



Brandywine-Christina

*State of the Watershed
Executive Summary*

2018



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May 2018

PREPARED BY

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BRANDYWINE
CONSERVANCY



Brandywine
Red Clay Alliance

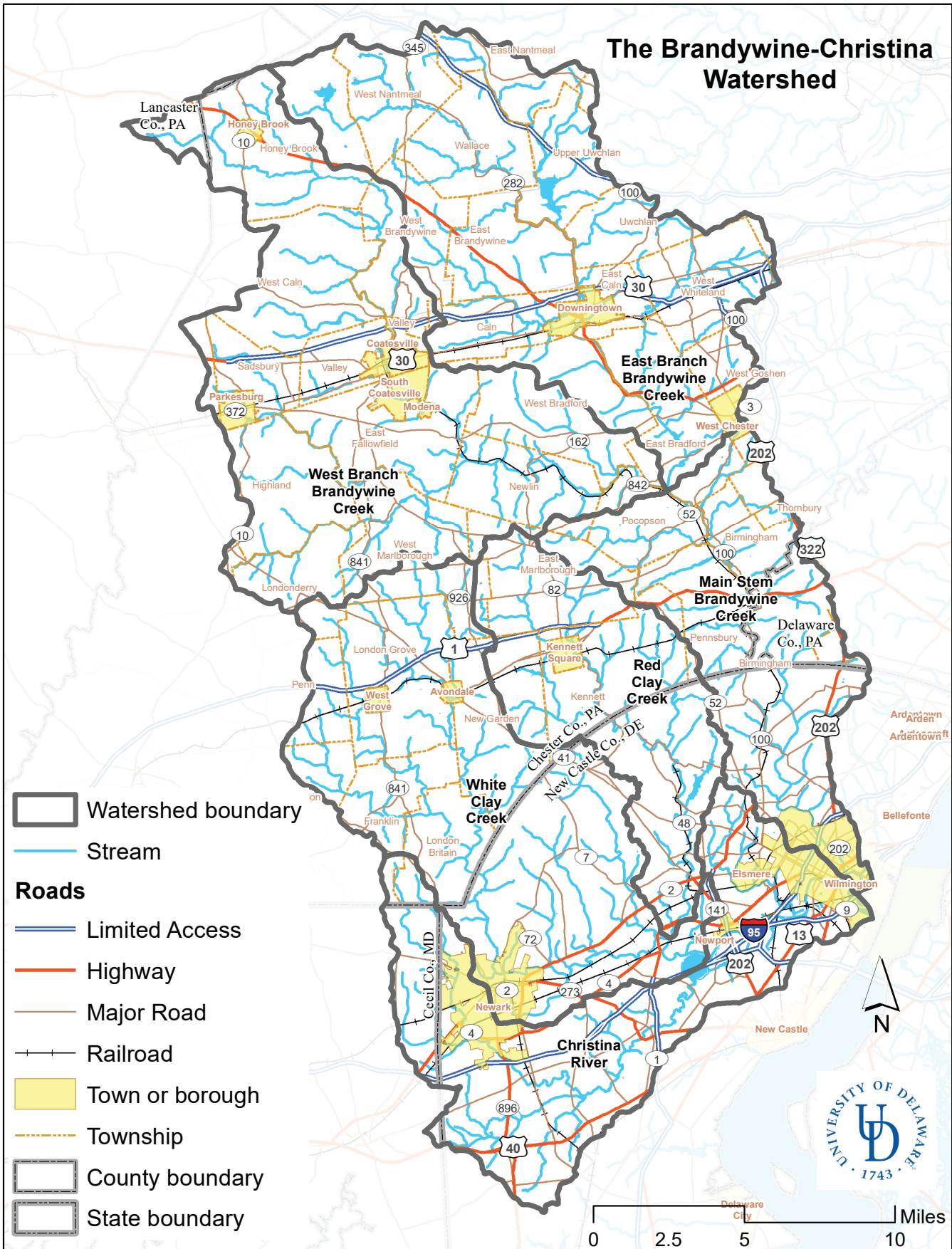


Chester County Water Resources Authority
CHESTER COUNTY - PENNSYLVANIA



Natural
Lands





Executive Summary

Goal

This report provides an overview of the trends and conditions of the Brandywine-Christina watershed. It is funded through a grant from the William Penn Foundation through the Delaware River Watershed Initiative (DRWI).

Overview

Several partners in Delaware and Pennsylvania have been working for decades on an integrated approach to water resources and land management in the Brandywine-Christina watershed. Governments, nonprofits, academic institutions, and the private sector have all played a significant role in restoring and protecting the Brandywine-Christina watershed through cooperative agreements, regulations, restoration, and land preservation programs. Many of these partner organizations within this area have worked to produce this report, which has also been informed by the many prior reports produced by these organizations and others.

In 2013, the William Penn Foundation launched the DRWI to help focus the efforts of numerous organizations across the Delaware Basin to improve watershed health and water quality. To date, over \$40 million has been distributed to over 50 nonprofits. The Brandywine-Christina Partnership, one of eight groups spread across the Basin, consists of six partners: Brandywine Conservancy & Museum of Art, Stroud Water Research Center, Natural Lands, Brandywine Red Clay Alliance, The Nature Conservancy in Delaware, and the University of Delaware Water Resources Center. The initial phase of this effort was directed toward six specific focus areas located across the watershed. A second phase of this initiative refines the geographic focus areas and extends the success from the earlier phase.

The Brandywine-Christina watershed is composed of four smaller watersheds—Brandywine Creek, White Clay Creek, Red Clay Creek and Christina River—covering 565 square miles extending from the tidal reaches of the lower Christina River in Delaware to the headwaters in the foothills of the valley and ridge system of southeastern Pennsylvania, more than 40 miles to the north. The Brandywine-Christina is one

of the most historic small watersheds in the nation, two-thirds of the land area lies in Pennsylvania, and it is home to over 600,000 people producing up to 100 million gallons per day (MGD) to serve northern New Castle County, Delaware and southeastern Pennsylvania.

Straddling Pennsylvania, Delaware and Maryland and two physiographic provinces – the Piedmont and the Coastal Plain, the Brandywine-Christina watershed begins at an elevation well over 1,000 feet above sea-level, through the fall line at the edge of the Piedmont and from there to the Delaware River at the northern edge of the Coastal Plain. The region is characterized by loamy soils which are suitable for farming and have a relatively high infiltration rate.

Most of the land in the study area lies in Pennsylvania while more than half (56%) of the current population of 613,000, is in Delaware. The Brandywine-Christina watershed has seen an 8% increase in population between 2000 and 2015, growth has occurred in most areas of Pennsylvania while in Delaware the growth rate has been somewhat lower. It is projected that by the 2030 census the majority of the population will reside in the Pennsylvania portion of the area. The governance structure of the watershed, with three states, five counties and 55 municipalities, creates a challenge in its complexity, yet affords ample opportunity for collaboration and coordination in efforts to protect and restore its waters.

The region has a rich and varied history from settlement by the Lenni Lenape, its discovery by the Swedes in the 17th century, the site of the largest battle of the Revolutionary War in 1777 and later the DuPont gun powder mills along the Brandywine at the turn of the 19th century. It provides opportunities for heritage tourism, outdoor recreation, and the exploration of its artistic legacy and agricultural tradition. The many parks and preserved open land throughout the watershed provide an abundance of destinations for residents and visitors to enjoy the outdoors. Activities throughout the watershed contribute \$4.9 billion and over 100,000 jobs to the economy of the region.

Key Findings of the Report

Precipitation: Over the period from 1960 to the present, precipitation has increased across the Brandywine-Christina watershed. Average annual rainfall has risen from 40-45 inches to approximately 50 inches. Generally, higher rainfall is seen in the northerly, more elevated portion of the study area.

Air Temperature: The record of temperature data goes back to the 1890s. Since that time there has been an increase in the average ambient air temperature, with the number of days over 90 degrees Fahrenheit more than doubling.

Streamflow/Mean Daily Flow/7Q10: Along with increased temperatures and precipitation, as well as urbanization in the watershed, there has been an overall increase in both peak stream flows (i.e., flooding), along with lower base stream flows in dry periods. Three major droughts since the 1960s saw low-flow extremes, but the past 15 years have seen higher flows due to wetter conditions.

Peak Events: The watershed has 19 continuously operating stream gages that measure stream flow and other parameters. It was determined that there was not a significant trend in the frequency or number of storm events resulting in the overtopping of streambanks at the Pennsylvania stream gages. In Delaware, peak streamflows have increased at the Brandywine, Red Clay and White Clay Creeks' stream gages over the last 20-30 years.

Impaired Streams: Pollutants, such as nutrients (nitrogen and phosphorus), bacteria and sediment, have caused waterways to be designated impaired (for a given use, such as swimming, use as a drinking water source, or as aquatic habitat). As of 2016, the Delaware portion of the watershed has 51.4 miles of stream impaired for nutrients and 116.5 miles impaired for bacteria, and the Pennsylvania portion has 135.5 miles impaired for nutrients, 68.7 miles impaired for bacteria, and 308.1 miles impaired for sediment.

Pennsylvania has 142.6 miles of stream designated "High Quality"; of those, 41 miles are also designated as "Exceptional Value" waters. Delaware has designated certain streams in the watershed, totaling 98.5 miles, as of Exceptional Recreational or Ecological Significance (ERES). The ability to support trout populations is also an indicator of water quality. In Pennsylvania there are 189 miles of designated cold-water fishery streams and 92 miles of naturally-reproducing trout streams.

Sea-Level: Approximately 40 square miles of the downstream portion of the watershed is tidally influenced, and therefore subject to impacts of sea-level-rise, including inundation and increased salinity. Peak high tides recorded along the two Christina River gages began to increase in 2000 and peaked in 2012 and declined in the four years since then.

Groundwater Levels: There are 12 monitoring wells that indicate groundwater levels throughout the watershed. Since the 1950s Chester County saw a 0.22 foot per year increase in groundwater levels at a key monitoring well. Delaware saw a nearly 5 foot average rise at the Wilmington monitoring well, with a slight decrease in levels at a monitoring well near Newark.

Macroinvertebrates: A long term macroinvertebrate monitoring program in Chester County, PA has been established by the USGS and the Chester County Water Resources Authority (CCWRA), and the Delaware Nature Society (DNS) runs a sampling program in Delaware. Of the nine monitoring sites in Chester County, three indicate good water quality, three indicate fair water quality and three indicate poor water quality. In Delaware 21 sites were monitored between 2011 and 2015. Of these nine were found to be of "good" water quality, and the remaining 13 "fair."

Birds: Changes in land use and water quality in the watershed can have a significant impact on native nesting species. Of six species considered: Eastern Meadowlark, American Kestrel, Common Yellowthroat, Kentucky Warbler, Louisiana Waterthrush, and Northern Parula, all except Northern Parula experienced a decline in breeding populations. Of particular concern are the two grassland-dependent species—Eastern Meadowlark and American Kestrel—which saw the largest declines, and are reliant on one of the most threatened habitats in the region.

Freshwater Mussels: The Partnership for the Delaware Estuary (PDE) has found that in some areas of the lower Brandywine Creek mussels are relatively abundant. In the Red Clay and White Clay Creeks mussels are not currently present, but the stream habitat appears suitable to host re-introduction.

Fish: Several migratory species of interest have historically been found within the watershed, and there are efforts to encourage their reestablishment—Striped Bass, American Eel, and American and Hickory Shad. Along with the focus on water quality

improvements, a key to reintroduction of these species is the removal of dams. To date only one dam, on the White Clay Creek, has been removed, but the farthest downstream dam on the Brandywine Creek is scheduled for removal in the fall of 2018.

Dissolved Oxygen (DO): The USGS and CCWRA maintain six stations that monitor DO in Chester County, and DNREC operates four stations in the Delaware portion of the watershed. Since the early 1970s, the percentage of days in Chester County that DO levels stayed above healthy levels has increased, and at all monitoring stations, DO levels have increased and improved.

Phosphorus: Orthophosphate is the form of phosphorus that runs off into streams from fertilizer and promotes plant and algal growth in streams. Orthophosphates are measured at ten USGS, CCWRA and DNREC monitoring stations in the watershed. Orthophosphate levels have improved since 1998 at three stations in Pennsylvania and all four stations in Delaware. Orthophosphate levels have remained constant at two stations in Pennsylvania and have increased along the East Branch Brandywine.

Nitrogen: Nitrogen is a nutrient of concern that can lead to excessive algal growth and drops in DO levels. Since 2000, nitrogen levels have improved at two water quality monitoring stations in Pennsylvania and four stations in Delaware. Nitrogen levels have increased, or become worse, at four water quality monitoring stations in PA.

Total Suspended Sediment (TSS): TSS is a pollutant of concern in the watershed, and can come from many sources, including instream erosion. USGS and CCWRA have established continuously operating turbidity sensors which can help determine TSS concentrations. Since 2008, sediment loads have declined somewhat at two stations in Pennsylvania. Sediment loads have declined at all four stations in Delaware since 2000.

Chloride/Salinity: The streams of the watershed have experienced increasing chloride concentrations (salinity) due primarily to winter road salting. These recent trends have raised concerns about stream health across the watershed.

Bacteria: Pennsylvania monitors fecal coliform levels in streams. Levels in winter were found to be below the swimming standard for this pollutant, while in the summer, that threshold is exceeded in the warmer months, June through September. Delaware, where *Enterococcus* bacteria levels are monitored, has seen varying trends since 2000, with slight declines in the

Brandywine and Red Clay Creeks, and no trend in the White Clay Creek and Christina River.

Water Temperature: The USGS has found statistically significant increases in water temperature in Chester County, while there appears to be no trend in Delaware. This may be caused by global changes in temperature, or more localized effects such as increased urbanization or reduction of riparian tree cover.

Land Cover: The watershed is characterized by a diversity of land types, with roughly equal amounts of urbanization, agriculture, and natural lands (e.g., forests and wetlands). In general the lower portions of the watershed are more urbanized, with agriculture concentrated upstream in the Brandywine, White Clay, and Red Clay Creek watersheds. Significant increases in developed land since the mid-1990s have occurred in the watersheds of the Brandywine-Christina, with a concomitant decrease in agriculture and natural lands. Future scenarios developed by the Shippensburg University Center for Land Use and Sustainability (CLUS) and others show that land cover characteristics of the Brandywine-Christina watershed will be affected by the planning and management decisions by regulators and policy makers.

Impervious Cover: Impervious cover has increased along with development in the watershed in recent decades. This trend has implications for water quality in streams and for overall watershed health. In the ten years from 2001 to 2011 many watersheds saw imperviousness levels approaching the critical 10% threshold above which they are considered negatively impacted.

Natural Resources Ordinances: Planning efforts dating back decades have helped Chester County develop strategies to guide growth and foster natural resource protection in the watershed. For instance, to date over half of the municipalities in the Chester County portion of the watershed have rigorous riparian buffer ordinances. Funding provided by the William Penn Foundation through the DRWI has allowed partners to provide technical assistance to municipalities in implementing further ordinances specifically to protect and enhance water quality. In Delaware, research by the University of Delaware Water Resources Center has found a similar level of ordinance-based protection for the waters of the watershed in New Castle County as that found in Pennsylvania.

Protected Lands: Protected lands can include local, county, state or national parks and preserves, agricultural easements, purchased development rights, deed-restricted lands such as



open space within residential developments, or land owned outright by conservancies or other conservation organizations. Within the Brandywine-Christina watershed the Brandywine Creek watershed has the highest percentage of protected land (31%), followed by the White Clay Creek (28%), the Red Clay Creek (27%), and the Christina River (15%).

Agricultural Restoration and Riparian Buffers: Many programs of the US Department of Agriculture Farm Service Agency (FSA) and Natural Resources Conservation Service (NRCS) provide funding assistance to reduce agricultural runoff. In Pennsylvania, in recent years, nearly 26 miles of protected riparian buffers, 10.3 miles of stream fencing, and over 7,100 acres of farmland are being stewarded with conservation plans. Delaware has implemented over 10 acres of riparian forest planting, 1,600 linear feet of stream fencing, and over 4,300 acres of land under nutrient management plans.

Stream Restoration: The Brandywine Red Clay Alliance has undertaken several stream restoration projects in the watershed. To date, over five miles of stream have been restored through 17 projects in the Brandywine and Red Clay Creek watersheds. Ongoing monitoring by Stroud Water Research Center and others is being used to determine the long-term effects on stream health.

Fish Passage: Fish passage research has been conducted on the Delaware portions of the Brandywine-Christina watershed, specifically in the Brandywine Creek and White Clay Creek watersheds. Successes include the removal of Dam No. 1 on the

White Clay Creek and the potential removal of the West St. Dam (Dam No. 1) in Wilmington.

Fish Consumption Advisories: DNREC and the Pennsylvania Fish and Boat Commission publish annual Fish Consumption Advisories for waterbodies in the watershed. Many Delaware waters have consumption advisories for legacy pollutants such as PCBs, DDT and dioxins. Mercury is increasingly a source of impairment of concern in Pennsylvania. In 2018 DNREC reinstated the Red Clay Creek as a stream suitable for trout, evidence of improvement.

Water Supply: The data show water demand is declining in both states in the period from 2001-2017 (for Delaware) and 2006 to 2016 (for Pennsylvania). Factors which explain the trends could include reduction in water loss due to leakage, increased water conservation measures, pricing water rates rising and loss of some industrial water users in the watershed.

Wastewater Dischargers: Wastewater dischargers in the watershed are largely located in Pennsylvania. The Brandywine Creek watershed has the largest number of wastewater dischargers. The 20-year trend for the dischargers in the Brandywine Creek and Red Clay Creek watersheds (1995-2015) show generally lower levels of discharge, due to some dischargers closing and some converting to spray irrigation. Other factors influencing this trend may be water conservation by commercial, industrial and residential users, and reduction of groundwater infiltration into sewer pipes. ■





Funding for this report is provided by

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