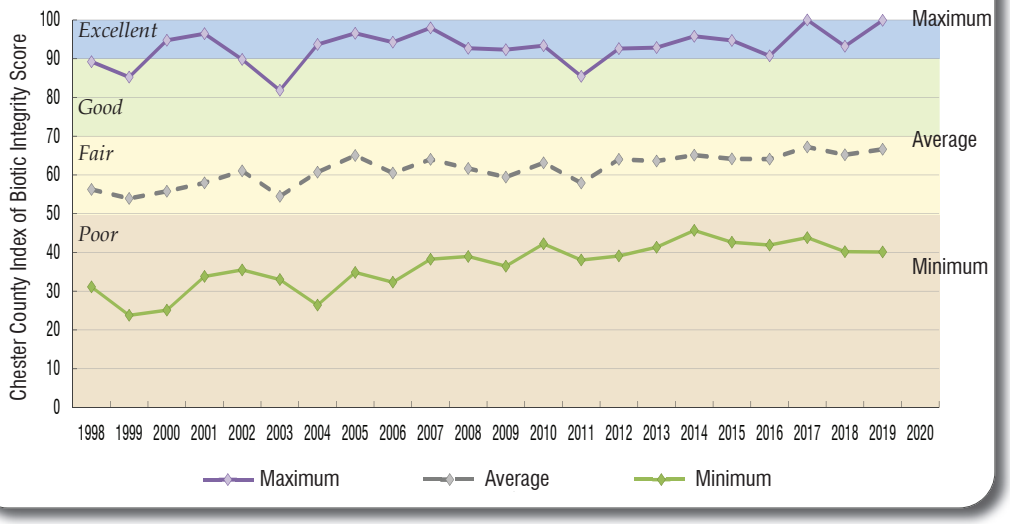
KEY FINDINGS

- Biodiversity scores across the County continued their gradual rise. Scores increased at 12 of the 18 annual sampling sites, with the County-wide average score increasing by just over 2%.
- The sites located in the County's northern tier streams (French, Pickering, and Pigeon Creeks) had the highest biotic integrity scores, with French Creek recording a score of 99.9.
- Ridley Creek (25.6%), East Branch White Clay Creek (22.9%), and the East Branch Brandywine below Downingtown (11.4%) sites had the greatest increase in biodiversity scores between 2018 and 2019
- The East Branch Octoraro (-20.8%), West Branch Brandywine Modena (-10.2%) showed the greatest declines in biotic diversity scores.

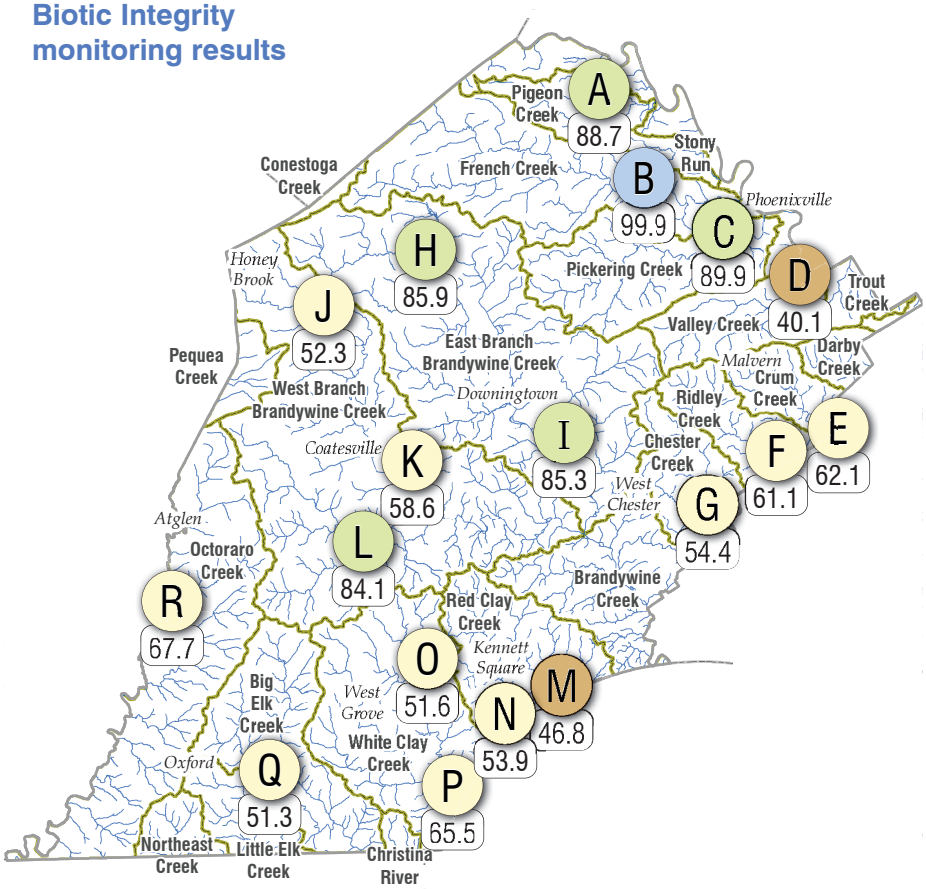
Biotic Diversity

Overall County-wide trends from 1998 - 2019

Combined County-wide maximum, minimum and average Biotic Integrity scores from 18 fixed sampling sites in Chester County (since 1998)



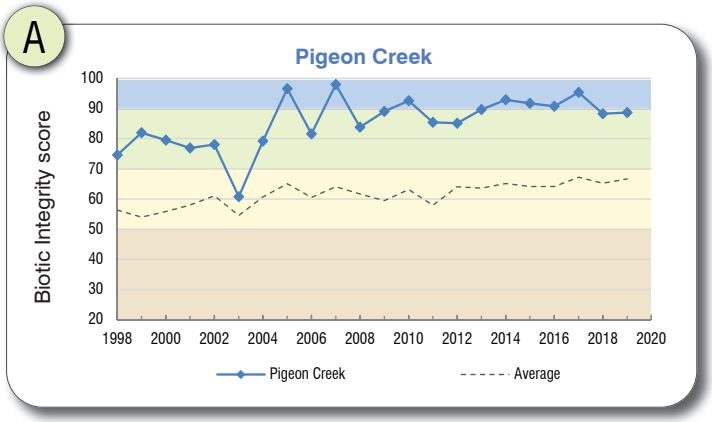
Fall 2019
Biotic Integrity monitoring results

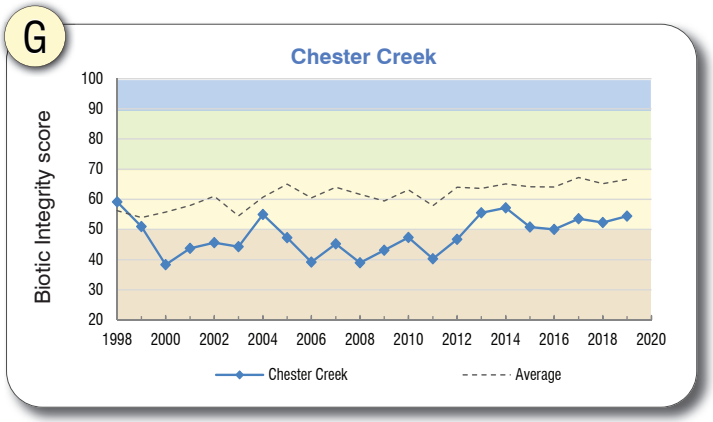


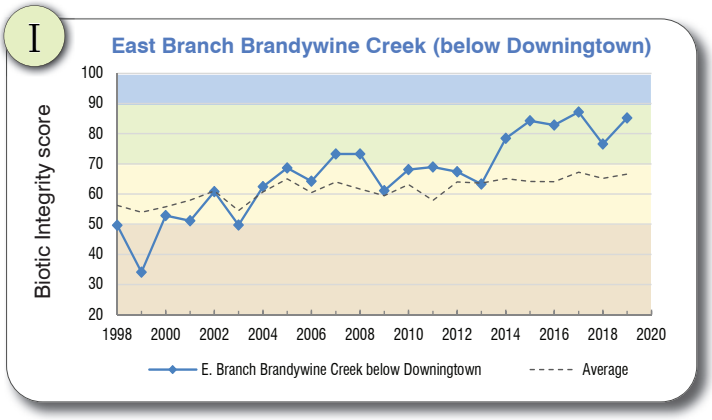
Biotic Integrity scores

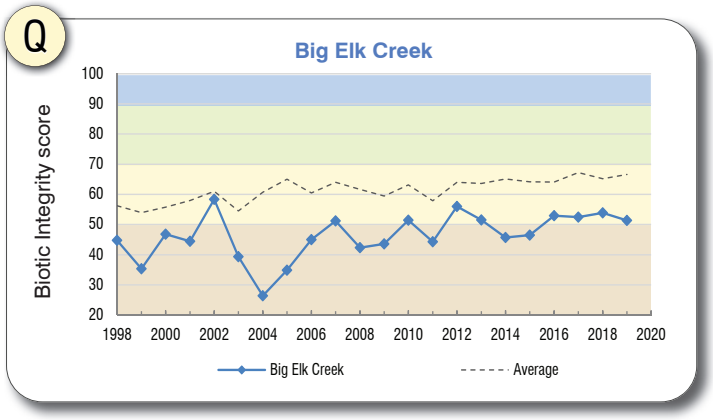
- Excellent: Above 90 | 1 sites
- Good: From 70 to 90 | 5 sites
- Fair: From 50 to 70 | 10 sites
- Poor: Below 50 | 2 sites

Map ID	Location	Biotic Integrity score
A	Pigeon Creek near Slonaker	88.7
B	French Creek near Phoenixville	99.9
C	Pickering Creek near Phoenixville	89.9
D	Valley Creek at PA Turnpike near Valley Forge	40.1
E	Crum Creek at Newtown Square	62.1
F	Ridley Creek at Rt. 3 near Willistown	61.1
G	East Branch Chester Creek at Westtown	54.4
H	East Branch Brandywine Creek at Glenmoore	85.9
I	East Branch Brandywine Creek below Downingtown	85.3
J	West Branch Brandywine Creek near Honey Brook	52.3
K	West Branch Brandywine Creek at Modena	58.6
L	Buck Run at Doe Run	84.1
M	East Branch Red Clay Creek near Five Points	46.8
N	West Branch Red Clay Creek near Kennett Square	53.9
O	East Branch White Clay Creek at Avondale	51.6
P	Middle Branch White Clay Creek near Avondale	65.5
Q	Big Elk Creek at Maple Grove	51.3
R	East Branch Octoraro Creek near Steelville	67.7









Nitrogen

Elevated nitrogen levels can impair streams by causing harmful algal blooms.

Average nitrogen concentrations in Chester County have remained relatively consistent over the past 20 years.

BACKGROUND

Nitrogen is an essential nutrient that comprises a significant amount of the structure of proteins that make up all living organisms. It occurs in many natural forms in the environment, including nitrogen gas that makes up the majority of our atmosphere. Nitrogen is often a component of the fertilizers added to crop fields and lawns used to increase soil fertility to improve plant growth rates.

Excess nitrogen applied to the landscape can be carried into streams by stormwater runoff and can leach into groundwater. High levels of nitrogen in streams can lead to excessive algal and aquatic plant growth. This often leads to lower levels of dissolved oxygen in these streams, which negatively impact the aquatic community. Implementing conservation practices, such as installing vegetated buffers along stream and planting cover crops on agricultural fields, helps to reduce the amount of nitrogen that leaches into groundwater and local streams.

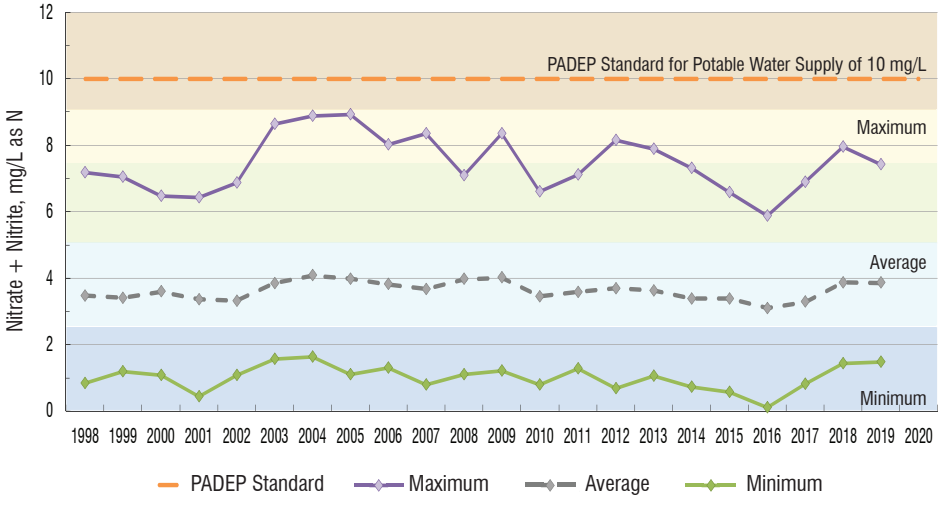
KEY FINDINGS

- Nitrogen levels in streams across the County have remained consistent over the past 20 years, but there have been a slight upward trend since 2016.
- Nitrogen concentrations remained relatively unchanged between 2018 and 2019, with mean concentrations decreasing slightly from 3.87 to 3.86 mg/L.
- The Schuylkill River tributaries (French, Pigeon, Pickering, and Valley Creeks) and direct Delaware River tributaries (Ridley and Crum Creeks) showed the lowest nitrogen levels in 2019.
- The highest levels of total nitrogen were recorded in areas of the County with a high percentage of agricultural land use.

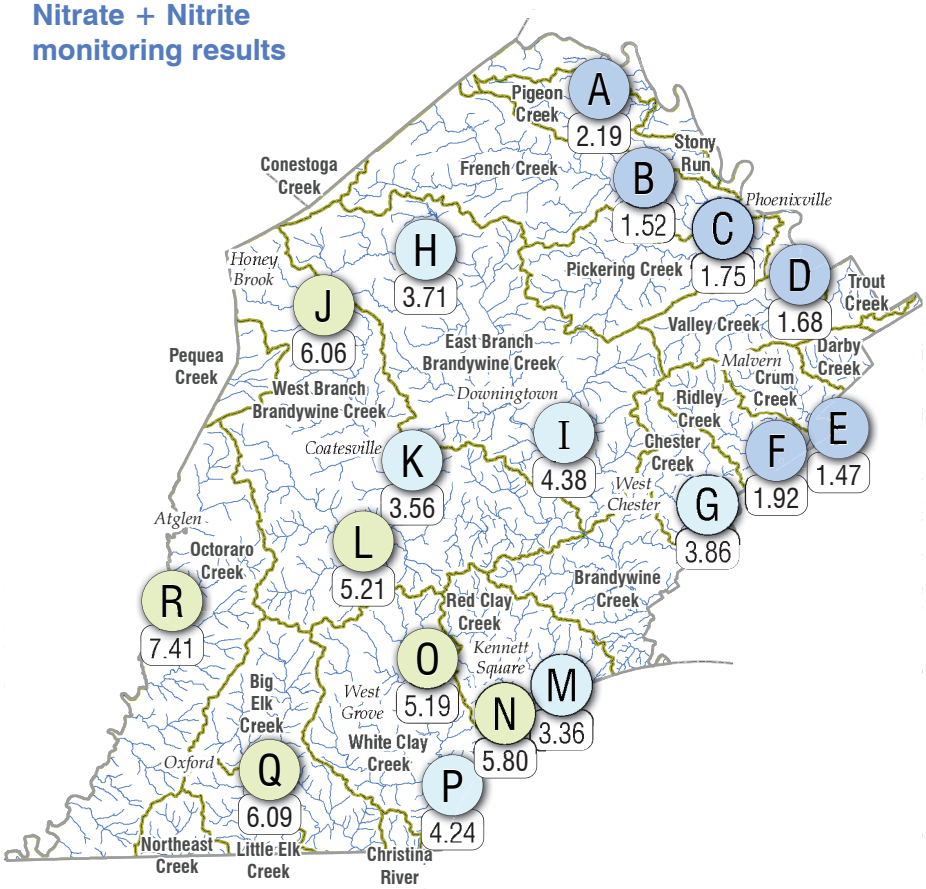
Nitrate + Nitrite

Overall County-wide trends from 1998 - 2019

Combined County-wide maximum, minimum and average Nitrate + Nitrite values from 18 fixed sampling sites in Chester County (since 1998)



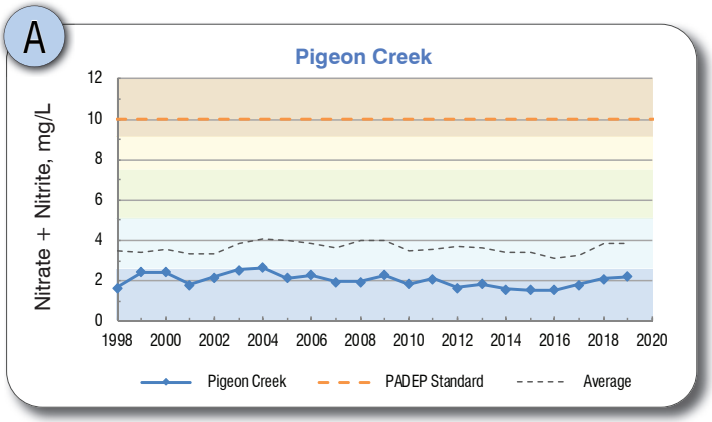
Fall 2019
Nitrate + Nitrite monitoring results

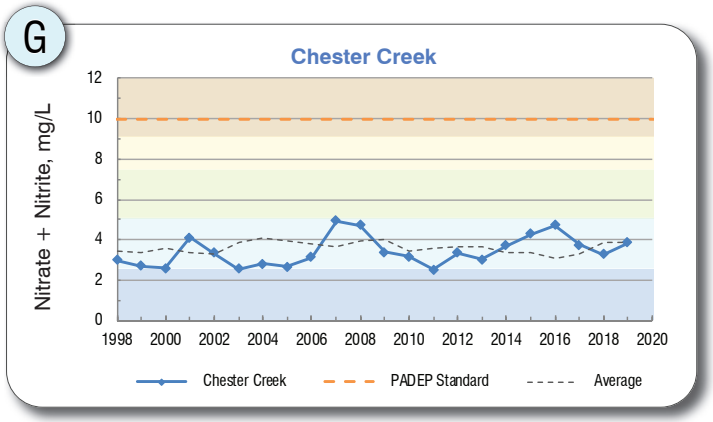


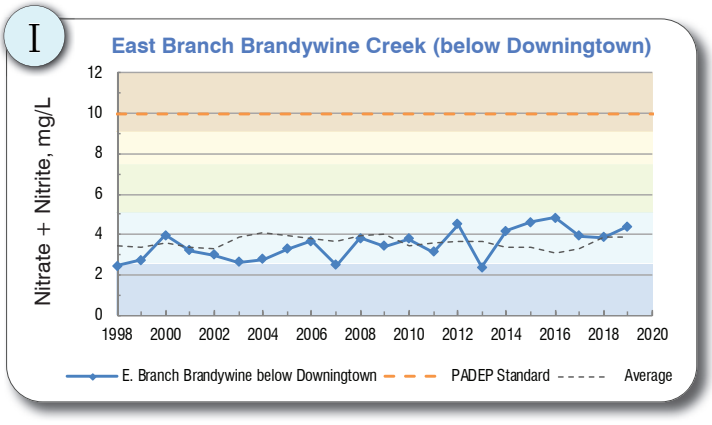
Nitrate + Nitrite: Relative to 10 mg/L standard

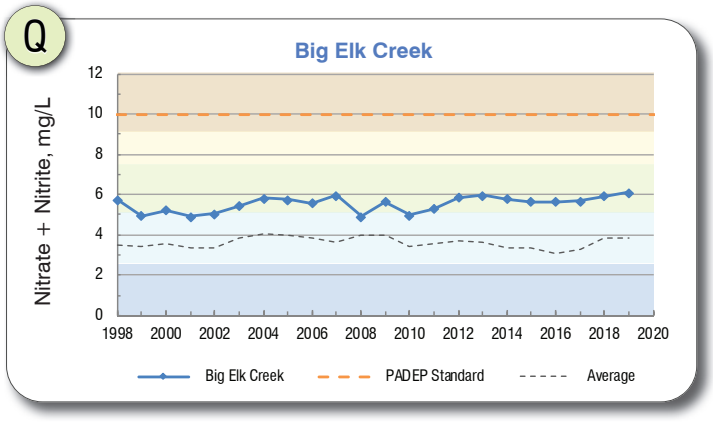
Below 2.5 mg/L (below 25%)	|	6 sites
From 2.5 to 5.0 mg/L (25% - 50%)	|	6 sites
From 5.0 to 7.5 mg/L (50% - 75%)	|	6 sites
From 7.5 to 9.0 mg/L (75% - 90%)	|	0 sites
Above 9.0 mg/L (90% and up)	|	0 sites

Map ID	Location	Nitrate + Nitrite, mg/L as N
A	Pigeon Creek near Slonaker	2.19
B	French Creek near Phoenixville	1.52
C	Pickering Creek near Phoenixville	1.75
D	Valley Creek at PA Turnpike near Valley Forge	1.68
E	Crum Creek at Newtown Square	1.47
F	Ridley Creek at Rt. 3 near Willistown	1.92
G	East Branch Chester Creek at Westtown	3.86
H	East Branch Brandywine Creek at Glenmoore	3.71
I	East Branch Brandywine Creek below Downingtown	4.38
J	West Branch Brandywine Creek near Honey Brook	6.06
K	West Branch Brandywine Creek at Modena	3.56
L	Buck Run at Doe Run	5.21
M	East Branch Red Clay Creek near Five Points	3.36
N	West Branch Red Clay Creek near Kennett Square	5.80
O	East Branch White Clay Creek at Avondale	5.19
P	Middle Branch White Clay Creek near Avondale	4.24
Q	Big Elk Creek at Maple Grove	6.09
R	East Branch Octoraro Creek near Steelville	7.41









Phosphorus

The greatest contributions of phosphorus to the County's waterways include wastewater treatment plants and stormwater runoff.

Phosphorus levels have declined at many sites over the past two decades, largely due to improvements in wastewater treatment infrastructure.

BACKGROUND

Phosphorous is another crucial plant nutrient that is naturally found in low concentrations in the environment. Human activities, such as discharging wastewater from a treatment plant or using fertilizers on lawns and crop fields, can increase phosphorus concentrations in our streams. Phosphorus is typically considered a limiting nutrient in freshwater systems, which mean keeping phosphorus levels low is essential to reducing excessive aquatic plant and algal growth.

When tracking phosphorus levels in streams, Chester County monitors the concentration of orthophosphate, which is the water soluble form of phosphorus. Phosphorus levels have been declining on average across the County at the 18 annual monitoring sites over the past 20 years.

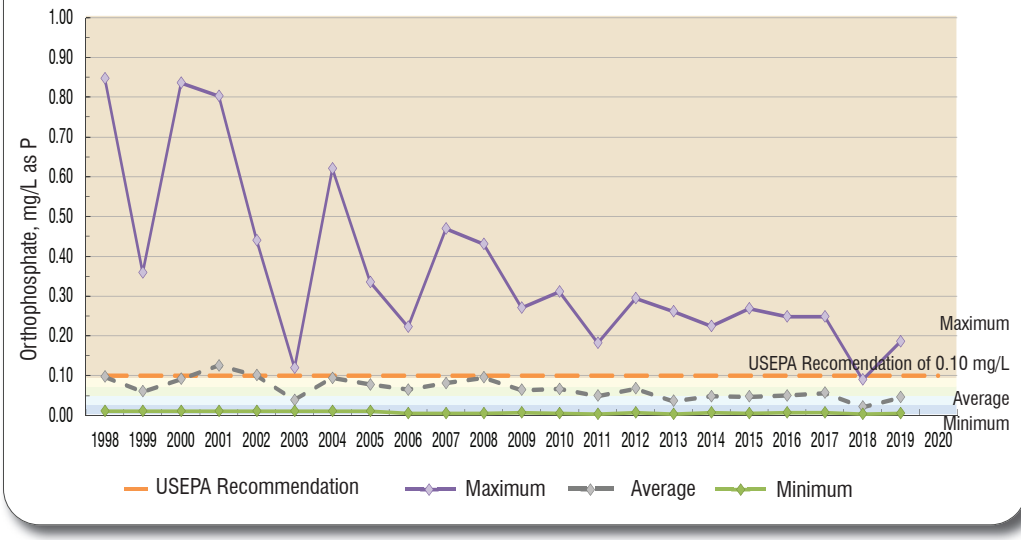
KEY FINDINGS

- Phosphorus concentrations rose at 13 of 18 sites, with average phosphorus concentrations rising from 0.021 to 0.045 mg/L.
- Sites below wastewater treatment plants, including the sampling sites on Chester Creek and East Branch Brandywine Creek below Downingtown, typically exhibit the highest phosphorus levels and the greatest annual variability in phosphorus concentrations.
- The increased concentrations seen in 2019 may be partially explained by lower base flow volumes during the 2019 sampling period compared to 2018, which would result in more concentrated wastewater treatment effluent.

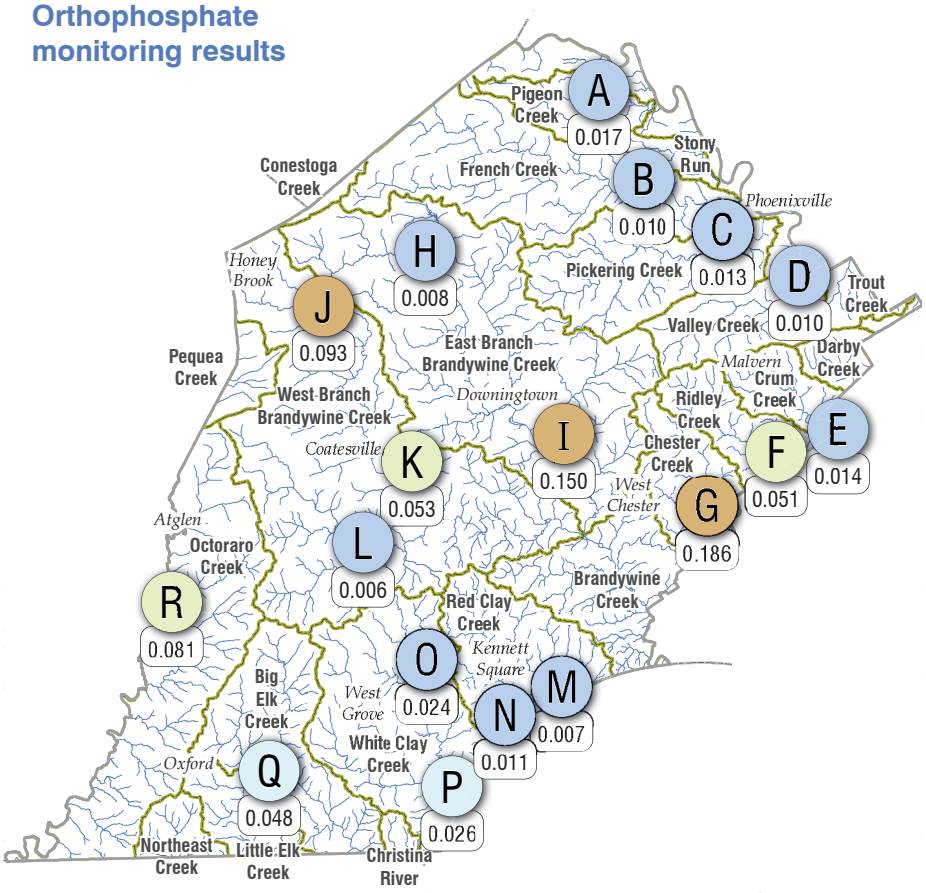
Orthophosphate

Overall County-wide trends from 1998 - 2019

Combined County-wide maximum, minimum and average Orthophosphate values from 18 fixed sampling sites in Chester County (since 1998)



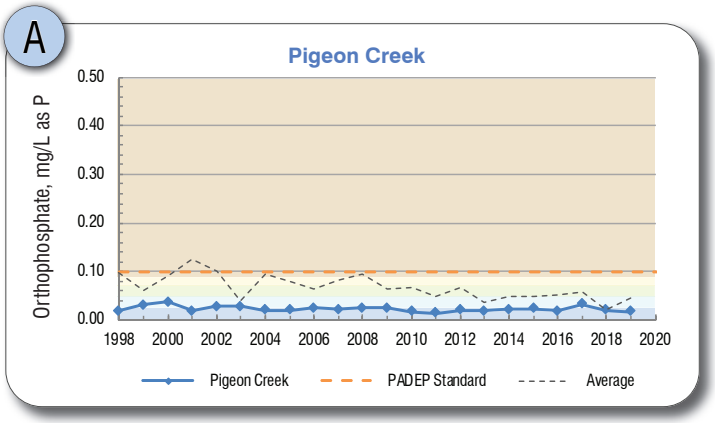
Fall 2019 Orthophosphate monitoring results

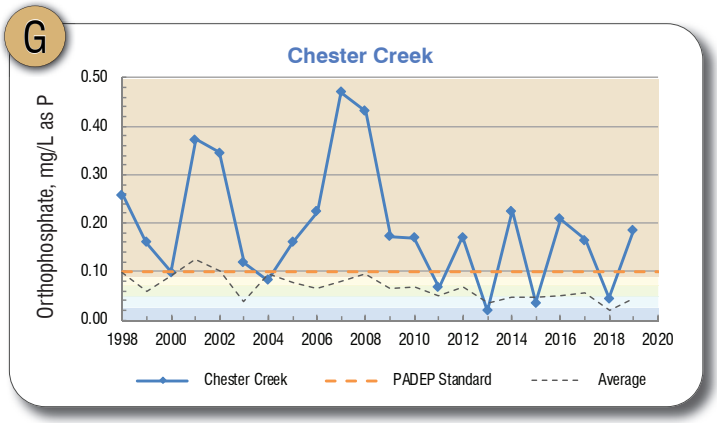


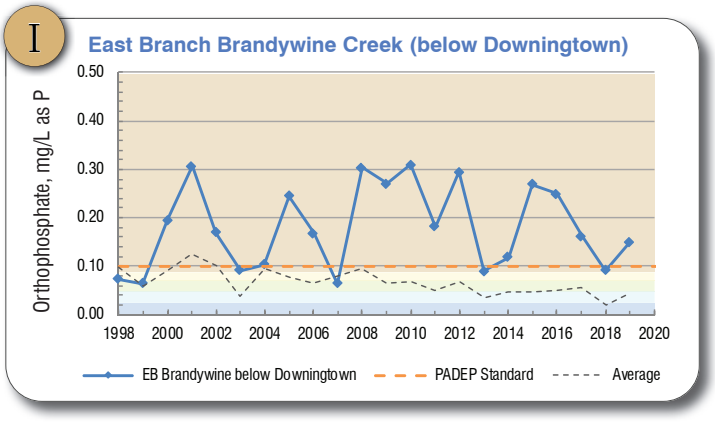
Orthophosphate: Relative to 0.10 mg/L standard

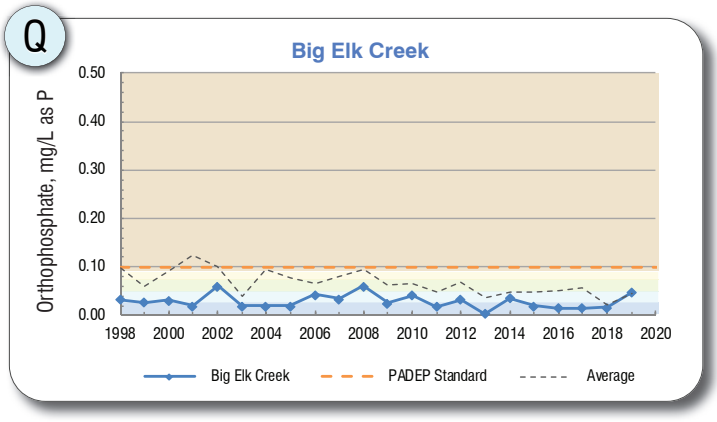
Below 0.025 mg/L (below 25%)	|	10 sites
From 0.025 to 0.050 mg/L (25% - 50%)	|	2 sites
From 0.050 to 0.075 mg/L (50% - 75%)	|	3 sites
From 0.075 to 0.090 mg/L (75% - 90%)	|	0 sites
Above 0.090 mg/L (90% and up)	|	3 sites

Map ID	Location	Orthphospate, mg/L as P
A	Pigeon Creek near Slonaker	0.017
B	French Creek near Phoenixville	0.010
C	Pickering Creek near Phoenixville	0.013
D	Valley Creek at PA Turnpike near Valley Forge	0.010
E	Crum Creek at Newtown Square	0.014
F	Ridley Creek at Rt. 3 near Willistown	0.051
G	East Branch Chester Creek at Westtown	0.186
H	East Branch Brandywine Creek at Glenmoore	0.008
I	East Branch Brandywine Creek below Downingtown	0.150
J	West Branch Brandywine Creek near Honey Brook	0.093
K	West Branch Brandywine Creek at Modena	0.053
L	Buck Run at Doe Run	0.006
M	East Branch Red Clay Creek near Five Points	0.007
N	West Branch Red Clay Creek near Kennett Square	0.011
O	East Branch White Clay Creek at Avondale	0.024
P	Middle Branch White Clay Creek near Avondale	0.026
Q	Big Elk Creek at Maple Grove	0.048
R	East Branch Octoraro Creek near Steelville	0.081









Chloride

Increased road miles and impervious cover are strongly correlated with higher chloride concentrations.

Chloride levels in many streams continued to show a gradual rise in 2019, with 14 of 18 sites showing an increase in concentration over the prior year.

BACKGROUND

Chloride is an ion that results from the dissolution of common salts such as road salts. Low concentrations of chlorides are naturally found in all freshwater environments, but elevated chloride concentrations associated with urbanized areas can negatively impact aquatic communities. Chloride levels have been steadily rising for decades in waterways across the County from wastewater discharges, agricultural runoff, and runoff from roadways carrying de-icing materials.

Chloride data is collected annually during fall stream baseflow conditions, which is typically before the first de-icing event of the season. Runoff from roadways, driveways, and parking areas after winter precipitation events delivers chloride into streams and onto adjacent lands, where it is slowly leached into groundwater throughout the year.

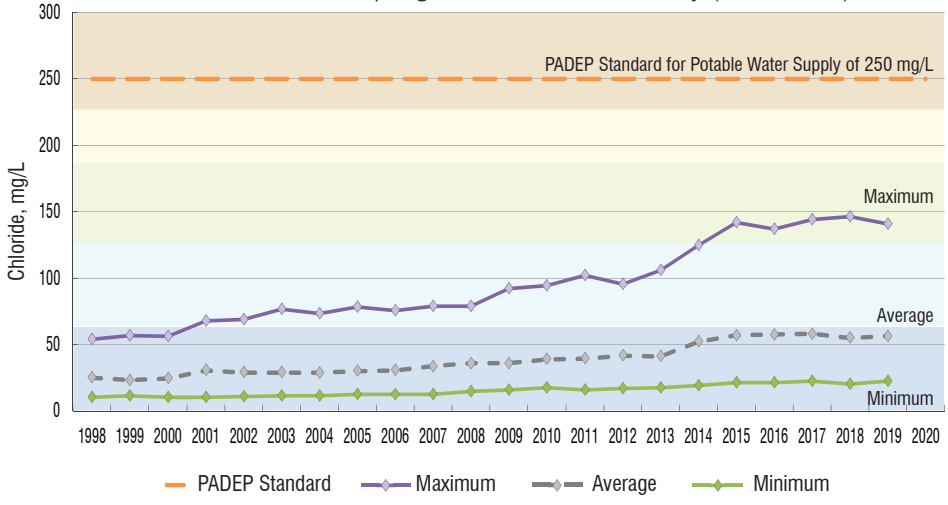
KEY FINDINGS

- Chloride levels continued their steady rate of increase, with concentrations increasing at 14 of the 18 sampling sites.
- Mean chloride concentrations across all monitoring sites rose from 55.0 mg/L in 2018 to 56.5 mg/L in 2019.
- Three of the four sites that showed a decrease in concentrations were located in urbanized watersheds, yet these watersheds still had significantly higher chloride concentration than rural watersheds. Valley Creek had the highest concentration of 141 mg/L.

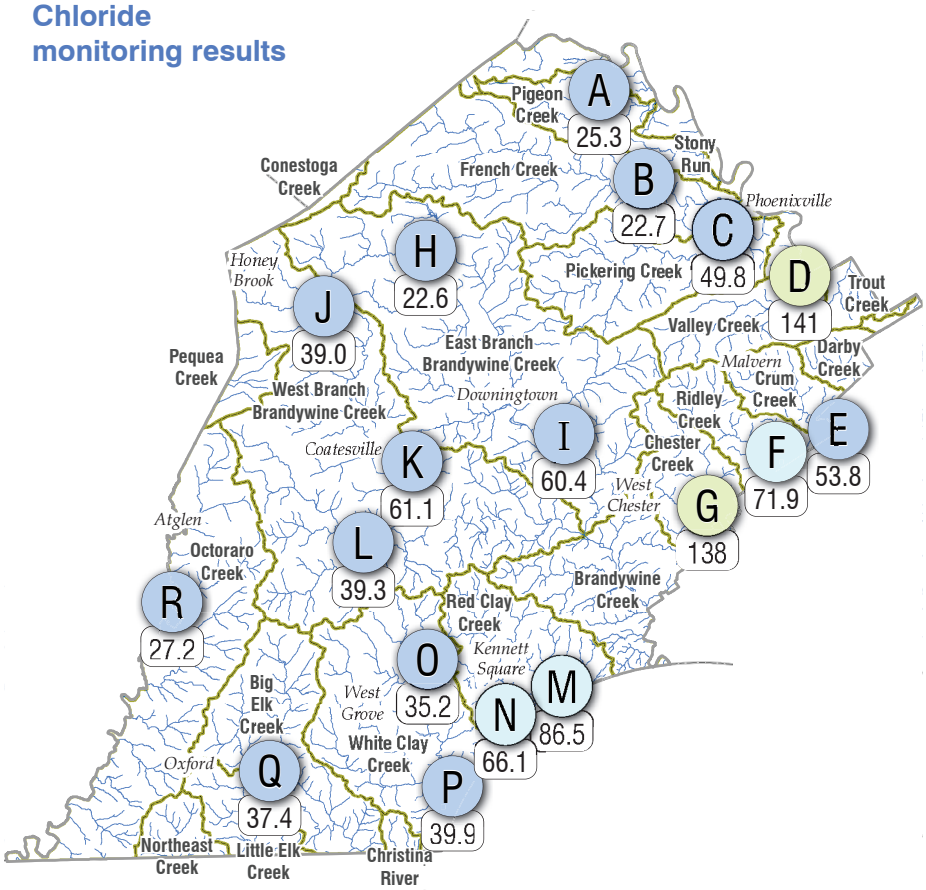
Chloride

Overall County-wide trends from 1998 - 2019

Combined County-wide maximum, minimum and average Chloride values from 18 fixed sampling sites in Chester County (since 1998)



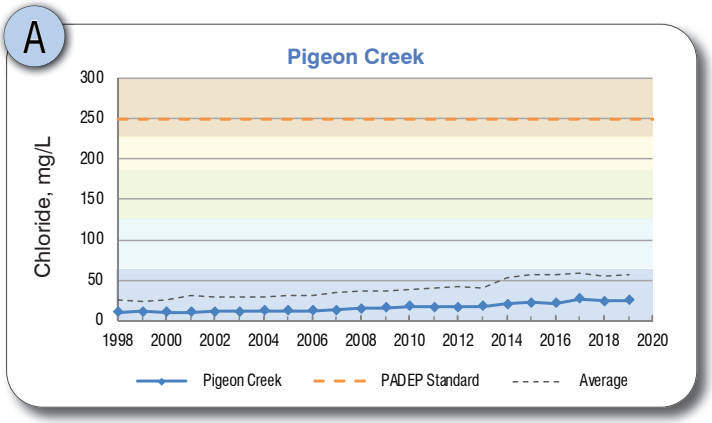
Fall 2019 Chloride monitoring results

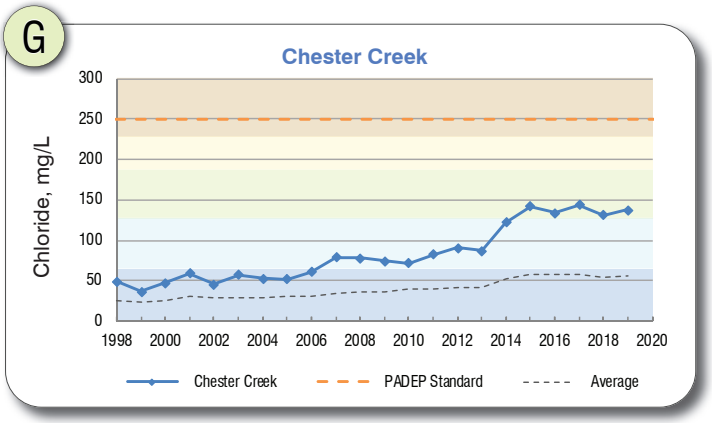


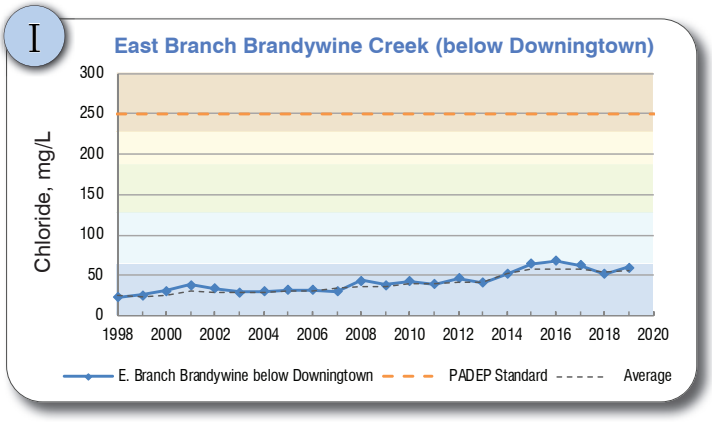
Chloride: Relative to 250 mg/L standard

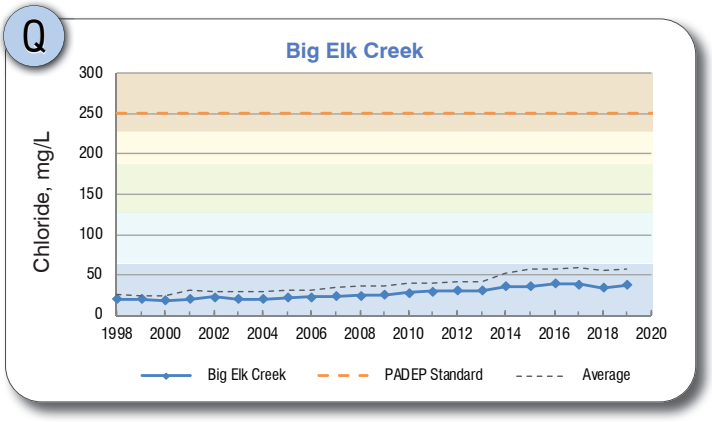
Below 62.5 mg/L (below 25%)	|	13 sites
From 62.5 to 125 mg/L (25% - 50%)	|	3 sites
From 125 to 187.5 mg/L (50% - 75%)	|	2 sites
From 187.5 to 225 mg/L (75% - 90%)	|	0 sites
Above 225 mg/L (90% and up)	|	0 sites

Map ID	Location	Chloride, mg/L
A	Pigeon Creek near Slonaker	25.3
B	French Creek near Phoenixville	22.7
C	Pickering Creek near Phoenixville	49.8
D	Valley Creek at PA Turnpike near Valley Forge	141
E	Crum Creek at Newtown Square	53.8
F	Ridley Creek at Rt. 3 near Willistown	71.9
G	East Branch Chester Creek at Westtown	138
H	East Branch Brandywine Creek at Glenmoore	22.6
I	East Branch Brandywine Creek below Downingtown	60.4
J	West Branch Brandywine Creek near Honey Brook	39.0
K	West Branch Brandywine Creek at Modena	61.1
L	Buck Run at Doe Run	39.3
M	East Branch Red Clay Creek near Five Points	86.5
N	West Branch Red Clay Creek near Kennett Square	66.1
O	East Branch White Clay Creek at Avondale	35.2
P	Middle Branch White Clay Creek near Avondale	39.9
Q	Big Elk Creek at Maple Grove	37.4
R	East Branch Octoraro Creek near Steelville	27.2









Surface Water Sources for Public Water Systems

Watershed management on land draining to water intakes is needed to maintain clean water supplies.

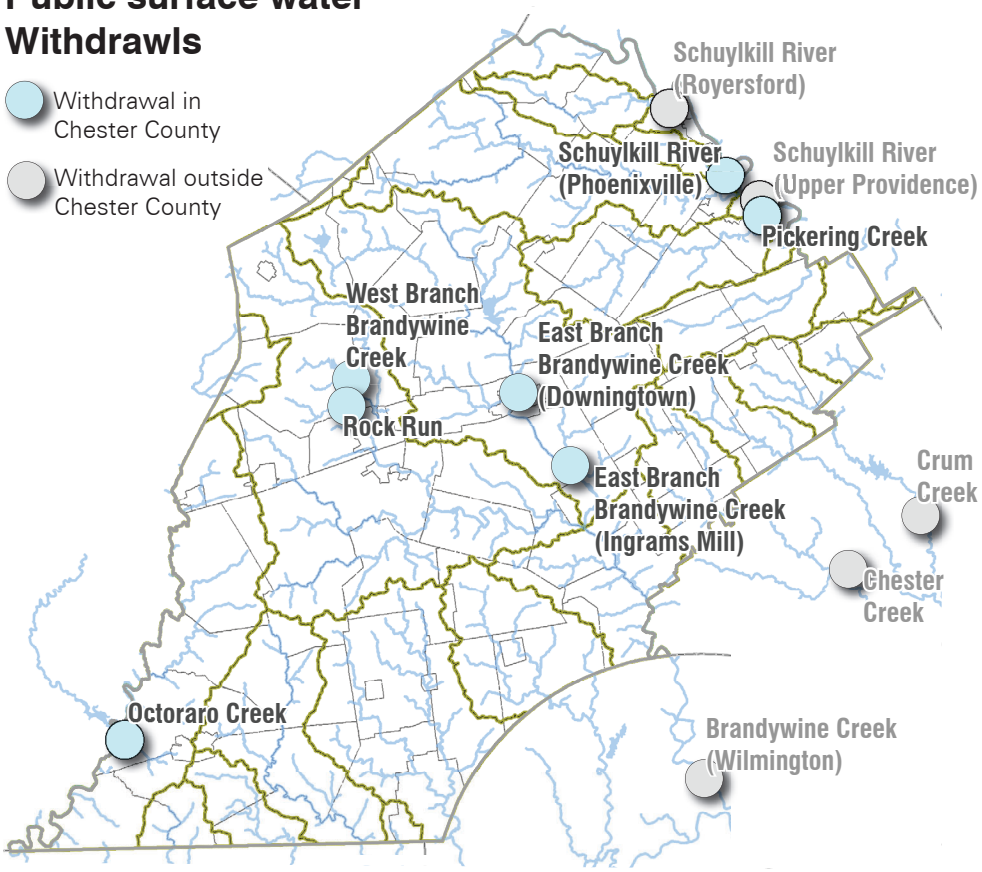
In 2019, over 11.6 billion gallons of water were withdrawn from seven surface water sources to provide public water supply to Chester County residents and businesses.

BACKGROUND

Chester County has a total estimated water demand of approximately 52.5 million gallons per day. While many residents rely on private wells for their water consumption needs, approximately 60% of County residents rely on public water supply. To meet this demand, a number of treatment plant facilities are located within or adjacent to the County. Treatment plants use source waters from both groundwater wells and surface water intakes. The surface water intakes include Octoraro Reservoir, Rock Run Reservoir, West Branch Brandywine Creek (Chambers Lake Reservoir), East Branch Brandywine Creek - Downingtown and East Branch Brandywine Creek - Ingrams Mill (Marsh Creek Reservoir), Pickering Creek Reservoir, and the Schuylkill River.

Additional intakes are located downstream of the County's boundaries, including intakes on the Schuylkill River (that support communities in Montgomery County), Crum Creek and Chester Creek in Delaware County, and the Brandywine Creek (City of Wilmington in New Castle County, DE).

Public surface water Withdrawls



Water utilities are required to report withdrawal volumes to PADEP, which is made available through a series of web portals. The table below presents monthly surface water withdrawals as reported by each utility.

Public surface water withdrawals in Chester County in 2019, Million Gallons

Month	Octoraro Creek - Chester Water Authority [1]	Rock Run - Pennsylvania American	West Branch Brandywine Creek - Pennsylvania American	East Branch Brandywine Creek - Downingtown Municipal Water Authority	East Branch Brandywine Creek (Ingrams Mill) - Aqua Pennsylvania	Schuylkill River - Phoenixville Borough	Pickering Creek - Aqua Pennsylvania
January 2019	678.0	104.3	3.0	16.7	114.6	66.0	168.6
February 2019	530.3	97.5	1.1	11.0	117.7	62.0	147.6
March 2019	757.8	103.8	1.8	15.1	116.8	68.3	154.0
April 2019	647.9	101.7	0.0	16.4	124.9	63.7	159.2
May 2019	541.6	108.8	0.0	18.8	125.3	68.8	149.0
June 2019	766.5	107.5	0.0	18.3	116.4	66.4	163.1
July 2019	294.8	98.7	16.2	18.8	122.6	69.0	185.5
August 2019	304.2	67.8	54.4	21.1	140.0	70.0	179.5
September 2019	264.6	34.2	81.6	21.1	151.5	64.7	177.9
October 2019	206.0	61.8	59.2	19.2	138.9	66.9	139.9
November 2019	148.3	77.3	30.8	19.0	122.3	65.9	144.8
December 2019	744.7	108.6	6.5	21.3	114.3	67.5	145.5
Total for 2019	5,884.6	1,072.0	254.7	216.7	1,505.3	799.2	1,915

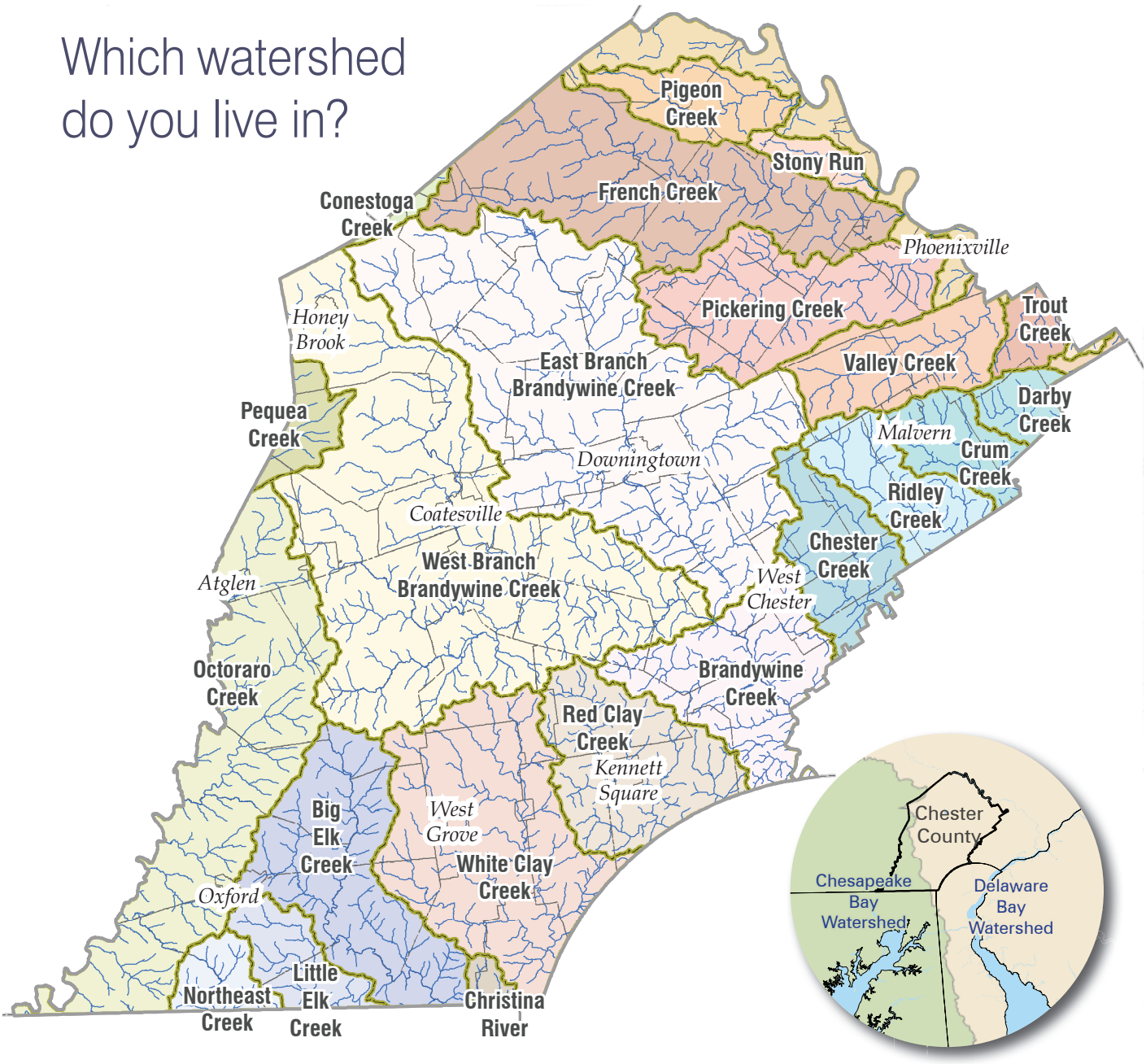
Source: Water Reports, PADEP web page, https://www.dep.pa.gov/DataandTools/Reports/Pages/Water.aspx
Note 1: Withdrawals listed in the table above for Chester Water Authority are only for withdrawals from the Octoraro Creek watershed; inter-basin transfers from the Susquehanna River Basin in 2019 totaled 5.805 billion gallons.

Annual surface water withdrawals from shared watersheds outside Chester County, million gallons in 2019

Brandywine Creek (City of Wilmington) = 5,212 million gallons
Chester Creek (Aqua Pennsylvania) = 406 million gallons
Crum Creek (Aqua Pennsylvania) = 5,888 million gallons
Schuylkill River - Royersford intake (Pennsylvania American) =701 million gallons
Schuylkill River - Upper Providence intake (Aqua Pennsylvania) = 6,117 million gallons

Chester County Watersheds

Which watershed do you live in?



Chester County Water Resources Authority
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