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Digging into Ditches: A Historical-Geographic Analysis of Agricultural Drainage
Ditches on Maryland's Eastern Shore

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Abstract

To this day, agricultural drainage ditches form a fundamental alteration to Maryland's Eastern Shore; however, the environmental impacts of the ditch network are relatively unknown. This ditch network has evolved in recent decades and now includes newer, larger, mechanically-dug 'tax ditches', introduced in Delmarva as methods of flood control due to the flat, swamp-like geography of the land. A mixed-method geographic analysis looked at this small-scale local water management infrastructure from several angles: (a) historical, utilizing Nabb Center archive research, documents obtained from various county offices, and oral history to establish the extent of the ditch network, (b) comparative land use, using applications of GIS mapping to display current ditch systems in relation to land use categories, and (c) spatial implications, assessing hydrologic proximity and drainage trajectory to the Bay. Information on ditches, both current and historical, is scattered and not easily found. This supports the need to compile this information for future reference and research. The hydrologic network shows tax ditches flow toward the Chesapeake Bay as an extension of natural streams, and land use maps display the great extent to which tax ditches are located in agricultural areas, yet still close to development. The question that remains is how much, volumetrically, of this ditch network drains into the Bay, and what water quality implications does this pose? This preliminary study has opened avenues for future research looking into this unique drainage network of Maryland's Eastern Shore.

Key words: ditches, Delmarva, environmental implications, GIS mapping

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INTRODUCTION

The need to drain swampy lands began with plantation economies in the late 1700s to make land arable for agriculture, as the land on Maryland's Eastern Shore is historically low-lying wetlands. Farmers drained the land through a process termed "ditching" followed later by a period of frenzied ditching in the 1950s for drainage and flood management in the form of large machine-dug "tax ditches." Tax ditches are deeper, wider, newer and sculpted out of the fields with back hoes, thus they can be seen as the water equivalent of freeways of water flow, relative to the original smaller, thinner more shallow ditches, which exist in the same network but are the equivalent of two-lane roads in terms of water flow. The implications of ditching are remarkably unappreciated and understudied throughout Maryland's Eastern Shore. There are several unknowns regarding ditches and their potential environmental impact, and there are even more unanswered questions about the ditch network as a whole. Collectively, the recorded tax ditch system which runs through the Eastern Shore is nearly 1,000 miles. Including the hundreds of miles of regular, on-farm ditches, it is speculated that the total ditch network spans closer to 2,000 miles. Considering the Eastern Shore of Maryland is only about 50 miles wide at its widest point, the scale of the land area that these ditches cover is enormous. This ditch network contains both regular ditches and tax ditches.

During the plantation era of the 1700s, the primary use of drainage ditching systems was for agriculture, and ditches were dug by hand. These ditches are generally small in size due to the manual labor used to dig them. In contrast, tax ditches are extraordinarily larger than these historically built ditches. While the exact beginning of the building of tax ditches is unknown, the 1950s saw a period of furious tax ditching with added federal money. These types of ditches can range anywhere in size from six to fifty feet wide and two to fourteen

feet deep. Tax ditches were introduced to address the need for drainage and flood management in Delmarva due to the flat, swamp-like geography of the land. The term “tax” ditch is derived from the fact that county taxpayer money from those landowners whose land benefits from the ditch serves as the source of funding to build and maintain these ditches. The wide array of unknowns surrounding the ditch network of the Eastern Shore goes to show that these drainage systems and the history of the hydrologic network in Delmarva are understudied. For the purposes of this manuscript, we use the term Delmarva as a blanket geographic reference to the Eastern Shore of the Chesapeake, although the study site is restricted to the Maryland portion of Delmarva. This developed two primary research questions of focus in this manuscript: What is the overall hydrologic extent of the agricultural drainage ditch network that runs throughout Maryland’s Eastern Shore, and how has the ditch network evolved from the pre to post-WWII era, to include its structure and management? Subsequently, how has land use changed in accordance with the ditch network, and what water quality implications does this pose for the Chesapeake Bay?

LITERATURE REVIEW

The Delmarva Peninsula is part of Maryland’s Coastal Plain, consisting of low elevation land with streams, bays, and rivers running through it that contribute to the poorly-drained nature of the land (DiLisio 2014, 43; Hammond 1968, 2-5). Literature regarding potential impacts of ditches is relatively new, and it has not been until recently that scientists have begun to look into and realize the impacts of ditching on the landscape and water quality. Not only do they serve as primary drainage systems for land, but ditches also control water tables, carry pollutants downstream, and provide aquatic and wetland habitats; thus,

“influencing landscape hydrologic, chemical, and biological processes” (Needelman et al. 2007a, 171-172). Since ditches expedite the transport of water flow off land, they eliminate natural filtration (Horton 1999a). Some research has been conducted to comment on the role ditch soils play in mitigating agricultural pollutants and nutrient losses by aiding in nutrient cycling, mediating transport of solutes and particles via ditch waters, and enabling vegetation growth that can trap sediments (Needelman, Ruppert, and Vaughan 2007b, 214). Much information is known about excess nitrogen and phosphorus content of streams and rivers in the watershed, a result of the intense agriculture and poultry farming on Delmarva (Denver et al. 2004, 1-3; Kobell 2008). It is known that “agriculture is responsible for approximately 43% of nitrogen (N), 45% of phosphorus (P), and 60% of the sediment loads released into the Bay”, with phosphorus typically being transported by surface waters, and nitrogen via groundwater and soil sediment (Niño et al. 2012, 270 and 272). Vaughan et al. (2007a) state that “ditches have the potential to act as key conduits for the export of nutrients from areas of intensive agriculture to surface waters,” suggesting that ditches could transport phosphorus and nitrogen into the Chesapeake Bay (1895).

In addition, the great number of poultry farms throughout the Eastern Shore pose environmental concerns with respect to transport of excess nutrients from poultry manure, especially with regard to surface runoff from agricultural farms and phosphorus leaching into groundwater and soils (Niño et al. 2012, 270-272; Vaughan et al. 2007a, 1896). There is high potential that ditches close in proximity to poultry farms could transport these nutrients into the Bay via surface waters, as most agricultural soils in areas of poultry industry have excess levels of nutrients (particularly phosphorus), greater than that required for crop production (Kleinman et al. 2007, 225-226). More than 400 surface waters in Maryland were considered

impaired in 2002, of which 25% were the result of nutrients, and most of which fell within the Chesapeake Bay watershed (Vaughan et al. 2007b, 1096). In some areas, land no longer used for agriculture has been converted back into wetlands to try to mitigate pollution via nutrient and sediment flow with the purpose of restoring wetlands to filter out these pollutants (Jordan et al. 2003, 1534). There has been suggestion to fill in agricultural ditches to allow the restoration of wetlands, although some view this approach as unfavorable because of potential adverse effects on land use on the Eastern Shore.

There has also been research on ditches in terms of agricultural runoff in relation to groundwater retention of nutrients and soil saturation (Vaughan 2005). With proper management techniques, ditch soils can work to filter out phosphorus in effluent as well as serving as stores of nitrogen (Kleinman et al. 2007, 234; Shigaki et al. 2009, 2449). Dredging is a popular technique to maintain water flow through ditches, however if not done properly it can remove material that serves as a nitrogen sink and assists in nitrogen cycling of sediments, impacting filtration of nutrients via ditch soils (Shigaki et al. 2009, 2456-2457). Characterizing whether sediments within ditches function as soils is also important, as the retention capacity and nutrient cycling of the ditch would be increased if some ditch soils function similarly to wetland soils (Vaughan et al. 2008, 660-661). Also, as tax ditches are “built to remove an inch of rain every 24 hours,” there has been some speculation about the impact of ditches on transporting water and pollutants downstream, especially considering stormwater runoff (Horton 1999b).

Land drainage systems are also recognized for a wide variety of benefits, including increased crop production, land value, improvements in soil characteristics (such as firmness and temperature), reduced erosion, and were once used for mosquito control (although

unsuccessfully) (Haswell 1914, 70-72, 99). Vaughan et al. (2007b) found that phosphorus has a spatial variation within ditches, and knowledge of this variation will allow for the targeting of best management practices, which increase nutrient retention and denitrification while also maintaining and improving ditches' hydrologic function (1102). The Maryland Department of Agriculture states that "research has shown that proper drainage of frequently saturated soils helps create more productive farmland, reduces flooding, protects public health, improves the transportation infrastructure and supports local economies" ("Cost-Share Assistance for Public Drainage Associations"). Ditches that are maintained properly using best management practices also contribute to landscape scale biodiversity, as they provide habitat for species of fish, plants, and macroinvertebrates, as long as alterations to the ditch for water flow do not affect the ability of the ditch to do so (Leslie et al. 2012, 802 and 811). Thus, the overarching goal of ditches is to drain naturally saturated soils so they are productive and valuable for a wide variety of land uses; but over time the purpose of ditches has evolved dramatically.

The Eastern Shore ditch network is unique in that there exist few hydrological equivalents elsewhere in the United States. In the Midwest, drainage systems similar to ditching are used for irrigation or to drain wetlands for agriculture (Fausey et al. 1995, 283-287; McCorvie and Lant 1993, 13-39). This drainage system is subsurface tile drainage, which is an extensive water management activity that can negatively affect surface water quality and has been shown to affect flow rates of water in these regions (King, Fausey, and Williams 2014, 438- 444; Williams, King, and Fausey 2015, 43-50). There are also instances of similar types of drainage in other areas of the United States, such as in irrigated areas of California, the Atlantic Coastal Plain, North Carolina, and Indiana (Needelman et al. 2007a,

171). In this regard, drainage ditches potentially serve a purpose in multiple regions of the U.S., though in a different sense as irrigation deliberately adds water to the land. Thus, the Eastern Shore is unique in altering the landscape with open ditches to purposefully drain the land. The newness of the existing information regarding ditches on the Eastern Shore serves as a motive to address some of the remaining unanswered questions revolving around this local hydrologic system. There are only a handful of scholars who have begun researching ditches, but their science provides valuable and significant information regarding this small-scale water management and its environmental impacts. This research adds to the literature as a comparative spatial analysis of counties within the Chesapeake Bay watershed of Maryland's Eastern Shore to assess the extent of the distribution and potential implications of the ditch network.

METHODOLOGY

The combined methodological frameworks of environmental studies and geography are of value in this study due to the shared belief across both disciplines that human-environment interactions are completely entwined in that the environment also has an impact on humans, and these impacts can be both positive and negative. Patterns of human impacts on the environment are ongoing, and thus allow us to predict future environmental impacts. This study employed a mixed-method geographic analysis to look at this small-scale local water management infrastructure from several angles: (a) historical, utilizing Nabb Center archive research, documents obtained from various county offices, and oral history to establish the extent of the ditch network, (b) comparative land use, using applications of GIS

mapping to display current ditch systems in relation to land use categories, and (c) spatial implications, assessing hydrologic proximity and drainage trajectory to the Bay.

The constraint applied to this study focused on three counties on Maryland's Eastern Shore that have drainage ditches within the Chesapeake Bay watershed: Wicomico, Somerset, and Worcester counties. There are essentially two units of analysis: 1) the political delineations of county boundaries, and 2) the subsequent geographic delineations of the watershed basins, using a hydrologic boundary to divide the land that drains into the Bay from the land that drains into the Atlantic Ocean. Worcester County borders the Atlantic, and about half of the county drains into this ocean. Therefore, for the purpose of this study only the portion of Worcester County that drains westward toward the Bay was considered. This created a figurative hydrologic boundary that cuts through the middle of Worcester County to allow for the study analysis of drainage ditches to be focused within the Chesapeake Bay watershed.

Historical

A historical understanding of land use and the ditch network was gained by conducting archival research in the Edward H. Nabb Research Center for Delmarva History and Culture housed in the Guerrieri Academic Commons at Salisbury University. In addition, documents were obtained from various county offices and an oral history of the ditch network was created by meeting with a wide range of county officials and landowners. The majority of research done for this project was conducted in the summer of 2017 from June through August with assistance of a research grant provided by the Guerrieri Summer Research Program through the Henson School at Salisbury University.

Comparative Land Use

Through the application of comparative spatial analysis, the extent of the ditch system was determined within the study area. While the initial goal was to apply geographic information systems (GIS) to map both the pre- and post-tax ditch eras of ditching to compare the changes in the ditch network across these time periods, unfortunately there is no data readily accessible and available to use to map the pre-tax ditch era of ditches. In order to do so, aerial imagery of Eastern Shore hydrology would have to be digitized, a task too tedious for the time constraint of this undergraduate thesis. Instead, maps were created using GIS technology (via the computer software ArcMap) to display the current tax ditch network overlaid with land use categories within the tri-county study area. All maps were created at Salisbury University in the GIS lab on campus.

Spatial Implications

The tax ditch network was also overlaid with the overall hydrologic network of the Eastern Shore in order to display ditch network proximity to the Chesapeake Bay watershed. By viewing the tax ditch network overlaid with the hydrologic network, speculations could be made about the trajectory and proximity of ditches in relation to hydrologic systems flowing into the Bay. These maps were also created using GIS technology (ArcMap) to display the tax ditch network overlaid with Bay hydrology within the tri-county study area. All maps were created at Salisbury University in the GIS lab on campus.

DATA

Research Angle One: Historical Data Collection

Historical research initially began at the Nabb Center by looking through archived newspaper clippings local to Maryland's Eastern Shore. Out of the thousands of newspaper

archives, a search was conducted for those containing any reference to a ‘ditch’, with approximately 100 individual advertisements and clippings referencing the word ‘ditch’ in terms of drainage. A handful of newspaper records of ditches dated back to the late 1700s, and there was notice of the construction of a ‘tax ditch’ dating as early as the 1870s. This preliminary search of archival newspaper records introduced the idea that the history of the tax ditch network throughout the Eastern Shore began earlier than believed before, as it was thought that the tax ditch network did not begin until the 1930s at the earliest.

The discovery of ditch references in old newspaper archives sparked the question if ditch references exist on historical maps as well. Land assessment maps for Wicomico County (dated 1967) were located in the Nabb Center in hopes to find reference to ditches on these maps. Through a tedious process of locating specific properties that may contain ditches for drainage on land assessment maps for the northeastern portion of Wicomico County, some reference to ditches on maps was discovered. This information was located by going through plats of land and associated written deeds in search of any reference to a ditch. Land assessment maps existed in print, while the linked deeds were searched through the Maryland Land Records online (via mdlandrec.net). Most references within deeds included the use of ditches as property boundaries, rather than specifically for the purpose of drainage; however, it is likely that the ditches served to drain land, but for the purpose of the deed were simply referenced as a boundary dividing one plat of land from the next. Although a comprehensive search could not be done for the entirety of Wicomico County due to time constraints (which also contributed to an inability to search all records in Somerset and Worcester Counties), finding record of ditches on land assessment maps and deeds dated in the 1900s supports the historical background of the ditch network.

Upon this initial look into the history of the ditch network by searching land assessment maps, plats, and deeds, this historical research then evolved into searching archived surveyor's notes and collections, also within the Nabb Center archives. Research began with the Miles Family Surveyor Collection, primarily for Somerset, Wicomico, and Worcester Counties, but with some records for Maryland's upper Eastern Shore, part of Kent and Sussex Counties in Delaware, and Accomack County in Virginia. The enormity of the archived surveyor's notes was a constraint in itself. The collection contained eleven boxes of archived, hand-written surveyor notes, with roughly 20 files in each box, and numerous stacks of notes and records within each file. However, searching through the Miles Family Surveyor Collection uncovered new and before undiscovered records of tax ditches. Amazingly, the first file found referenced the Manokin Tax Ditch, in Somerset County, dated 1869. Finding record of the Manokin Tax Ditch from 1869 supported the claim that the tax ditch network existed far sooner than believed before, and the present-day system likely evolved from this historical network of ditches. The Manokin Tax Ditch records included hand-written surveyor's notes accompanied by a list of 'taxables', showing that even in the mid to late-1800s landowners were taxed for ditches on their land. These records also included a hand-drawn plat of the Manokin Tax Ditch, outlining its structure and location on the land. This provided exciting and necessary evidence to support the evolution of the ditch network throughout the Eastern Shore.

The box of surveyor's notes on the Manokin Tax Ditch led to the discovery of a file of "Tax Ditches", located within the Ballard Miles Surveyor Index. Through the use of this index, individual files of hand-written surveyor's notes, plats, and deeds for numerous tax ditches were located within the archives. Discovering these records was vital in building the

historical background of the ditch network, as it provided concrete evidence of the record and existence of tax ditches in the 19th and 20th centuries. These tax ditch records also support records found later at county offices to document the building of various tax ditches throughout Wicomico, Somerset, and Worcester counties. Five boxes of tax ditch records were searched encompassing years from as early as the mid-1800s to as late as the late-1970s, with numerous files including information about specific, named tax ditches that still exist today. Uncovering these records at the Nabb Center serves as the beginning of compiling the history of tax ditches throughout Maryland's Eastern Shore, as these records had not been located or known about prior to this research. Now knowing these archival records exist will be of great importance in future research conducted surrounding the ditch network and opens avenues for continuing to sort through archival records of the ditch network.

Upon gaining a background on the ditch network through the archives at the Nabb Center, focus of the project was shifted to traveling to county courthouses and other county offices in search of historical information about ditches. The Wicomico County Public Library did not contain specific information on ditches, and unfortunately all newspaper clippings were on microfilm and were thus unsearchable digitally via a specific word search. However, library liaisons noted most archival newspapers were held at the Nabb Center, which had been searched at the beginning of this research. Travel to the Wicomico County Courthouse resulted in meeting with the courthouse manager, who informed that land records were housed in the courthouse and dated back to 1867. Unfortunately, it was unclear if these records pertained to ditches specifically, but a list of personal contacts was provided by the courthouse manager in order to create an oral history of the ditch network. This list of

contacts included an auctioneer, a few local farmers, and a historian. Subsequent conversations and meetings with these contacts increased the wealth of information surrounding the history of ditches, and also provided leads to meet with additional people well-versed on the topic of ditches.

The personal contacts proved to be more useful in gaining insight and information into the historical background of the ditch network, thus rather than traveling to the Somerset and Worcester County Courthouses, phone calls were made to their offices in search of information on ditches. Most conversations led back to the recommendation to meet with managers at each county's respective Soil Conservation District. In following this advice, arrangements were made to meet with the managers of both the Wicomico and Somerset County Soil Conservation Districts (SCD). In the advent of time during the summer research period, travel to the Worcester County SCD was not able to occur; however, in speaking to the managers at the Wicomico and Somerset SCD information about Worcester County was gained as well.

In addition to meeting with these managers, the oral history of the ditch network was compiled through meeting with employees of the Maryland Department of Agriculture at the Office of Resource Conservation extension office located in Salisbury, Maryland. Several local residents also were contacted via phone, leading to a meeting with one resident who is a farmer, auctioneer, and tax ditch manager in Wicomico County. Meeting with and speaking to this wide variety of people allowed for a complete background and understanding to be gained about the history, structure, and management of Maryland's ditch network.

Research Angle Two: Utilizing GIS to Map Ditch Network and Land Use

Pre-existing data of known tax ditch networks and their associated watersheds are available through the Eastern Shore Regional GIS Cooperative (ESRGC) and were used to map current tax ditch networks using ArcGIS software. The ESRGC worked with the Maryland Department of Agriculture to create a dataset of the tax ditch networks throughout Maryland's Eastern Shore, which is available online for public access. Thus, this tax ditch network data for Wicomico, Somerset, and Worcester Counties was used to map the extent of these networks in conjunction with land use categories.

Research Angle Three: Spatial Implications of the Hydrologic Network

The data to map the tax ditch network obtained from the ESRGC was used in this portion of data collection as well. Data for the overall hydrologic network of the Eastern Shore was obtained from the U.S. Geological Survey (USGS) National Hydrography Dataset (NHD). This data was accessed online, and included a layer titled "Canal Ditch." This layer was later presumed to be either old tax ditches that had fallen out of maintenance and function, or pre-tax ditch era ditches, which would have been dug by hand. In speaking with Soil Conservation District managers and employees at the MDA Office of Resource Conservation, no conclusive statements could be asserted as to what exactly the data shows on this layer. However, it was still included on maps to show the supposed overall extent of the ditch network as it is known thus far, in addition to the remaining hydrology of the Eastern Shore. In both the maps displaying land use and those indicating spatial proximity to the Bay watershed, a shapefile of the Chesapeake Bay watershed was used to divide Worcester County to clearly separate land which drains westward toward the Bay from that which drains eastward into the Atlantic Ocean.

ANALYSIS

Structure and Management of Ditches as We Know Them Today

The present-day ditch network has greatly evolved and expanded from the small connection of hand-dug ditches that began the era of drainage on the Eastern Shore. Today, this system of ditches is known as ‘tax ditches.’ Tax ditches, unlike regular ditches, are maintained with county taxpayer money of those whose land benefits from the ditch, hence the name ‘tax’ ditches. The majority of these newer and larger ditches were built in the mid-1950s and 1960s, and tax ditches alone run nearly 1,000 miles throughout Maryland’s Eastern Shore.

In Maryland, tax ditches are managed by either Public Drainage Associations (PDAs) or Public Watershed Associations (PWAs) (Maryland Department of Agriculture n.d.). Both PDAs and PWAs are separate entities of the government, and are overseen by the Maryland Department of Agriculture. There are a total of 101 PDAs and four PWAs throughout the Eastern Shore (Maryland Department of Agriculture n.d.). PWAs are essentially the same as PDAs; they operate the same and serve the same functions. The only difference is technical in the procedural manner of how PWAs are set up and the steps followed for a PWA to be created.¹ Thus, since most tax ditches are maintained by PDAs, these establishments are of focus for this project.

Public Drainage Associations

The structure and management of Public Drainage Associations (PDAs) is quite complex. The majority of PDAs were established in the 1950s and 1960s when there were federal funds available to build them. PDAs themselves are established by a group of landowners, community, or watershed that determines there is a drainage issue in their area

that needs to be addressed. Often, this determination involves individual landowners with adjacent properties getting together and deciding there needs to be a ditch built across their land to help with drainage. These landowners will then propose a drainage plan to their affiliated county Soil Conservation District (SCD) with the knowledge that if the SCD approves the ditch project (after meeting to discuss the need for drainage and creating a tax ditch), the cost of building the tax ditch will be shared by all landowners. Thus, even though tax ditches are built with the assistance of the SCD, all landowners involved must be in agreement.

Additionally, at the time the ditch project is proposed by the landowners, a board of viewers is appointed by the Maryland Department of Agriculture (MDA), which works in conjunction with the SCD to establish a PDA. The board of viewers consists of unbiased citizens who do not depend on the drainage, and they are involved with the design up to the completion of the PDA.² The board of viewers creates a viewer's report which lays out the location of the ditch, states the benefits, taxables (landowners), and associated expenses.³ If the viewer's report is approved by the SCD and the MDA, then the plans are put in place to create the tax ditch. In the case where the land is not already under the jurisdiction of a PDA, one will subsequently be created; if the ditch were created after a PDA had already been established, then it would simply fall under the management of this PDA.

Once a tax ditch project is approved and an associated PDA established, the building of a ditch begins. At this point in time, a board of managers is elected to manage the PDA and tax ditch. Often, these people are landowners within the area of the PDA, although they do not have to be.⁴ Typically, there are three to four managers for each tax ditch, who work in accordance with the MDA to properly maintain the tax ditch.⁵ This board of managers is

required to create an operations and maintenance plan for the tax ditch, in addition to inspecting the ditch and maintaining a tax roll. These procedures, from the proposal of the ditch to its completion, are outlined in the Maryland Drainage Law, Article 25, Sections 52 through 121H of the Annotated Code of Maryland (Maryland Department of Agriculture 2008). Additionally, each PDA and subsequent ditch is classified according to their function and purpose, as some PDAs and ditches are larger than others and thus serve as drainage for greater land areas, while other ditches are much smaller and may only drain a single, privately-owned farm (Maryland Department of Agriculture 2008).⁶

At the MDA Office of Resource Conservation located in Salisbury, Maryland, the Public Drainage Coordinator for the Lower Eastern Shore (encompassing Wicomico, Somerset, and Worcester Counties) is the liaison between PDA managers, land owners, and the state.⁷ This position ensures that PDAs submit an annual operations and maintenance plan for their tax ditch, in addition to keeping a walking inventory of each tax ditch within a PDA. This involves actually traveling along the ditch systems, observing maintenance concerns, and then relaying these concerns to PDA managers.⁸ The MDA also assists tax ditch associations primarily by advising and encouraging them.

However, the MDA is non-regulatory; thus, it cannot impose or enforce rules or regulations upon PDAs or their managers. The MDA simply provides recommendations to PDA managers regarding how they feel a ditch will be best maintained, to include what areas of the ditch require maintenance (e.g. cutting woody growth, removing fallen trees, or replacing drainage tiles) in order to ensure the ditch is kept clear to allow water to flow. Each group of managers for a PDA must submit an Operations and Maintenance Plan to the MDA, which outlines how the managers intend to maintain the tax ditch. The MDA then sends this

plan to the Department of the Environment (DOE) and the Department of Natural Resources (DNR) to review. If the DOE and DNR both approve the plan, this is relayed to the MDA, which then gives the go-ahead to the PDA managers to move forward with their plans to maintain the tax ditch.⁹ As part of the tax ditch management, PDA managers are required to hold an annual public meeting with all landowners to discuss plans for the upcoming year, address maintenance concerns, and answer any questions proposed by landowners. These landowners are citizens whose land directly benefits from the ditch, meaning that the tax ditch provides drainage for their land. However, if three years pass and PDA managers have not maintained the ditch or kept up with public meetings with landowners and Soil Conservation Districts, the PDA becomes non-functional and dissolves.¹⁰ In the event that this occurs, it is nearly impossible for a PDA to be re-instated because of the tedious process and cost of creating a PDA.

Each tax ditch has an associated watershed boundary, encompassing the land which is drained (or benefitted) by the tax ditch.¹¹ Only citizens who live within the watershed boundary pay the tax associated with the ditch, and within this area in the watershed, only benefitted land is taxed. Thus, a property owner may only be taxed on part of their land that is being directly benefitted by the ditch. Within the viewer's report at the beginning stages of the creation of the tax ditch, benefitted land is determined and cannot be altered from that point on; thus, the same land will always be taxed for provided benefits. At this time, a ratio of cropland to forest is determined to create a use-value, and then associated tax amounts are assessed. Because cropland is the most benefitted, it is the most expensively taxed, although taxes are generally only \$10- \$25.¹²

Although technically the land which a tax ditch runs through belongs to individual landowners, PDAs have rights-of-way and easements which allow them to tax landowners directly and also access the tax ditch for maintenance. The right-of-way extends 20 feet from the top of the slope and includes the area where PDAs have the right to clear trees, mow grass, remove brush, or any other actions to upkeep the ditch (Maryland Department of Agriculture 2008).¹³ This right-of-way also enables PDA managers to access the ditch as it provides a clear pathway to travel along in order to assess the ditch for possible maintenance concerns. Land easements enable PDA managers to travel along the rights-of-way that run through private property of the landowners living alongside a ditch, or whose land may need to be crossed in order to access a tax ditch.

In sum, the structure and management of PDAs involves cooperation between multiple stakeholders at varying scales. Not only are PDAs a function of a relationship between landowners and county officials, but they also are influenced by management at the state government level through the Maryland Department of Agriculture and Departments of the Environment and Natural Resources. Because they incorporate several different management structures and offices, it can be difficult to ascertain who truly is in charge of PDAs. Thus, the structure and management of PDAs is a complex and intricate process.

The Evolution of the Ditch Network

The agricultural drainage ditch network as it is known today has a long history on Maryland's Eastern Shore. While it is known that regular, hand-dug ditches have existed throughout the Eastern Shore since the plantation era, the evolution from regular ditches to tax ditches is less clear. Archival research at the Edward H. Nabb Center revealed new and exciting information concerning the history of ditches on the Lower Eastern Shore. These

archival findings were combined with information learned by creating an oral history of the development of ditches and the Eastern Shore in order to piece together the evolution of the ditch network.

The Very Beginnings

Maryland's ditch network began during the plantation era of the 1700s, as stated before, for the purpose of drainage in order to allow for the production of crops. During this time, individual farmers dug ditches by hand, or used slave labor to dig the ditches. Because they were dug using manual labor, the ditches of the 1700s were narrow and shallow, quite simple and unsophisticated. There were often several ditches on the landscape of a single plot of land to ensure that land was drained efficiently. This early system of drainage ditches serves as the very beginning of the alteration of land on the Eastern Shore, which later enabled the settlement and development of the Eastern Shore.

The first recorded, organized drainage project in Maryland occurred in 1789 in Queen Anne's and Caroline Counties for drainage of the Long Marsh (Ritter 2010, 2; Maryland Department of Agriculture 2008). The Long Marsh Ditch served as approximately a twelve-mile dividing line between Queen Anne's and Caroline counties and drained about 50,000 acres of farmland ("Formulating Plans to Reclaim 50,000 Acres on Eastern Shore" 1927). However, due to the cost of maintaining the ditch, it was closed. The jurisdiction of drainage systems began in 1844, when county commissioners were given jurisdiction over drainage laws, rather than projects being authorized by state legislature (Maryland Department of Agriculture 2008; Ritter 2010, 2).

It is generally believed that during the time between 1789 and the 1930s, drainage projects were still regular, hand-dug ditches created and maintained by individual farmers.

Although county commissioners had jurisdiction over drainage laws, there is hardly any record of drainage projects, other than reference to the first project for drainage of the Long Marsh. This lack of records makes it difficult to build a history of how the present-day tax ditch network evolved, but archival research at the Nabb Center provided insight and newfound information concerning this history.

Prior to searching archival records, it was believed that the system of tax ditches began to evolve during the 1930s. Yet, records at the Nabb Center yielded new information about the history of tax ditches. In searching through thousands of digitally-archived newspaper clippings and searching by the term ‘ditch’, nearly one hundred references to ditches were found, with a handful of references dating back to the seventeen- and eighteen-hundreds. Included in these newspaper clippings was the first piece of telling and exciting evidence about tax ditches, found in the *Salisbury Advertiser* within the Nabb Center’s collection of “Historical Eastern Shore Newspapers”: a “Tax Ditch Notice” from the Commissioner’s Office of Wicomico County, dated May 7th, 1872. This piece of evidence shows record of the order for a tax ditch dating back to the 19th century, helping to build the evolution of the tax ditch network (Figure 1).

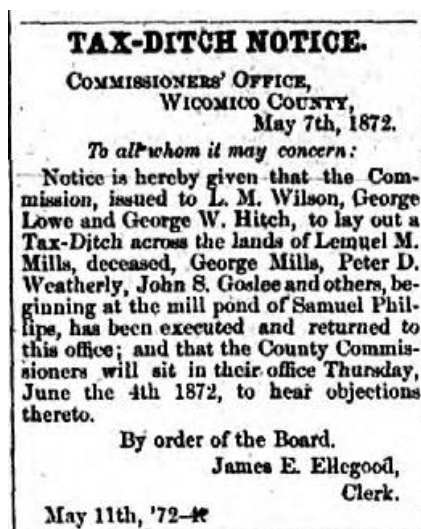


Figure 1. Notice of the order of a tax ditch in Wicomico County, dated May 7th, 1872. *Courtesy of Edward H. Nabb Research Center for Delmarva History and Culture, Salisbury University, Salisbury, Maryland.*

This was the earliest notice of a tax ditch found within the archived newspaper collection at the Nabb Center. In addition to this particular newspaper clipping, several other tax ditch notices were found throughout the historical Eastern Shore newspapers, including the *Salisbury Advertiser and Eastern Shoreman*, *Marylander and Herald*, and *Courier*. Some tax ditch notices even referenced specific tax ditches, such as Pine Branch Tax Ditch and Green Branch Tax Ditch. These tax ditches still exist today, thus finding record of them before the 1900s suggests their current system under management of a PDA evolved out of a much older management system. Also included in the newspaper archives was a record in *Herald and Eastern Shore Intelligencer* from 1801 referencing ditching and drainage for Long Marsh. This is an additional record to support Long Marsh being the first recorded drainage project in Maryland. Rather than first evolving during the Depression Era, these newspaper clippings support the claim that the system of tax ditches evolved much earlier

than this. Discovering this record provoked more questions regarding if other records of tax ditches exist elsewhere in the archives.

This historical record search continued deeper into the archives at the Nabb Center to search within surveyors' collections, documenting land surveys for counties on the Eastern Shore. The Miles Family Surveyor Collection became the focus for this project, and yielded additional new information regarding the history of tax ditches. The land plats and deeds within this surveyor's collection focus primarily on Somerset, Wicomico, and Worcester Counties, but also includes land boundaries in the Upper Eastern Shore. In the first file pulled from this collection was a hand-drawn plat for the Manokin Tax Ditch, dated 1889. Not only did this discovery show that tax ditches existed in the late 1880s, but it also showed that their location along the land was being recorded.

Additionally, accompanying the plat of Manokin Tax Ditch were hand-written surveyor's notes documenting the extent of Manokin Tax Ditch. Within these notes was a list of taxables, displaying the names of the landowners whose land benefitted from Manokin Tax Ditch and how much each landowner was taxed (Figure 2).

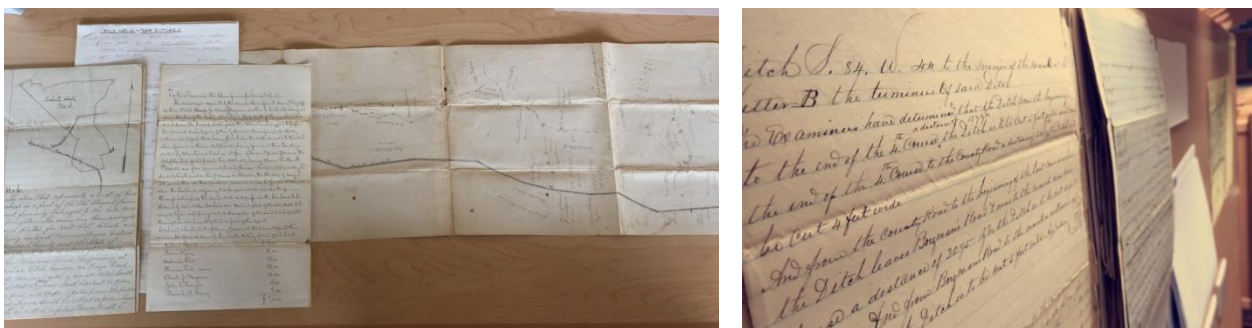


Figure 2. Miles Family Surveyor Collection, Somerset County: Manokin Tax Ditch, surveyed 1889. Photographs courtesy of Edward H. Nabb Research Center for Delmarva History and Culture, Salisbury University, Salisbury, Maryland.

Not only do these archival records show that tax ditches were present and their locations recorded, but they also reveal that landowners were being taxed for provided benefits in the late 1880s. This is at least 40 years earlier than it was believed the concept of ‘tax’ ditches came to be. Thus, these archived findings at the Nabb Center have greatly helped to build the history of the tax ditch network, as it is now known that this system of ditches existed prior to the Depression Era, which is when it was originally believed tax ditches were created.

Leading into the 1950s and 1960s: A Ditching Frenzy

Although newly-discovered archival records now support the existence of tax ditches in the late 1880s, the tax ditch system as it is best known and understood presently began in the Depression Era. During this time of economic strife and national struggle, with unemployment rates at a historic high, the federal government created programs to provide people with jobs. Throughout the nation, labor camps were established under the Department of Agriculture through the Civilian Conservation Corps (C.C.C.) to provide jobs for hundreds of thousands of unemployed men. On Maryland’s Eastern Shore, it was through C.C.C. camps that widespread ditching began.¹⁴ In addition, the Long Marsh Ditch was reopened during this time. In a 1927 newspaper article published in *The Baltimore Sun*, Senator D. G. Roe claimed the state of Maryland wished to re-open the ditch ("Formulating Plans" 1927). To do so, a machine would be purchased which would allow for facilitated clearing and maintenance of the Long Marsh Ditch and thus other ditches in the county. This marked the starting period of machine-dug ditches. The need to drain Long Marsh for farmers caused the state of Maryland to deem it necessary to upkeep ditches in order to ensure productive land

use, and subsequently labor camps on the Eastern Shore became a viable way to do so while also providing unemployed men with work.

A manuscript titled *Camp Somerset*, found in the Nabb Center and believed to have been written by a woman named Linda Boston, documented the establishment of labor camps in Somerset County to provide jobs for unemployed men. Although an exact date is unclear, it is believed that this manuscript was written post-WWII to document the work done by the C.C.C. camp “Camp Somerset” during the Depression. The manuscript helps to document the history of drainage on the Eastern Shore, as it states, “Due to the serious problem of drainage, in 1933, the County Drainage Board and the County Agent appealed to the Dept. of Agriculture for a C.C.C. Camp in Somerset County,” which was located between Princess Anne and Westover (Boston n.d., 1). This labor camp employed 200 men, who began clearing debris from twenty-eight tax ditches on November 5, 1935 (Boston n.d., 2). The written record of Camp Somerset men clearing tax ditches in 1935 supports the claim that tax ditches were prevalent at this time, and steps were being taken to maintain them.

The manuscript also refers to “taxables” and specific tax ditches, namely Kings Creek Tax ditch and Pegg’s Neck, which also serves to document the history of tax ditches (Boston n.d., 2). Just four years later, in 1939, “the number of tax ditches in Somerset County had increased from twenty-eight to thirty-nine [and] around this time, the C.C.C. project was transferred from the Agriculture Extension Service to Soil Conservation Service,” which is known as the Soil Conservation District today (Boston n.d., 3). However, Somerset County today only has four recorded tax ditches, the reason being that the county lost a lot of their tax ditches because they were not properly maintained, thus the PDAs became non-functional and dissolved.¹⁵ Regardless, the *Camp Somerset* ditch manuscript serves a valuable purpose

of documenting the ditching done by the C.C.C. during the Depression Era in order to provide labor to boost the economy and moral of Somerset County.

The system of tax ditches maintained by the C.C.C. and labor camps on the Eastern Shore continued to evolve in the mid-20th century. During the Depression, Agricultural Boards were created, and every state had its own districts for agriculture. At one point in time, there were over 35,000 agricultural districts throughout the nation, and on the Eastern Shore these districts became what are known as PDAs today.¹⁶ The county commissioner jurisdiction laws that were created in 1844 were amended in 1941 to form Public Drainage Districts, which began the construction and reconstruction of agricultural drainage projects (Ritter 2010, 2). At this time, funding for ditch construction and maintenance was provided by taxing beneficiaries. Local county governments provided some support in 1951, but it was not until 1954 that drainage projects really took off.

The creation of the federal Watershed Protection and Flood Prevention Act of 1954 under Public Law 566 changed the course of drainage on the Eastern Shore (“The Maryland Comprehensive Plan” 2009, 57). This act enabled the Soil Conservation Service (now the Natural Resource Conservation Service) to assist Soil Conservation Districts with watershed projects. It was through this relationship that “the federal government provided approximately 75% cost-share funding for PDA construction; coupled with an additional 12.5% from Maryland and county funds, government support could cover as much as 87.5% of project costs” (“The Maryland Comprehensive Plan” 2009, 57). This federal funding is what allowed for the frenzied ditching of the 1950s and 1960s to occur. Because costs to construct ditches and create PDAs were covered by the federal government, as the majority of the ditching projects were completed by the U.S. Army Corps of Engineers, nearly all of

the tax ditches and PDAs on the Eastern Shore were formed in the 1950s and 1960s. Forty out of the 103 PDAs active on the Eastern Shore today were created during this time, and West Henderson PDA was the last to be built with Federal Public Law 566 funds, completed in 1985 (“The Maryland Comprehensive Plan” 2009, 57).

The End of an Era

Although the mid-20th century saw a frenzy of ditching occur throughout the Eastern Shore, this was only possible because of the cost-share assistance provided by the federal government. According to Maryland law, as stated in “The Maryland Comprehensive Plan,” “only the Maryland Department of Agriculture (MDA) has the authority to provide cost-share funding for maintenance of PDA/PWA drainage (Article 8, Section 602)” (2009, 57). Additionally, in order to create a PDA a permit must be issued by the U.S. Army Corps of Engineers. Today, Public Law 566 is called the Small Watershed Program and is administered by the federal government. The Small Watershed Program still assists local governments with resource and economic problems on the small watershed scale; however, because the U.S. Army Corps of Engineers no longer issues permits for new ditch construction, it is unlikely that a new PDA could be established through the Small Watershed Program (“The Maryland Comprehensive Plan” 2009, 57).¹⁷ Thus, in recent history no new PDAs/PWAs have been created.

Compounding this issue is budget reductions that occurred in 1995. The cost-share assistance programs provided by the MDA began in 1978 and helped to provide additional funds to build and maintain ditches, but with budget cuts the MDA could no longer provide cost-share assistance (“The Maryland Comprehensive Plan” 2009, 57).¹⁸ This source of funding and support provided by the MDA has not been restored to support ditch

maintenance, thus PDAs are forced to rely solely on county taxpayer money to maintain tax ditches. Therefore, due to budget cuts and reduced funding, the era of ditching essentially ended in the mid-1990s. Not to mention that with 821 miles of tax ditches, and another estimated 1,000 miles of regular, on-farm ditches, there is not much land remaining on the Eastern Shore that could be ditched anyway.

The Purpose and Function of Ditches Today

Since ditches are no longer being created, efforts have been focused on their upkeep and maintenance. While originally created to drain land for agriculture, ditch drainage systems now serve a variety of functions on the landscape. The Maryland Department of Agriculture (MDA) states that “research has shown that proper drainage of frequently saturated soils helps create more productive farmland, reduces flooding, protects public health, improves the transportation infrastructure and supports local economies” (“Cost-Share Assistance”). Drainage ditch systems still serve their primary purpose to create more productive land for agriculture; however, they have also helped to promote the development and growth of the Eastern Shore. The purpose of drainage networks has evolved along with the land they alter.

The economy of the Eastern Shore is dependent upon agriculture, with 48% of the land in Delmarva used for agriculture (Denver et al. 2004, 3). In the eyes of local farmers and the MDA, without ditches farming would not be possible, and it is the network of ditches throughout the Eastern Shore that has allowed agriculture to expand to the great extent that it has. They view ditches as extensions of natural streams, as they are connected to farmland but then run into a nearby river or stream, draining water off the land to ensure productive crop growth.¹⁹ Additionally, many tax ditches are created to straighten a pre-existing stream

in order to expedite water flow, while other ditches function more as intermittent wetlands and have perennial water flow (Needelman et al. 2007a, 171). In this sense, ditches have become part of the hydrologic infrastructure of the Eastern Shore. Some feel ditches are integral to managing water resources in this region, while others recognize negative impacts of ditches, such as that they are a leading cause of stream degradation.

Ditches that are efficient and well-designed not only transport and drain water, but also conserve water for crop production via water-control structures that allow ditch managers to control both the water depth and flow rate (Needelman et al. 2008). Some ditch managers feel the livelihoods of those who live on the Eastern Shore are dependent on viable crop yields, which would not be reached without the assistance of ditch drainage. They claim these crops are not only relied upon for exportation, but are also essential to the economy of the Eastern Shore because they feed the people and the chickens.²⁰ Additionally, through maintenance by PDAs, sediment buildup within ditches is dredged or cleaned out to facilitate better transport of water. The soil is often displaced along the banks of ditches to help prevent and control erosion (Needelman et al. 2008). While sometimes this is a beneficial best management practice to help preserve ditch banks, it is important to ensure the dredged soils are not those that assist in pollution control, as some ditch soils are sinks for nitrogen and phosphorus (Shigaki et al. 2009, 2449-2450 and 2456-2457; Vaughan et al. 2007a, 1895-1896 and 1902). Another purpose of ditches from the point of view of the MDA is their ability to conserve and protect land by carrying both point and nonpoint sources of pollutants (Needelman et al. 2008). On the agricultural land of Delmarva, ditches help transport excess nitrogen and phosphorus, which are products of farming. In this sense, the MDA claims ditches protect public health by transporting these pollutants away from populous areas.

However, the issue with this is that ditches transport this nitrogen and phosphorus into the rivers in which they drain, polluting these waterways and quite possibly the Chesapeake Bay. The Choptank River Watershed Project Final Report states that “studies have shown that an average of 6% of nitrate applied to agricultural fields can be transported in drainage water to receiving surface water” (Natural Resources Conservation Service). In multiple other studies, ditches are noted for their potential adverse effects on Chesapeake Bay water quality because of nutrient transport, and the proximity of agricultural areas to the Chesapeake Bay has caused nutrient management to be a primary concern for this region (Vaughan et al. 2007b, 1096; Kleinman et al. 2007, 225; Shigaki et al. 2009, 2449).

The soils within the ditches also collect nutrients such as phosphorus, as most ditches retain more phosphorus than they lose, preventing it from flowing downstream (Needelman et al. 2008). This is necessary because ditches can also serve as key conduits for phosphorus transport from agricultural lands to surface waters (Kleinman et al. 2007, 234). In the short term, ditches can potentially help prevent surplus phosphorus from leaching into groundwater storage used for human consumption. However, over time the soils can accumulate large amounts of phosphorus and should be treated or removed, and ditches are generally dredged every 10-30 years (Needelman et al. 2008). The vegetation surrounding the ditch networks can also help to protect public and ecosystem health as a best management practice by filtering pollutants as they run off into the ditches from the land. These plants and grasses along ditch banks also provide ecosystem habitats for various organisms (Needelman, Ruppert, and Vaughan 2007b, 214; Needelman et al. 2007a, 172). Within ditch channels, vegetation also serves as habitats for organisms, stabilizes sediments and soils, and aids in nutrient cycling (Needelman et al. 2008). So long as ditches are maintained utilizing best

management practices as outlined by Needelman et al. (2007a), they can properly serve their intended function to drain agricultural land while also mitigating nutrient and pollution concerns for connected waterways.

In addition to the aforementioned functions, the ditch network of the Eastern Shore also serves other purposes. Drainage of Delmarva's naturally saturated soils has enabled the development and growth of the area. Ditches now also drain land used for community development projects and shopping malls, assisting in population growth throughout Delmarva. Another function of ditches is stormwater and flood management. As the system of ditches throughout the Eastern Shore has grown and expanded, it has subsequently helped to control flooding of the area. Ditch systems now support "storm drainage from urban town centers, state highways and county roads, and new commercial and residential development" (Maryland Department of Agriculture n.d.). On Route 50 alone, there are several ditches which run under the highway, contributing to floodwater management and allowing for use and access to the road.²¹ The maintenance of ditches is necessary to ensure land drains properly so community developments, roadways and highways, and shopping centers are not negatively impacted. However, it is also necessary that ditches be maintained with regard for best management practices that will mitigate their possible adverse effects on water and soil qualities. The evolving use of ditch systems means that Delmarva has become dependent upon them, as ditches are an alteration to the landscape that have become an essential component to the infrastructure of the Eastern Shore.

The Geographic Scope of the Ditch Network

As outlined in this paper, the geographic extent of the ditch network throughout the Eastern Shore is enormous. With 821 miles of known and recorded tax ditches and another

estimated 1,000 miles of regular, on-farm ditches, the total mileage of ditching throughout the Eastern Shore is nearly 2,000 miles. Considering the Eastern Shore is only 50 miles wide at its widest point, the amount of land these ditches alter is staggering. The 821 miles of tax ditches alone help drain 183,000 acres of cropland, forest land, and commercial and residential areas, approximately 8% of the total land area of Maryland's Eastern Shore (Maryland Department of Agriculture n.d.; Maryland Geological Survey 1988-89).

In Wicomico, Somerset, and Worcester Counties there is a combined total of 35 PDAs/ tax ditches. While not equally distributed across the three counties, looking at the total land coverage of the ditches in each of these counties gives a sense of how integral they are to the Eastern Shore (Table 1).

Table 1. Extent of the tax ditch network throughout Maryland's Lower Eastern Shore expressed as the total number of miles and total number of acres covered by all tax ditches per county as well as in all three counties combined. Data obtained from Karen Hoy at the Maryland Department of Agriculture Office of Resource Conservation.

County	Number of Tax Ditches	Total Mileage	Total Acreage
Wicomico	14	179.7	39,073.3
Somerset	4	42.2	13,258.0
Worcester	17	225.3	61,807.0
Totals	35	447.2	114,138.3

The tax ditches within the Lower Eastern Shore make up more than half of the total mileage of tax ditches in all of the Eastern Shore of Maryland. Thus, it can be assumed that these ditches have great impacts and functions on the landscapes of these three counties.

How Has Ditching Evolved in Relation to Land Use Change?

The advent of tax ditches is really what allowed for the development of the Eastern Shore. Although the history of this region's landscape has been farming, ditches enabled more intense and widespread agricultural practices. In addition, the development of Delmarva also became possible because of tax ditching. As ditching and land use change seem to coincide, the question that arose was what the land use of the three Lower Eastern Shore counties looks like in relation to the ditch network?

In working with the Eastern Shore Regional GIS Cooperative, the Maryland Department of Agriculture's Office of Resource Conservation had the extent of the tax ditch network digitized so that maps could be created to assist in locating and maintaining the tax ditches in their entirety.²² This same data of tax ditch networks was used to map their extent in Wicomico, Somerset, and Worcester Counties. The following series of maps were created to display the tax ditch network overlaid with land use categories for each of these three counties (Figures 3, 4, and 5).

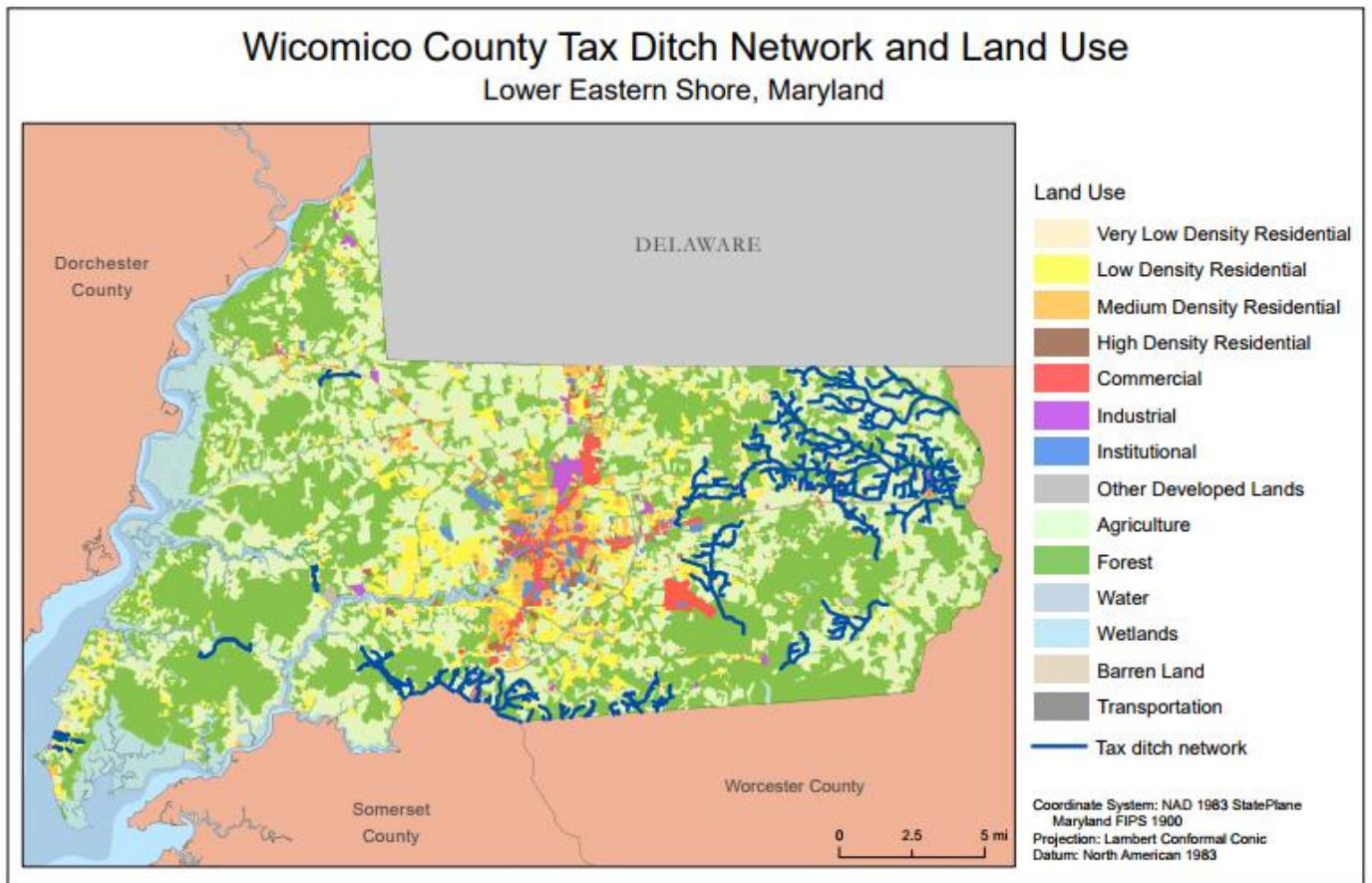


Figure 3. Tax ditch network and land use categories for Wicomico County, Maryland. Data obtained from the ESRGC.

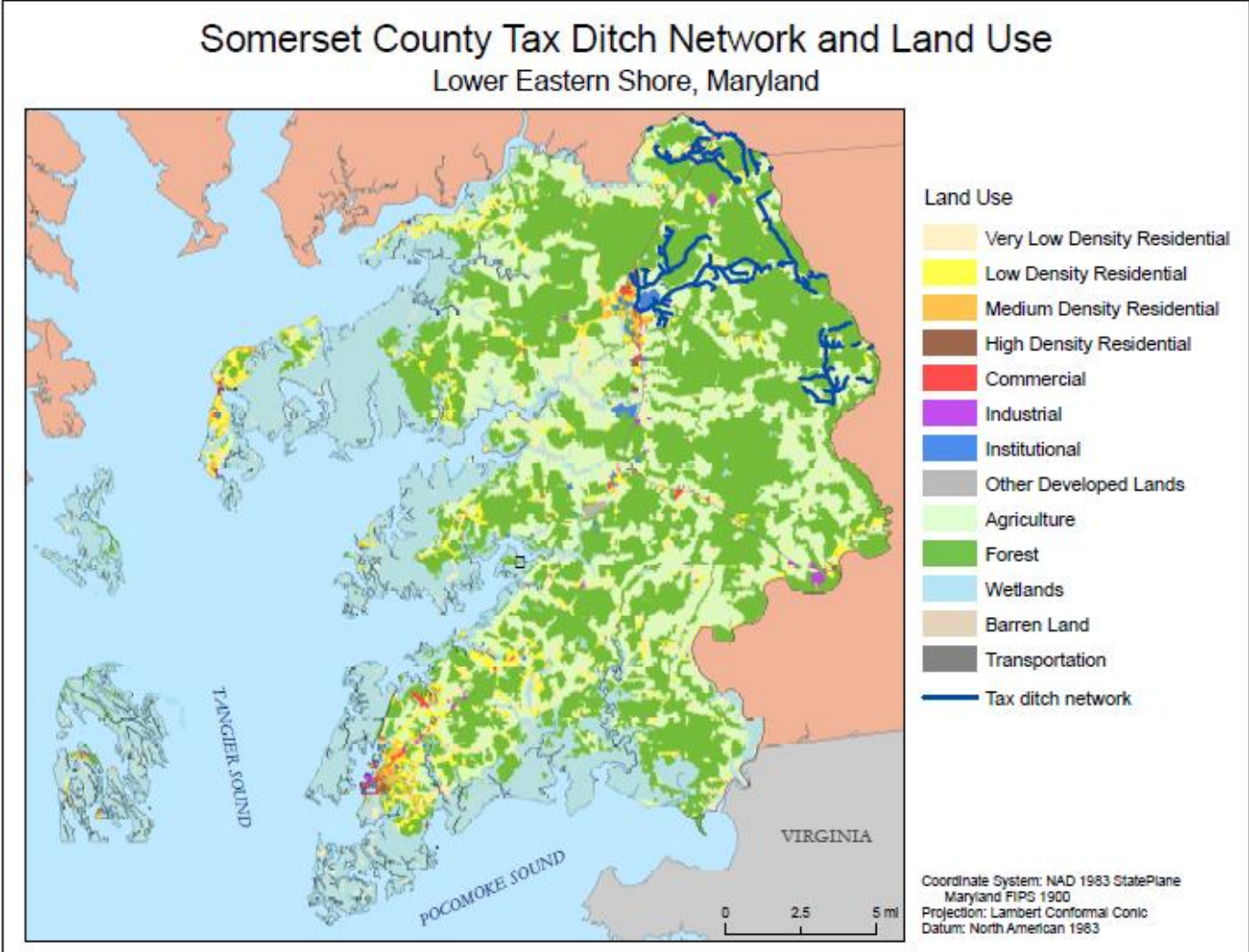


Figure 4. Tax ditch network and land use categories for Somerset County, Maryland. Data obtained from the ESRGC.

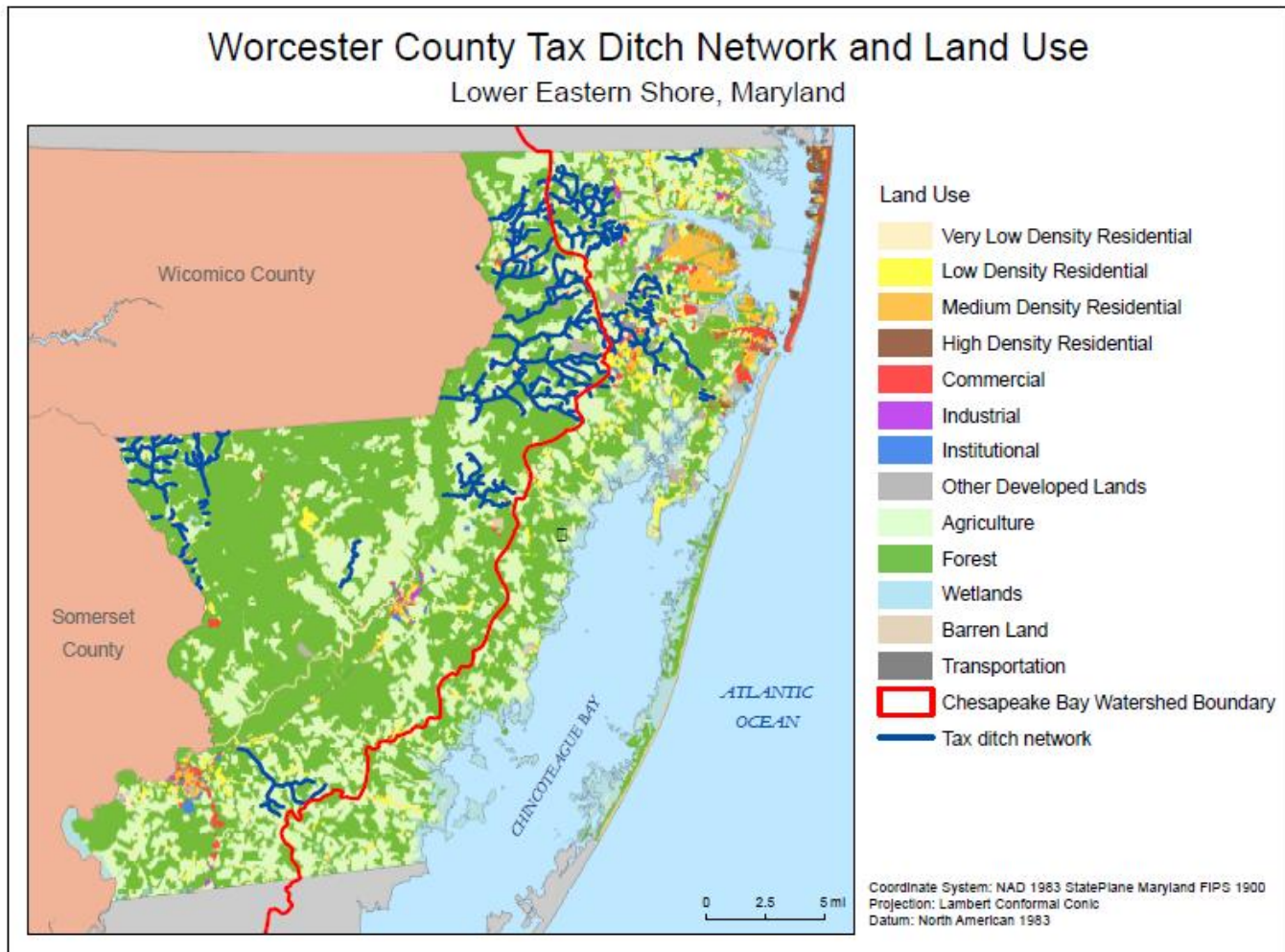


Figure 5. Tax ditch network and land use categories for Worcester County, Maryland. Note the hydrologic boundary of the Chesapeake Bay Watershed, delineating the land that drains westward toward the Bay from the land that drains eastward toward the Atlantic Ocean. Data obtained from the ESRGC.

In each of the three counties, the location of the tax ditches overlaid with land use categories provides insight into the function of ditches on the landscape. While Wicomico and Worcester Counties have far more tax ditches than Somerset County, the extent of the tax ditch networks throughout agricultural land in all three counties is prominent. In addition, the tax ditches are also located on forested land, supporting the historical development of the Eastern Shore, as forests were frequently cut down and converted into agriculture. These land use maps display the extent to which tax ditches are located in agricultural areas, yet still close to development.

The Hydrologic Extent of the Ditch Network

As extensions of natural rivers and streams, ditches impact the overall hydrologic network of the Eastern Shore as they straighten rivers and streams to expedite water flow. However, the exact extent to which ditches affect the Eastern Shore's hydrology is unknown. There has been speculation that ditches could transport water flow into the Chesapeake Bay, potentially carrying nutrients and runoff from agricultural land as well. This nutrient transport into the Bay could have possible effects on Bay water quality.

To analyze the spatial extent of the ditch network in relation to the Chesapeake Bay hydrologic network, a series of maps was created to overlay the ditch network with Eastern Shore hydrology (Figures 6, 7, and 8).

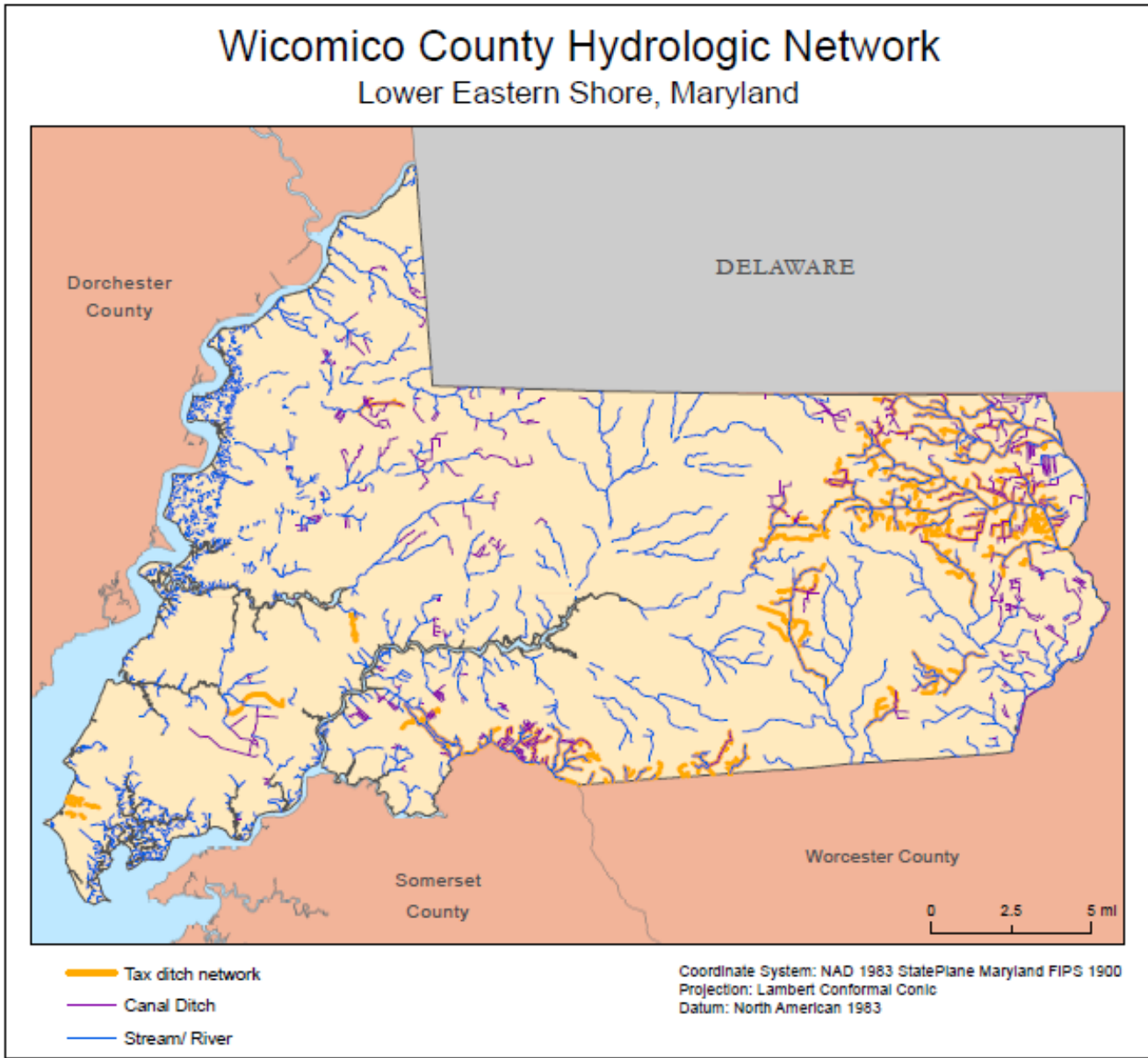


Figure 6. Tax ditch network and hydrology for Wicomico County, Maryland. Note the layer named “Canal Ditch”, believed to be old tax ditches no longer in function under management of a PDA. Data obtained from the ESRGC and USGS National Hydrography Dataset (NHD).

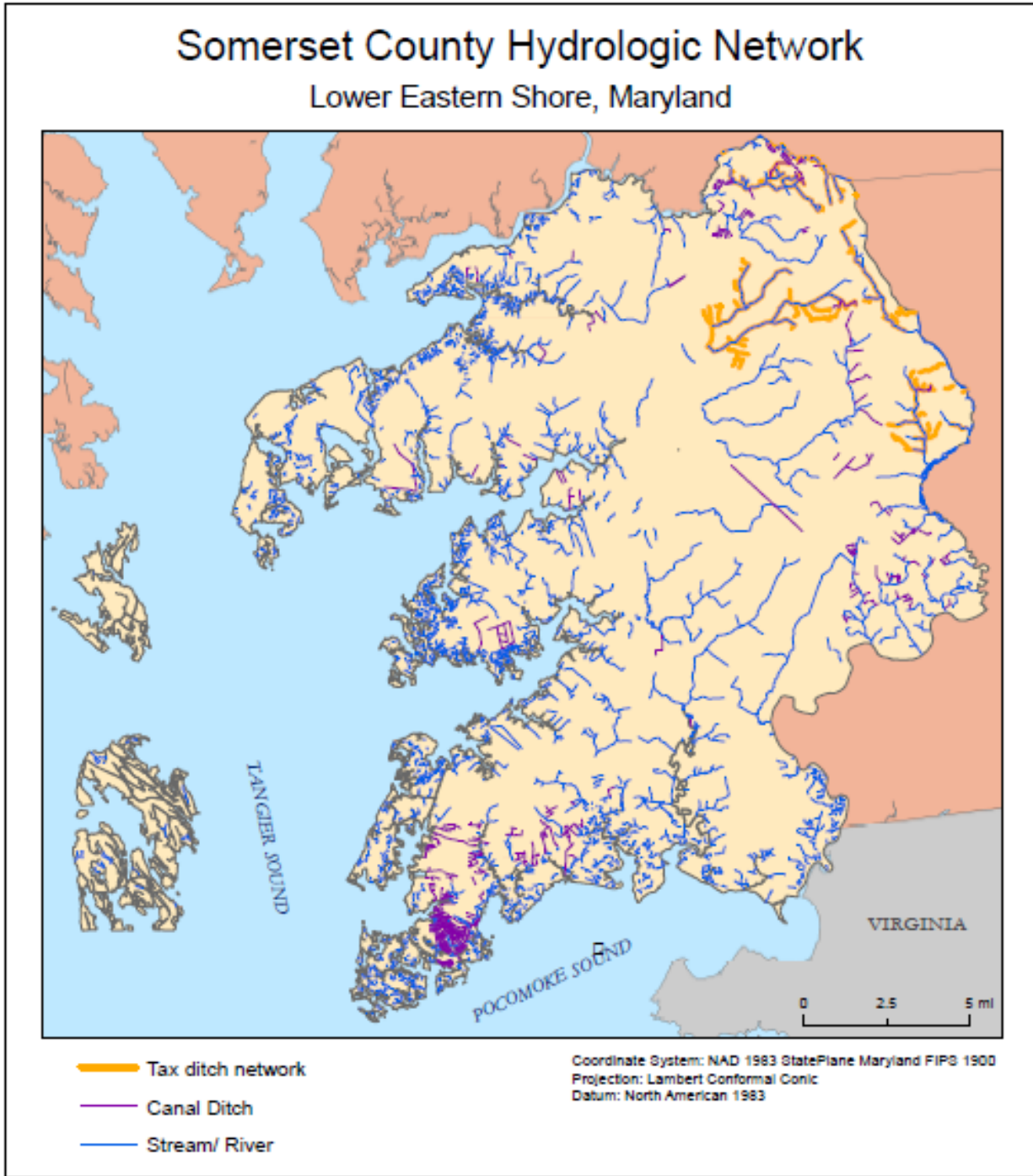


Figure 7. Tax ditch network and hydrology for Somerset County, Maryland. Note the layer named “Canal Ditch”, believed to be old tax ditches no longer in function under management of a PDA. Data obtained from the ESRGC and USGS National Hydrography Dataset (NHD).

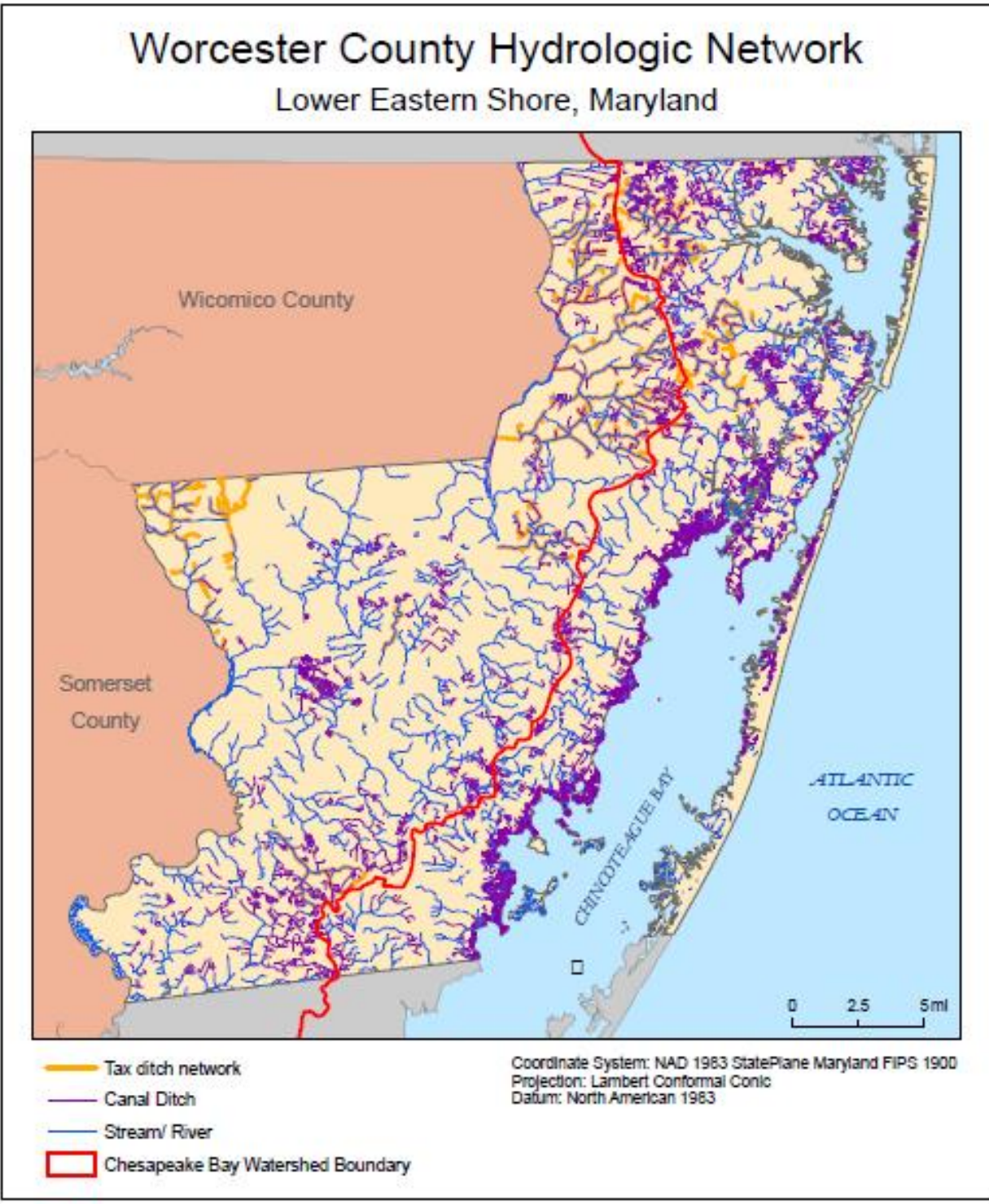


Figure 8. Tax ditch network and hydrology for Worcester County, Maryland. Note the layer named “Canal Ditch”, believed to be old tax ditches no longer in function under management of a PDA, and the hydrologic boundary of the Chesapeake Bay Watershed, delineating the land that drains westward toward the Bay from the land that drains eastward toward the Atlantic Ocean. Data obtained from the ESRGC and USGS National Hydrography Dataset (NHD).

The map series displays the extent to which tax ditches overlay with the natural hydrology of the landscape. The tax ditch network (shown in orange) aligns with the rivers and streams (shown in blue), which run throughout Wicomico, Somerset, and Worcester Counties. As these rivers and streams drain into the Chesapeake Bay, this suggests that tax ditches also drain into the Bay. It is unclear exactly what the layer titled “Canal Ditch” shows (displayed in purple), but after speaking with several county officials, it is believed that this canal ditch network is old tax ditches that are no longer in function.²³ If a tax ditch or PDA is not properly maintained, meaning they do not upkeep their operations and maintenance plan or hold public meetings for three consecutive years, then the PDA/tax ditch will dissolve and become non-functional. This is what happened in Somerset County, as this county had a total of 39 tax ditches in 1939, but today only has four.²⁴

Today, the Maryland Department of Agriculture is working toward creating a more positive future for tax ditches and their impact on the Chesapeake Bay. Considering 75% of the land in Delmarva lies within the Chesapeake Bay watershed, and 48% of this land is used for agriculture, drainage ditches pose a threat to Bay health (Denver et al. 2004, 3 and 17). Public Drainage Associations have begun implementing Best Management Practices (BMPs) as part of their maintenance plans to mitigate potential negative environmental impacts. One of these BMPs is increasing vegetation on the banks of ditches to help prevent erosion and to filter pollutants draining from adjacent farmland. The MDA has also created a tool called a “weed wiper” which applies herbicides to woody vegetation in ditches, rather than mowing the entire ditch and applying herbicides broadly over the entire area. This practice maintains nonwoody vegetation, which helps to retain sediment, stabilize soils and banks, and provide ecosystem habitat (Needelman et al. 2007a, 174).

Other BMPs that PDAs can implement include water control structures that slow the transport of water and allow for natural filtration, pocket wetland systems to help reduce runoff and create habitat for wildlife, enhancements to create more natural flow of ditches, expanding vegetative buffers to help filter and prevent contaminants from surface and groundwater, and repairs and modifications to reduce sediment loss and improve water quality (“Cost-Share Assistance”). All of these BMPs are part of a Conservation Reserve Enhancement Program implemented by the MDA, in addition to cost-share grants provided by the MDA (“Cost-Share Assistance”).²⁵ An ongoing study on the Choptank River Watershed looked at the efficiency of nutrient reduction as a result of applying agricultural BMPs and supports the use of these practices for their stated benefits (Natural Resources Conservation Service). As supported by the science that shows ditches are conduits for the transport of nutrients and pollutants, these environmentally-focused practices and programs help to mitigate potential impacts of the drainage ditch network on Chesapeake Bay water quality.

CONCLUSIONS AND FURTHER RESEARCH

This paper serves as a reference to compile the scattered information regarding agricultural drainage ditches, including their history, management, location, and development over time. As a complicated system of water resource management integral to Maryland’s Eastern Shore, ditches will continue to serve several functions on the landscape. An understanding of their structure and management is important to ensure their continued success, especially entering a time with greater focus on environmental effects of changing landscapes.

Coupled with this understanding of the structure and management of tax ditches as managed by PDAs as separate entities of the government is a realization that often these management structures fluctuate from one county to another, and even from one tax ditch to another. In moving into the future of Eastern Shore development and a continued reliance on ditches, increased rules and regulations on the ditch network will be beneficial. This will ensure drainage networks evolve in a consistent manner across the landscape. It also should include incorporating environmental management techniques to mitigate potential effects on water quality of connected river and stream networks.

As the hydrologic network shows, tax ditches flow toward the Chesapeake Bay as extensions and modifications of natural streams; and land use maps display the great extent to which tax ditches are located in agricultural areas, yet still close in proximity to development. Ditches have become an integral piece of the hydrologic infrastructure of the Eastern Shore. Their existence on the landscape dating back to the late 1800s suggests ditches have long been a fundamental alteration to the Eastern Shore, and cataloging the development of this drainage network over time may help to understand its function on the landscape. As the environmental implications of the ditch network become of greater concern, the knowledge of their location on the land in relation to land use categories and the overall hydrologic network will be beneficial to better determine their potential impacts on surrounding land and water systems.

To gain a better understanding of the implications of the ditch network, further study could determine the proportional relationship to the totality of the hydrologic network. Knowing proportionality will allow for a more accurate hydrologic understanding. This will assist in developing improvements for managing this water infrastructure. As the total extent

of the ditch network is relatively unknown and understudied, knowing this information could help managers develop more efficient ways to manage the system of ditches through a catalogued assessment of their location and extent on the landscape, which would enable them to better allocate resources for their management.

In addition, areas for future research should answer the question of how much, volumetrically, the ditch network drains into the Bay, and what water quality implications this poses? This could involve looking into the total volumetric flow of individual tax ditches, and then determining an aggregate volumetric flow for all tax ditches. Volumetric flow coupled with proportionality will reveal the extent of any dangers ditches pose to the hydrology of the Bay. Future research could also continue to look into nutrient transport within ditches, especially in relation to their proximity to poultry farms. The poultry industry is a major economic factor on the Eastern Shore that has possible negative environmental effects. A better understanding of the impacts the poultry industry has on the land and hydrology of the Eastern Shore will help to devise ways to more effectively mitigate negative effects, especially concerning nutrient transport to the Bay via adjacent agricultural drainage ditches. While this may not be a politically easy question to ask, it is an ecologically necessary question to answer. As a primary economic source for the region, the poultry industry will continue to impact the landscape. In an age of working to improve Bay health, knowing the impacts of this industry on water quality via ditches will be vital to ensure proper steps are taken to reduce adverse effects.

On a more pragmatic, less controversial note, there is currently no research at all regarding even basic public awareness and environmental perception of the ditch network. This paper serves as a beginning source of this conversation, to piece together the complex

infrastructure of drainage that has a wide range of impacts on the Delmarva landscape. The development and establishment of Maryland's Eastern Shore would not have been possible without ditches, and the region today remains dependent on this drainage network. As we enter an age focused on Chesapeake Bay health, the unknowns pertaining to the ditch network can no longer be ignored. This mysteriously unaddressed water management infrastructure must be brought to the surface and acknowledged for the clouded understanding of this system. People need to know that the 'river' they are kayaking on is actually a tax ditch, and without it they would not be living on the Eastern Shore. It is likely that ditches will remain a fundamental characteristic on Delmarva's landscape, although some efforts have been made to revert ditches back to natural wetlands. The change that must occur is a conscious effort to maintain this system with regard for water quality. The remaining unknowns of the ditch network can no longer be swept away, but instead must be actively pursued, straightened out, and widened in their scope to begin to drain away some of the confusion that floods the understanding of this hydrologic infrastructure.

APPENDIX

An example of a regular, hand-dug ditch:



An example of a tax ditch:



ENDNOTES

¹ Dave Mister, Eastern Shore Resource Conservation District Supervisor, 25 April 2017, personal communication.

² Pete Richardson, manager of Green Branch PDA, 3 August 2017, personal communication.

³ Ibid.

⁴ Ibid.

⁵ Karen Hoy, Public Drainage Coordinator, 25 April 2017, personal communication.

⁶ Dave Mister, Eastern Shore Resource Conservation District Supervisor, 25 April 2017, personal communication.

⁷ Karen Hoy, Public Drainage Coordinator, 25 April 2017, personal communication.

⁸ Ibid.

⁹ Dave Mister, Eastern Shore Resource Conservation District Supervisor, 25 April 2017, personal communication.

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