Case Report for Wilmington, Delaware, USA

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ABSTRACT

Work package 1 of the Creating Interfaces project[1] aims to evaluate the governance of the food, water, and energy systems in three mid-sized cities on the water: Wilmington, DE, USA; Tulcea, Romania; and Slupsk, Poland. The project team sought to understand the existing governance structures as well as the interactions between participants. The team also sought to learn of problems or concerns in the governance of food, water, and energy systems that could inform later project efforts.

This report reflects initial information collected for the city of Wilmington, DE, USA. Information sources included publicly available documents obtained through a broad online search, and available secondary datasets. Primary data were obtained from one community workshop held on April 6, 2019 and semi-structured interviews with key informants in the region conducted up until August 2020.

Human subjects research approval for the primary data collection was obtained from the University of Delaware's Institutional Review Board (IRB) in March 2019. Workshop participants were invited through the existing networks of the University of Delaware's Community Engagement Initiative, the Biden School of Public Policy & Administration, and the City of Wilmington Partnership. Prospective interviewees were identified in documents as well as named by other interview participants in a snowball fashion. Confidentiality of participants was assured at all times. Interviews were conducted in-person or by phone at the request of the participant, and some but not all of the interviews were audio-recorded. All researcher notes from the workshop and interviews were reviewed by the research team and coded with respect to food, water, energy systems and their governance. Additional interviews were sought to fill knowledge gaps until reaching saturation on many topics of interest to the research team.

Information in this report will be used next to produce a comparative case evaluation of governance in the project's three case cities.

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[1] https://creatinginterfaces.eifer.kit.edu/

Table of Contents

List of Figures

1 Case Background

Wilmington is the largest city within the state of Delaware, which is located in the Mid-Atlantic Region of the United States. It lies along the Delaware River in the northern part of the Delaware Bay, 65 miles (105 km) from the Atlantic Ocean, and is bisected by the Christina and Brandywine Rivers (see Figure 1). Wilmington is 29 miles (46.7 kilometers) from the city of Philadelphia to its east and 70 miles (112.65 kilometers) from the city of Baltimore to its west.
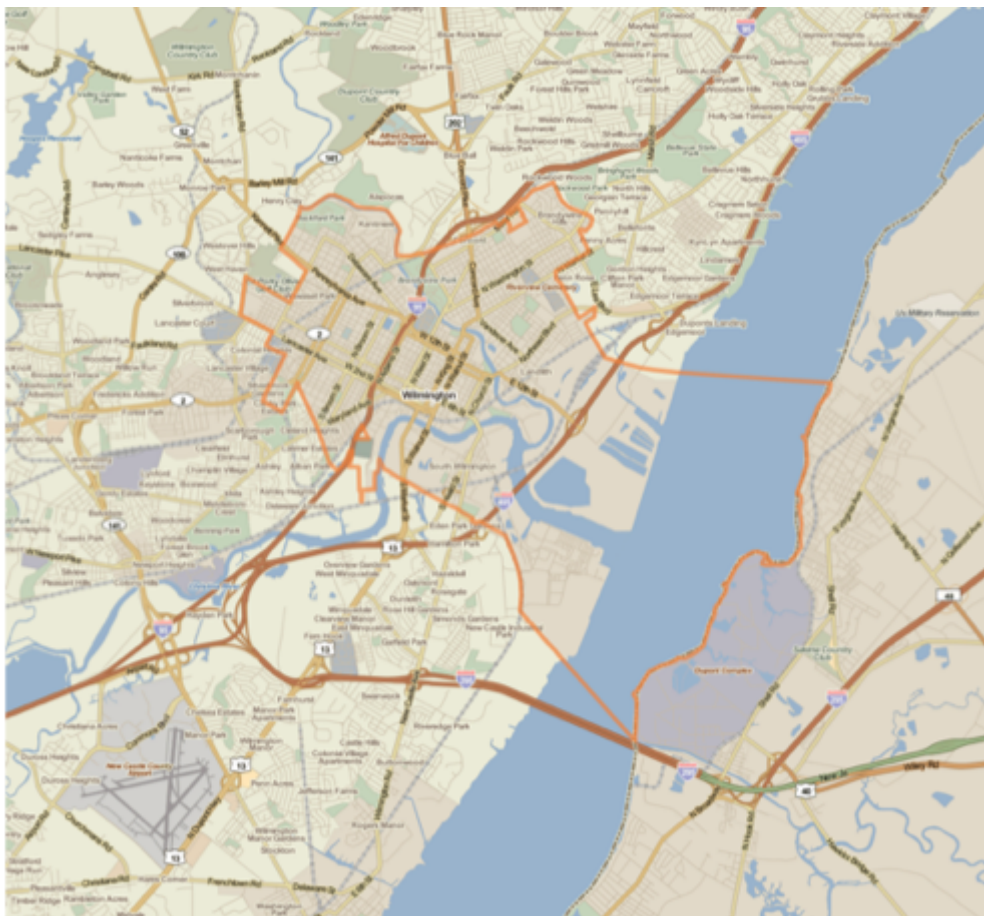
Figure 1 : City of Wilmington, DE, USA | Source: Policy Map

The city's neighbors include the Elsmere town[2] to the west and unincorporated lands of New Castle County. Wilmington lies across the Delaware River from the state of New Jersey, although the principal river crossing lies outside city limits on the Delaware Memorial Bridge (I-295).

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[2] https://delaware.gov/topics/municipalities

Wilmington is a principal city of the Philadelphia-Camden-Wilmington Metropolitan Statistical Area, comprising the city of Philadelphia in Pennsylvania, the city of Camden in New Jersey, Wilmington in Delaware, and the surrounding areas connected by commuting across four states (Pennsylvania, New Jersey, Delaware, and Maryland). This designation has little functional purpose in public management and is used predominantly for aggregating census data and performing comparative research.

Several zip codes are located in or around the city of Wilmington. The city boundaries contain all of 19806, most of 19801 and 19802, and some of 19805.[3] Other Wilmington, DE zip codes are located outside of city limits in New Castle County.

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[3] https://www.zipmap.net/Delaware/New_Castle_County/Wilmington.htm

2 Urban characteristics and infrastructure

2.1 Transportation and land use

2.1.1 Transport

Wilmington city is highly urbanized with extensive transportation infrastructure.

Interstate highway I-95 bisects the city near to the central business district. Interstate highway I-495 splits from I-95 south of the city limits and runs along the Delaware River to join back up with I-95 north of the city. South of the city limits is a major intersection of I-95 and I-495 with I-295, which crosses into the state of New Jersey on the Delaware Memorial Bridge (tolled). All interstates in the area experience extensive traffic congestion. State routes 13 and 9 serve as primary arteries connecting the city to its southern suburbs.

Wilmington is connected to the city of Philadelphia through the Wilmington/Newark line of the Southeastern Pennsylvania Transportation Authority (SEPTA), which operates regional passenger rail service[4]. Wilmington is also well connected to New York, Boston, and to Washington, DC, via Amtrak's Northeast Corridor, which provides intercity passenger rail. Multiple freight rail carriers operate in Wilmington, including CSX (Wilsmere Yard) and Norfolk Southern (Edgemoor Yard), although most freight travels in the region by truck.[5]

Wilmington is served by the regional New Castle Airport (ILG) located to the southwest, outside of city limits, and operated by the Delaware River and Bay Authority. Many air travelers use the Philadelphia International Airport (PHL) located 21 miles (33.8 kilometers) to the northeast of the city.

Wilmington's deep water port handles millions of tons of cargo each year, including petroleum, wind energy components, and bananas. It is owned by the state and operated by the Diamond State Port Corporation[6]. The port recently won a contract for nearly US$1B renovation and expansion to unused industrial land on its northern boundary[7]. The expansion will add freight rail access to the port, which may reduce energy demands for goods transport. The port does not have ship-to-shore energy at the moment, requiring ships to use their own power while in port (usually produced from diesel) and

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[4] http://www.septa.org/

[5] https://www.dvrpc.org/Freight/pdf/2011-10_Geier.pdf

[6] http://www.portofwilmington.com/

[7] https://news.delaware.gov/2018/09/12/tuesday-signing-port-wilmington-expansion-agreement/

resulting in high air pollution around the port[8]. Efforts to reduce air pollution from the port have included updating engine technology and expanding electrification[9]. [NEXUS CONNECTION: WATER, ENERGY]

2.1.2 Urban growth

Wilmington is located on lands originally occupied by the Lenape Indians. It was settled by the Swedes in the early 17th century, changing hands to the Dutch and then the British before the American Revolution. "The area stabilized under British rule (with Quaker influence) and was granted a borough charter in 1739 by the King of England which changed the name from Willington (after Thomas Willing, the first 'developer' of the land who organized the area in a grid pattern like Philadelphia) to Wilmington, presumably after Spencer Compton, Earl of Wilmington, a favorite of the King."[10] According to a mid-19th century map, the city of Wilmington lay confined to the west of the Brandywine and north of the Christina Rivers[11]. By 1881, the city's boundaries had expanded east to the Delaware River and added some lands on the southern bank of the Christina and eastern bank of the Brandywine.[12] Further annexation was curtailed by the state of Delaware in 1987 by requiring the city to get permission of New Castle County, which so far has resisted[13].

2.1.3 Land use

Wilmington's total area, including land and water, is 74.7 square kilometers. The land area is 47.1 square kilometers and 93.6 square kilometers are within the "tax area."[14] The tax area is larger than the land area because of buildings with multiple stories, therefore increasing the taxable area within the city.

The city has 28,511 parcels in 9 "property classes," including apartment, commercial, exempt commercial, exempt farmland, exempt residential, farmland, industrial, residential, and utility (see Figure 2).[15]

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[8] Interview1

[9] Interview 7

[10] https://www.wilmingtonde.gov/about-us/about-the-city-of-wilmington/city-history

[11] https://www.loc.gov/resource/g3833n.la000070a/?r=0.423,0.706,0.676,0.389,0

[12] https://www.loc.gov/resource/g3833n.la000071/?r=0.187,0.094,0.58,0.333,0

[13]

https://www.delawareonline.com/story/news/2016/03/15/bill-would-let-wilmington-annex-county-land/81823 10/

[14] Municipality area data source: New Castle County GIS https://www.arcgis.com/home/item.html?id=f980e48b187d4e1587d3fb108c24c3da

[15] Within the GIS data, information is provided on the following attributes: parcel identification numbers, address, property class, owner name, owner address, and tax zone. When an individual property is selected in the online New Castle County GIS Viewer, more information is available on the parcel, including: all districts (school, government, fire, traffic), zoning, deed history, tax info, sewer history, and building structure characteristics (including occupancy, stories, year constructed, condition, area, wall type, ac,

Figure 2: Parcel zoning in Wilmington, DE | Source: New Castle County GIS Data Viewer

- 42.9% of Wilmington's area is **exempt commercial**, with 1,008 parcels. This is the largest area occupied by a property class in the city of Wilmington. Exempt commercial properties are distributed throughout the city of Wilmington, with very large properties at the mouth of the Christina River where it leads into the Delaware River. Exempt commercial properties distribute along the borders of the city limits more so than commercial properties. Exempt commercial properties also have a pattern of distribution along the northwestern sections of Brandywine Creek not seen by the commercial properties.
- 36.3% of Wilmington's area is **residential**, which contains 23,405 parcels. This is the largest number of parcels in the city and the second largest in terms of area. Residential properties are in the northern portion of Wilmington, with a small

rentable units, year renovated, basement, basement utilities, structure class), and a building floor plan sketch.

pocket of development south of the Christina River. The properties furthest from the city center have larger size parcels.

- 10.4% of Wilmington's area is **commercial**, with 2,675 documented commercial parcels. This is the second largest number of parcels of all of the categories. Commercial properties are distributed throughout the city, and vary in size and purpose. Larger commercial properties are focused around the mouth of the Brandywine Creek and Christina River, in the southern part of Wilmington.
- 7.0% of Wilmington's area is **industrial**, with 178 documented parcels. Industrial parcels are predominantly at the southern portion of Wilmington, around the foot of the Brandywine Creek and Christina River. These parcels are generally large and bordering water.
- 2.1% of Wilmington's area is **utility**. There are 41 parcels for utility, which is the smallest number of parcels for any property class in Wilmington. Utility has a large presence on the eastern edge of town, along the Delaware River.
- 0.8% of Wilmington's area is **exempt residential**, which contains 1,107 documented parcels. This is the third largest number of parcels. Exempt commercial properties are predominantly small, and cluster in the center of Wilmington, generally away from any of the water bodies that intersect the town.
- 0.4% is comprised of **apartments**, and there are a total of 96 documented apartment parcels within the city. Apartments are distributed throughout the city, primarily in the western and central areas of Wilmington.

2.1.4 Residential vacancy

The city of Wilmington has a total of 26.9 square kilometers of residential units according to the Census Bureau. In these units, 5,705 were **vacant** in 2018 (see Figure 3). Of the city's total residential area defined by census block groups (26.9 square km) 43.8% has 0-50 vacant units per block unit, 37.7% has 50-100 vacant units per block unit, 8.9% has 100-150 vacant units per block unit, and 9.5% has 150 or more vacant units per census block group.
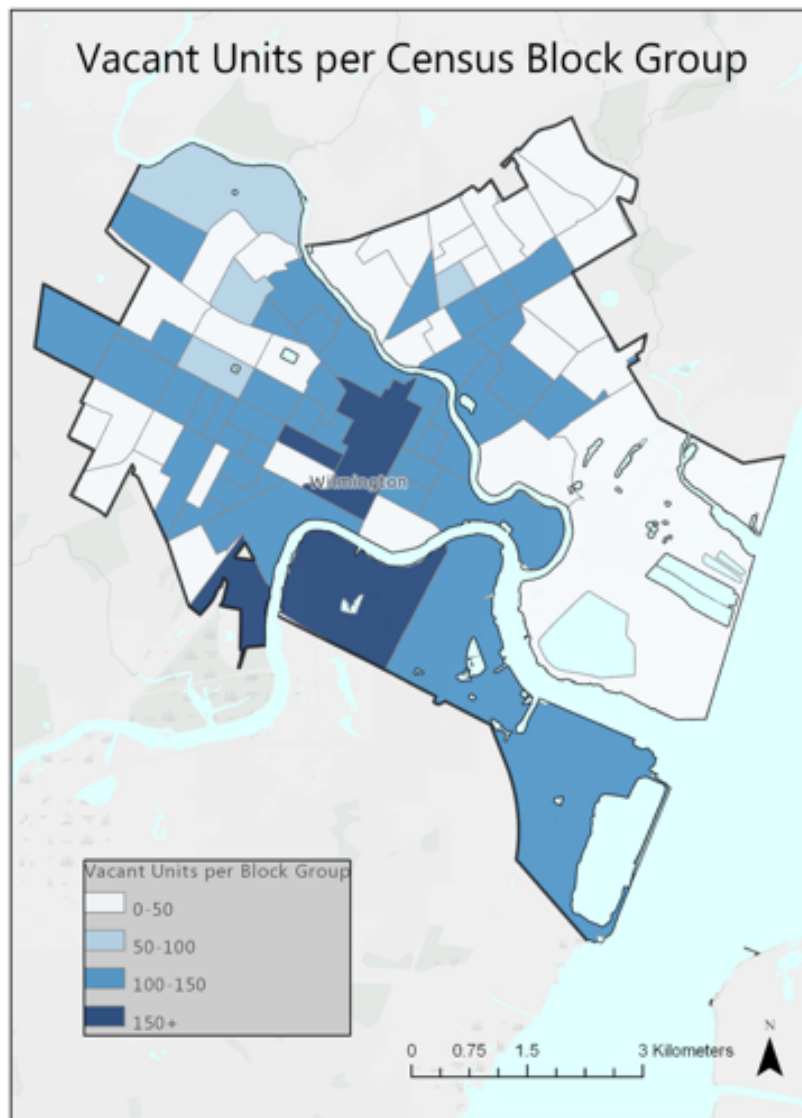
Figure 3: Vacant residential units in Wilmington, DE | Source: U.S. Census Bureau

2.1.5 Socioeconomic Context

The city is home to approximately 70,000 residents today (see Figure 4). Population growth in Wilmington city mirrored that of New Castle county through World War II, after which the population in the suburban areas began to grow rapidly and the city's

dominance in state and regional affairs declined. The city's population has held stable since 1980 despite the surrounding growth.
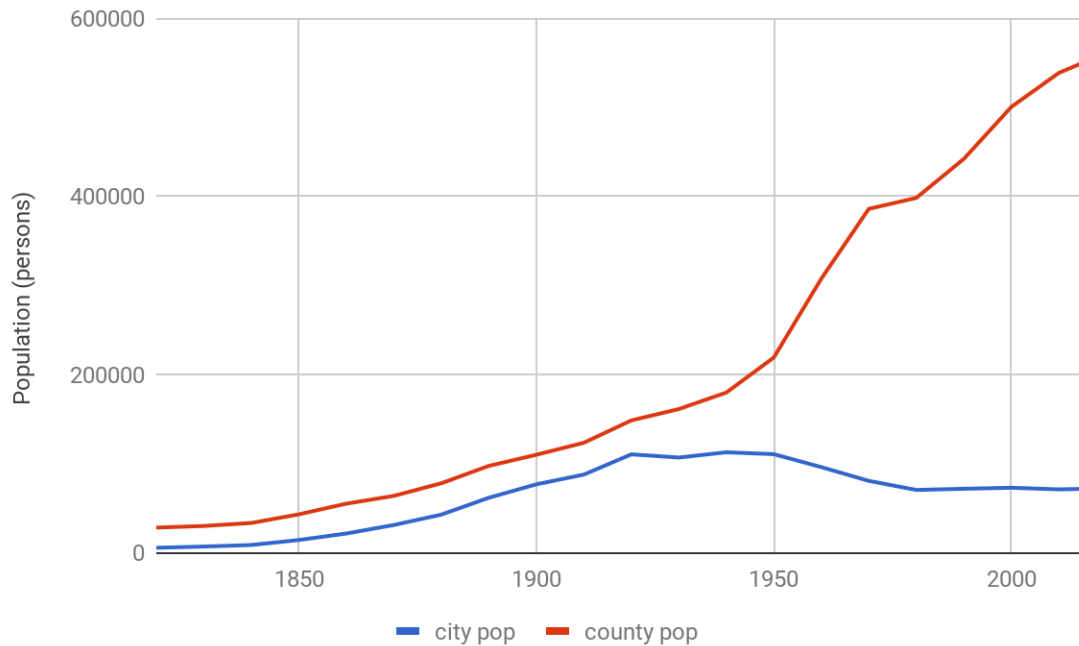
Figure 4: Population, Wilmington City and New Castle County, DE, USA | Source: U.S. Census, Decennial Census and 2012-2016 Estimates

The city of Wilmington presently has a majority-minority population with approximately 58% black residents and 34% white residents (Figure 5). Notably, only 15% of city residents were black in 1950.[16] By 1980, the city had transitioned to majority-black, and the proportion of black residents has continued to increase since. The rapid increase in the black population in the city reflects widespread "white flight" in the post-war period, especially 1950-1980. Riots in 1968 following the assassination of Martin Luther King, Jr., led to a ten-month-long occupation of the city by the National Guard at the behest of the Delaware state governor, leaving a legacy of persistent racial tension and distrust of government.[17]

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[16] http://udspace.udel.edu/bitstream/handle/19716/1596/CHAD13.pdf

[17] Bourke, J. (2018). Urban Governance and Political Economic Development: An Analysis of the Changing Political Economy of Wilmington, Delaware 1945-2017 (Unpublished doctoral dissertation). University of Delaware.
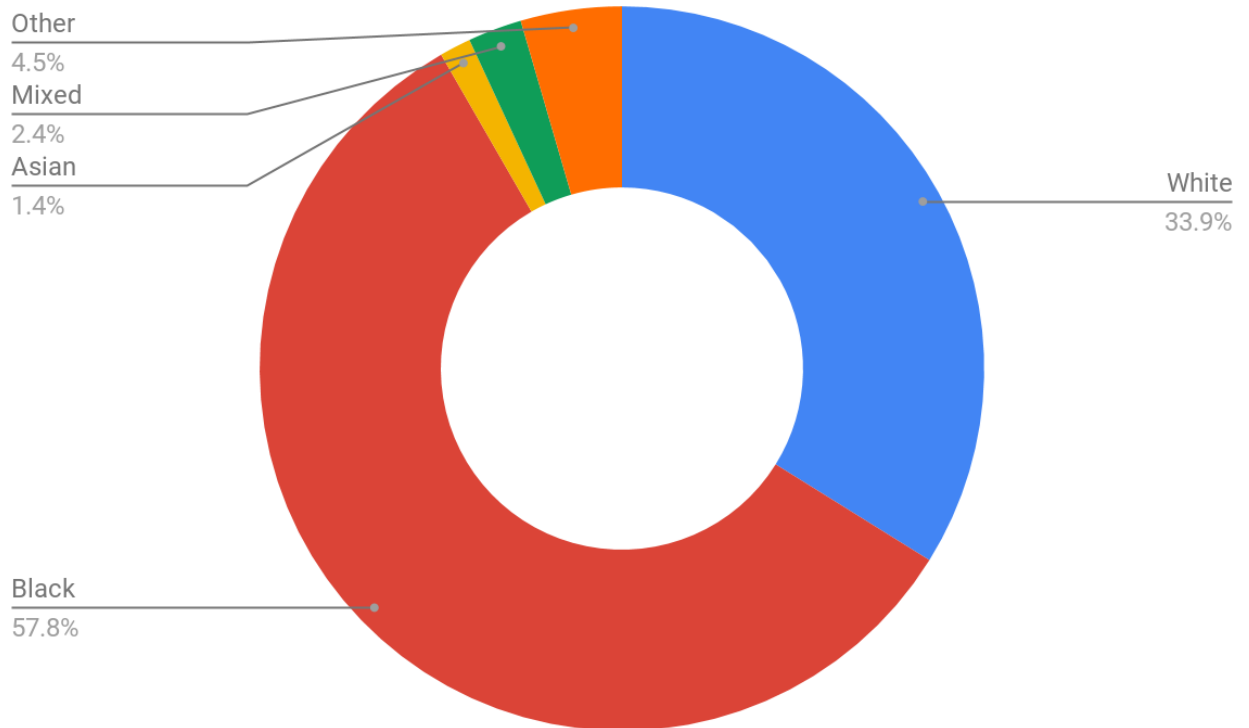
Figure 5: Racial Composition, Wilmington city, DE, USA | Source: U.S Census, 2012-2016 Estimates

City residents experience much higher rates of poverty than the surrounding county or state, on average (Figure 6). Eight of the twelve census tracts across the state with poverty rates higher than 40% - known as concentrated poverty tracts - are located in Wilmington city.[18] Wilmington's black community has been hit particularly hard by poverty (Figure 6). Predominantly black neighborhoods such as West Center City experience black poverty rates of nearly 80% or higher today.[19]

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[18] ACS 2012-2016 data

[19] https://www.wilmingtonde.gov/about-us/about-the-city-of-wilmington/population-demographics
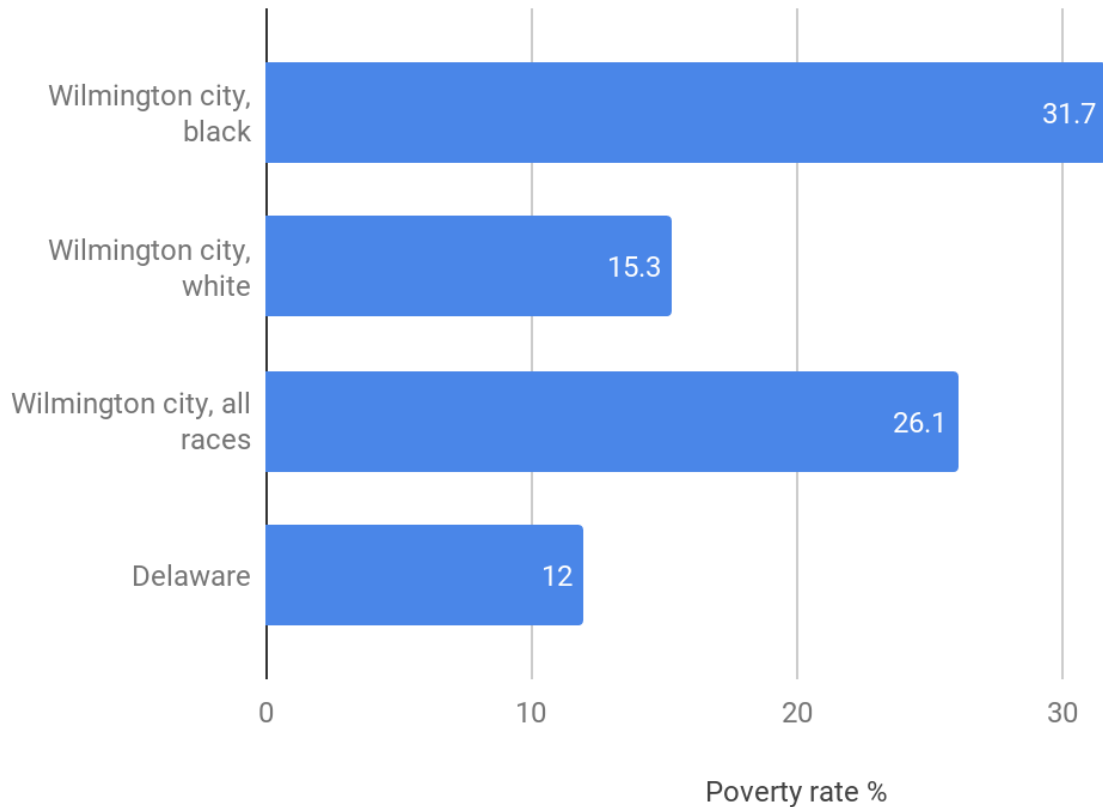
Figure 6: Poverty rate by race, Wilmington city, DE, USA | Source: U.S. Census, 2012-2016 Estimates

Wilmington's economy was dominated by manufacturing historically, including for munitions and other chemicals, shipbuilding, and ironworks. The DuPont Corporation and its subsidiaries were a dominant force in the area until recently. The city's economic base shifted towards finance, insurance, real estate, and other professional services in the 1980s. Today, the city's largest employers are in health care and social services, retail trade, professional services, and financial services (see Figure 7).[20]

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[20] City of Wilmington
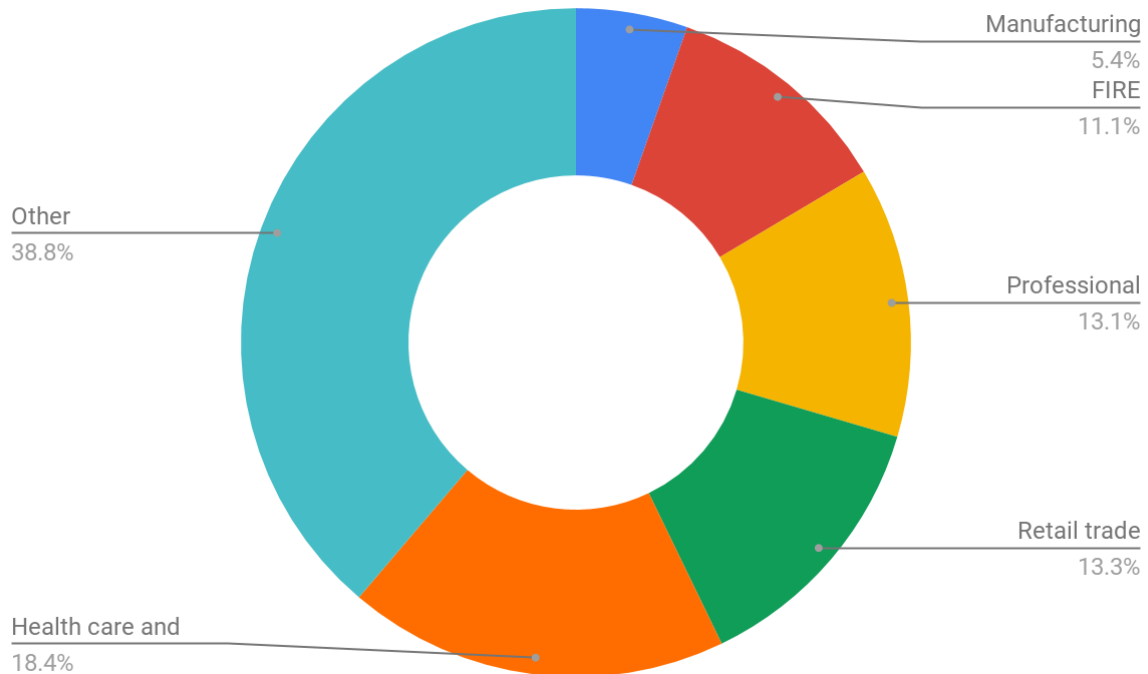
Figure 7: Employed population 16+ years, Wilmington city, DE, USA| Source: U.S. Census, 2012-2016 Estimates

The city has been recovering from the Great Recession of the late 2000s.

The city suffers from a spatial mismatch in employment. "85% of Wilmington's workforce commutes into the city from elsewhere; 73% of Wilmington's employed residents commute to jobs outside of the city."

The city of Wilmington is now home to fifteen state-designated "Opportunity Zones," which are low-income census tracts into which investors of "Opportunity Funds" may receive a tax incentive under the federal Tax Cuts and Jobs Act of 2017[21].

2.2 Environmental context

2.2.1 Hydrology

Wilmington is located in the lower watershed, within the tidal zone of the Delaware River Basin and part of the Christina River watershed. Wilmington is in Water Quality Zone 5.

21

ttps://www.wilmingtonde.gov/government/city-departments/planning-and-development/wilmington-2028/public-forum-slideshow p.43

The confluence of the Christina River and Brandywine Creek (the two principal watercourses in Wilmington) lies in the southwest part of the city.[22] The Christina River watershed drains approximately 565 square miles (1,482 km^2) with Brandywine Creek draining approximately 60% of this area; only 10% of the Brandywine Creek catchment (approximately 32.5 sq miles) lies in Delaware the remainder is in Pennsylvania.[23]

Tributaries of Brandywine Creek rise in Caernarvon county PA (west) and West Nantmeal county PA (east branch), respectively. While other major tributaries include Red Clay Creek (west and east branches rising in East Marlborough county PA) and White Clay Creek (west, east and central branches rising in Penn, Londonderry and West Marlborough counties PA, respectively).

Wilmington city boundaries intersect five watersheds (see Figure 8):[24]

- **Lower Brandywine Creek** underlines 35.9% of the area of Wilmington, 9.9 sq. km. The total area of lower Brandywine creek is 29.33 sq. km.
- **Lower Christina River** underlines 33.2% of the area of Wilmington, 9.2 sq. km. The total area of the Lower Christina River watershed is 36.14 sq. km. This is the largest of the watersheds that are contained within Wilmington.
- **Shellpot Creek** underlines 17.5% of the area of Wilmington, 4.9 sq. km. The total area of the Shellpot Creek watershed is 26.41 sq. km.
- **Little Mill Creek** underlines 10.1% of the area of Wilmington, 2.8 sq. km. The total area of little Mill Creek is 25.24 sq. km.
- **Broad Dyke Canal** underlines 3.3% of the area of Wilmington, 0.9 sq. km. The total area of Broad Dyke Canal is 23.59 sq. km.

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[22] ttps://data.delaware.gov/Economic-Development/Delaware-Opportunity-Zones/bbda-7kwe

[23] http://delawarewatersheds.org/piedmont/brandywine-creek/

[24] https://www.usgs.gov/core-science-systems/ngp/national-hydrography

Figure 8: Watersheds in Wilmington, DE | Source: USGS

The Christina River is tidal from just south of the town of Christiana, DE. Several tidal/freshwater wetlands are present in the downstream reaches. Both the Red Clay and White Clay Creeks are primarily free flowing, being tidal only in the vicinity of their confluences with the Christina River. Brandywine Creek is tidal for approximately the last two miles of the watercourse prior to its confluence with the Christina River.[25]

[25] https://en.wikipedia.org/wiki/Christina_River

The basin receives approximately 45" total rainfall per annum, in the upper parts of the Brandywine Creek catchment this translates primarily into surface runoff over the consolidated sedimentary rocks of the Appalachian Highlands. Surface water is the source of approximately 90% of all drinking water in these reaches. In contrast the Christina River and White Clay Creek catchments are primarily groundwater driven. Streamflow fluctuates seasonally, depending on demand and precipitation. In general flows are higher in the spring. There are no dams for flow control on the main Delaware River, but reservoirs and lakes on all main branches of the Christina River provide flow control as well as public water supply intakes. There are few large-scale agricultural surface water withdrawals upstream of Wilmington compared with other parts of Delaware state and river basin. However, there are several large-scale industrial and thermoelectric water withdrawals on the main branch of the Delaware River, both up and downstream of Wilmington, which may provide sources of contaminants and affect fish and other aquatic livestock in the vicinity.

Brandywine Creek is the sole drinking water source for Wilmington city; together the freshwater tributaries in the Christina River basin supply water to 75% of New Castle County as a whole[26]. In 2013, it was estimated that surface water and wells from the Brandywine Creek watershed supply 61.7mgd with around 44mgd supplying the City of Wilmington (who also manage the treatment and supply).[27] Other water utility companies upstream of Wilmington include the Artesian Water Company, Philadelphia Suburban Water Company, City of Newark, and United Water Delaware. Estimates for population growth and increased industrial usage suggest that the watershed demand will increase by 10.4mgd by 2020.

New Castle County experienced 7 droughts in the 25-year period up to 2008. Remedial actions in 2003, such as installation of an iron removal plant to treat ground water and a 300-million-gallon capacity reservoir on the White Clay Creek were built to increase the City of Newark's self-sufficiency.[28]

2.2.2 Geology

The Brandywine Creek Catchment is predominantly crystalline rocks (Wilmington Complex) with a band of carbonate rocks in the northwest part of the watershed (Wissahickon Formation). In contrast the Christina River watershed is primarily underlain by coastal plain sediments, composed of the Potomac Formation overlain by Quaternary-aged sediments. Tributaries to the Christina River cross the Wissahickon

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[26] https://en.wikipedia.org/wiki/Christina_River

[27] https://www.chesco.org/DocumentCenter/View/14096/Brandywine?bidId

[28] https://www.state.nj.us/drbc/library/documents/SOTB/entire-singles.pdf

Formation and Wilmington Complex before ending in Coastal Plain Sediments. The Cockeysville Formation, which is an important aquifer lies in the northwest of the watershed. Excessive demand on this aquifer means that the groundwater levels are currently lower than stream levels, and thus sensitive to water quality and surficial contamination. This also leads to losses from the Brandywine Creek surface water to facilitate groundwater recharge. The other crystalline rocks are more compacted and have less groundwater storage. In contrast the unconsolidated sands and gravels in the coastal plain sediments have substantial groundwater storage. There are recharge protection and Class-A Wellhead Protection zones in the lower Christina River near Wilmington Airport. High withdrawal rates/low recharge rates have historically led to high levels of dissolved iron. This also flags a concern that with rising sea levels that there will be increased saline incursion to the groundwater, and reduced abstraction permits.

The overlying soils in the upper parts of the watershed have a higher percentage of clays than those in the coastal plain. This means that runoff arising from heavy precipitation, flooding, and in the vicinity of construction or agricultural activities can contribute considerable sedimentation to the watercourses.

2.2.3 Water Quality

There are 20 permitted surface water-discharge-sewage-treatment plants on the Brandywine Creek, of which only one lies in Delaware.

The two most common pollutants found in the main Delaware River Basin are mercury and polychlorinated biphenyls (PCBs), both of which have led to fish advisories in all four riparian states. In particular, American eel and carp caught throughout the main stem of the Delaware should not be eaten at all. Contaminants found in Delaware River basin fish tissue causing consumption advisories include: PCBs, Mercury, Dioxin, Chlorinated Pesticides, Dioxin/Furans, Dieldrin, DDT, Chlordane, and Toxaphene.[29]

Atrazine and metolachlor are among the pesticides most frequently detected in groundwater and surface water near Wilmington. Atrazine is a Restricted Use Pesticide that is classified as toxic to aquatic life, a human carcinogen, groundwater contaminant, and a suspected endocrine disruptor. Atrazine is used primarily to control weeds on agricultural fields for crops such as corn and evergreen tree farms—especially for conservation tillage or "no-till" farming—and along highways for non-selective vegetation control. Metolachlor is of low toxicity to humans but slightly to moderately toxic to some aquatic life. Metolachlor is primarily used for weed control in the production of corn, soybean, and woody ornamentals. Decreases in forestry and agricultural activity are likely

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[29] https://www.nj.gov/drbc/

to lead to decreases in these contaminants. However, changes in precipitation patterns may increase their runoff potential into watercourses.

2.2.4 Ecology

Brandywine Creek is 20% urban, with the remainder split between forestry/wetland and agriculture. The upstream watershed, in PA, is designated as naturally reproducing waters trout, while the lower watershed is the only sustainable smallmouth bass fishery in Delaware. The Christina River, in contrast, is 60% urban, 25% forestry/wetland and 15% agriculture. White Clay Creek (a Christina River tributary) is a US designated wild and scenic river, considered to be Delaware's premier trout fishing stream and supporting a high variety of aquatic, amphibian and bird life. Red Clay Creek (also a Christina River Tributary) was recipient of the 2005 Scenic Byway designation in tribute to its high quality natural and scenic resources. A 2013 reported estimated that the Brandywine Creek watershed contributed $1.16bn in annual economic activity from its environmental and outdoor recreational potential.[30]

2.2.5 Potential Pollution Sources

Sedimentation, and hence increased turbidity, from construction and agriculture is considered to be a high source of nonpoint pollution in the Christina River Basin as a whole. In view of the industrial nature of this area, the potential for contaminated sediments is very high. Similarly, increased urbanization poses a risk for increased stormwater runoff (and hence pollution from hydrocarbons and other highway collected pollutants and sediments). In the period 1990-2000 the Christina River Basin saw an increase in population of 20,000, a trend which appears to be continuing and which will have considerable impacts on water resource management.

2.2.6 Industry

While there are active coal and anthracite mines in Pennsylvania upstream of the Brandywine Creek watershed, they are within the Schuylkill River watershed. There are no coal mines in Delaware. Any groundwater contamination or pollution from flooding of these sites is, thus, more likely to come from the Delaware River, which receives the Schuylkill River.

The USGS lists 6 active mining activities in Delaware for steel, sulfur, sand and gravel, magnesium compounds and titanium dioxide pigment. Of these, the steel and titanium dioxide pigment plants are located near to Wilmington. In total non-fuel mineral related activities employed 35 people in extraction and 36 in mills and preparation plants during

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[30] https://www.chesco.org/DocumentCenter/View/14096/Brandywine?bidId

2013. A 1981 report by the Delaware Geological Society states that the primary mineral resource is construction materials (sand, gravel, clay, stone) which are all mined in open quarries and contribute significantly to the potential sources of water pollution. Stone quarries were only located in northern New Castle County, but have not operated since the late 1960s. The report cited escalating costs for extraction and competing mining activities in neighboring states, suggesting that the mining industry was unlikely to survive.[31]

Historical mining activities near to Wilmington included kaolin clay and feldspar quarries (both used in the production of high-quality porcelain). Production ceased in the early 1900s when mines became too deep for safe or economical quarrying. However, historical mines may pose a risk of subsidence or watercourse contamination where they were not adequately capped off.

Oil and gas deposits occur in the rock sediments on the Coastal Plains, but not within the state of Delaware. In summer 2018, Delaware General Assembly banned offshore drilling for oil and gas.

Wilmington's historical industrial activity has left a legacy of brownfield sites, many of which are either under or proposed for redevelopment, and considerable below ground contamination. These sites are primarily located in South Wilmington in the Southbridge area. Southbridge is surrounded on three sides by the Christina River and is an Environmental Justice neighborhood with twice the poverty rate of the state of Delaware as a whole – at high risk from flooding and pollution. Contaminants from former tanneries, diamond oil and other heavy industry are increasingly at risk of exposure and contact with saltwater and groundwater through rising sea levels and post-inundation high water tables. The risks of increased exposure are increasing with continued sea level rise and changing precipitation patterns.

2.2.7 Agriculture

Agriculture in New Castle County has been declining since 1980 and only represents 1-8% of the land use in the Christina River Basin or Brandywine Creek watershed. The majority of agricultural land lies to the south of Wilmington. Delaware's major agriculture activity is poultry raising – specifically broiler (young chicken) farming.

Agriculture in the Delaware River Basin includes cropland, orchards, vineyards, pasture and livestock operations. These all declined as a percentage of overall land use in the period 1995-2001. Forestry, comprising deciduous, coniferous and mixed forests, also declined in the same period.

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[31] https://www.dgs.udel.edu/sites/default/files/publications/OFR13.pdf

2.2.8 Solid Waste

The Delaware Solid Waste Authority operates three landfills, one in each of the counties, in the state of Delaware. Cherry Island Landfill at 1706 E. 12th Street is located in Wilmington, and located on reclaimed land in the Christina River. It is highly susceptible to flooding. It accepts municipal and residential solid waste, including white goods and household yard waste, asbestos and other construction and demolition waste. Cherry Island has been operating since 1985, covers an area of 513 acres and receives approximately 1850 tons of waste per day.[32]   Condition of expansion of the site in 2006 was to establish a Citizen's Advisory Board (CAB), selected by Senators, Representatives, Mayor's Office, New Castle County Council and the Governor's Office from citizens residing north of Canals C and D. The CAB meets at least quarterly to discuss issues relating to the management of the site and ensure compliance with the overall statewide Solid Waste Management Plan.

Cherry Island Landfill operates a Landfill Gas Recovery program, which is utilized by Cummins Power Generation to generate electricity for the Croda Atlas Point Facility.[33]

There is also a private waste facility located in New Castle County, Delaware Recycled Products Inc., that receives commercial and domestic waste.

2.2.9 Natural Hazards

The main natural hazards facing Delaware are floods, nor'easter/extratropical storms, tropical cyclones, droughts, earthquakes, sinkholes, and landslides. As coastal flooding is an issue in the coastal region of south Delaware, Delaware Geological Survey has also conducted several reviews of the impacts of wind and tidal surge on coastal erosion. Northeasters, generated by low pressure systems off the east coast, bring gale force or stronger winds and can result in considerable beach erosion. The most destructive northeaster on record was that of March 1962, which it is estimated would cause damage in the billions of dollars together with human casualties were it to occur today. The highest recorded tidal water level (7.71') on the Christina River at Wilmington, prior to Hurricane Sandy, was from a low-pressure system in 2011. This was exceeded in October 2012 by a water level of 8.26'. In contrast the highest fluvial water level was 18.71' recorded on Brandywine Creek, recorded during Hurricane Irene in 2011. Many of the industrial areas in southern Wilmington are at risk from coastal inundation, at even 2' surge. The most severe flooding on record in the Christina River watershed was caused by Hurricane Floyd in 1999.

[32] https://scholarsmine.mst.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=2364&context=icchge
[33] https://www.cummins.com/news/2012/06/27/cummins-turns-landfill-gas-power-delaware-customers; https://www.delawarepublic.org/post/croda-seeks-approval-new-power-system-uses-landfill-gas

Preliminary analysis for Delaware DOT indicates that 44 road miles in the Christina River watershed would be inundated by a 1% annual probability (aka "100-year event") flood. Across the state, approximately 62,000 acres of land lie <5' above the high tide line, containing $1.1 billion in property value; 20,000 homes and 19,000 residents; 9 houses of worship; 2 power plants; and 87 EPA listed sites such as hazardous waste or sewage treatment plants.

Although Delaware does not face the same earthquake risk as many parts of the country, it was reclassified to a moderate risk zone in 1997. Seismic activity could pose a substantial threat to Wilmington as a secondary effect – for instance through dam failure at reservoirs in the upstream of Brandywine Creek.

The Hockessin area northeast of Wilmington, in New Castle County, is underlain by marbles and other carbonate bearing rocks and is susceptible to sinkhole formation.

2.3   Transportation/critical infrastructure[34]

In New Castle County, 121 bridges and culverts (44%) have inadequate capacity to pass a flood with 10% annual probability ("10-year event") and 47 of these structures would be overtopped by the same event. This increases to 204 bridges and culverts (74%) with inadequate capacity for the 1% annual probability event, of which 112 would be overtopped. These structures include US Highway 13 through Wilmington, which would not be overtopped but would cause flooding in the surrounding areas, and the railroad, DE896 and I95 on the Christina River. Inundation of any of these routes would have immediate consequences for evacuation, as there is little redundancy of principal arterials, it could also have considerable secondary impacts through limited access to remediate other infrastructure failures – e.g., at power plants or water supply. According to the EPA there is a 1-3% annual probability that New Castle county will be directly hit by a hurricane.

The Henrietta Johnson Medical Care center in Wilmington would be inundated in the event of a 1% annual probability fluvial flood occurring at the same time as coastal surge from a Category 3 hurricane. Both of Wilmington's fire stations would be inundated by a 1 % annual probability fluvial flood occurring in conjunction with a Category 1 hurricane, as would those in Christiana and New Castle – providing limited scope for emergency backup. Within these same scenarios, approximately 10% of the housing stock was constructed prior to 1950; 17% between 1950-1970 and 73% since 1970. Although building vulnerability increases with age, it is also noted that construction methods and

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[34] Racca, D., Best, E., King, R., Homsey A., Martin, J., Kauffman, G., 2018. "Worst Case Effects of Hurricanes, Fluvial Flooding, High Tides and Sea Level Rise on DelDOT assets." https://www.wrc.udel.edu/wp-content/uploads/2018/07/WorstCaseEffectsofHurricanesandSevereStormso nDELDOTAssetsfinaldraftreportJuly162018.pdf

materials have changed over the years such that the most vulnerable properties are likely those built between 1950 and 2000.

Statewide, 3640 mobile homes are at risk of inundation in a combine 1% annual probability fluvial and Category 1 hurricane event, rising to 8731 under a 0.5% annual probability fluvial and Category 3 hurricane event. Not all of the mobile homes are permanent residences. Similarly, 157 transit facilities/bus routes would be affected statewide in the former event, rising to 319 under the latter situation. As ~73% of the inhabitants in the upper region of the state (i.e., in Wilmington and surrounds) are below the poverty line, it is likely that they would be disproportionately affected by any inundation. Similarly, approximately 2% of residents in Wilmington have limited English proficiency and would be severely disadvantaged with respect to evacuation orders.

Estimates of wind damage from a 1% annual probability storm place 94 fire stations across the state, 11 hospitals, 36 police stations, and 357 schools at risk of the loss of >1 day of operations.

A GIS service including Delaware DOT assets, critical infrastructure, emergency responses, vulnerable sites and shelters, etc. as listed above has been created for Delaware DOT. Contact David Racca (CADSR, email: dracca@udel.edu) for information. Data are proprietary, subject to DelDOT approval and user agreements.

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Economic Value of the Brandywine Creek Watershed, 2013

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Doyle R.G., and Pickett T.E., 1981, OFR13 Delaware's Extractive Mineral Industry

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http://scholarsmine.mst.edu/cgi/viewcontent.cgi?article=2364&context=icchge

https://www.nccde.org/589/Maps-Interactive-Viewers

https://www.eia.gov/state/analysis.php?sid=DE#45

https://firstmap.delaware.gov/arcgis/rest/services/Environmental

2.4 Challenges

Wilmington city routinely experiences "nuisance flooding"[35] throughout much of the city along the Christina River, south of the Amtrak rail lines, and mostly west of Interstate 495. Since 1978, City of Wilmington residents filed 179 claims for losses under the National Flood Insurance Program, totaling $2.7 million.[36]

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[35] Defined as "periodic minor-to-moderate shallow coastal flooding events—typically as a result of meteorological factors that include high tides, winds, and rain." (NOAA, Sea Level Rise Viewer)

[36] https://www.fema.gov/policy-claim-statistics-flood-insurance

Delaware 2017 Coastal Inundation Maps
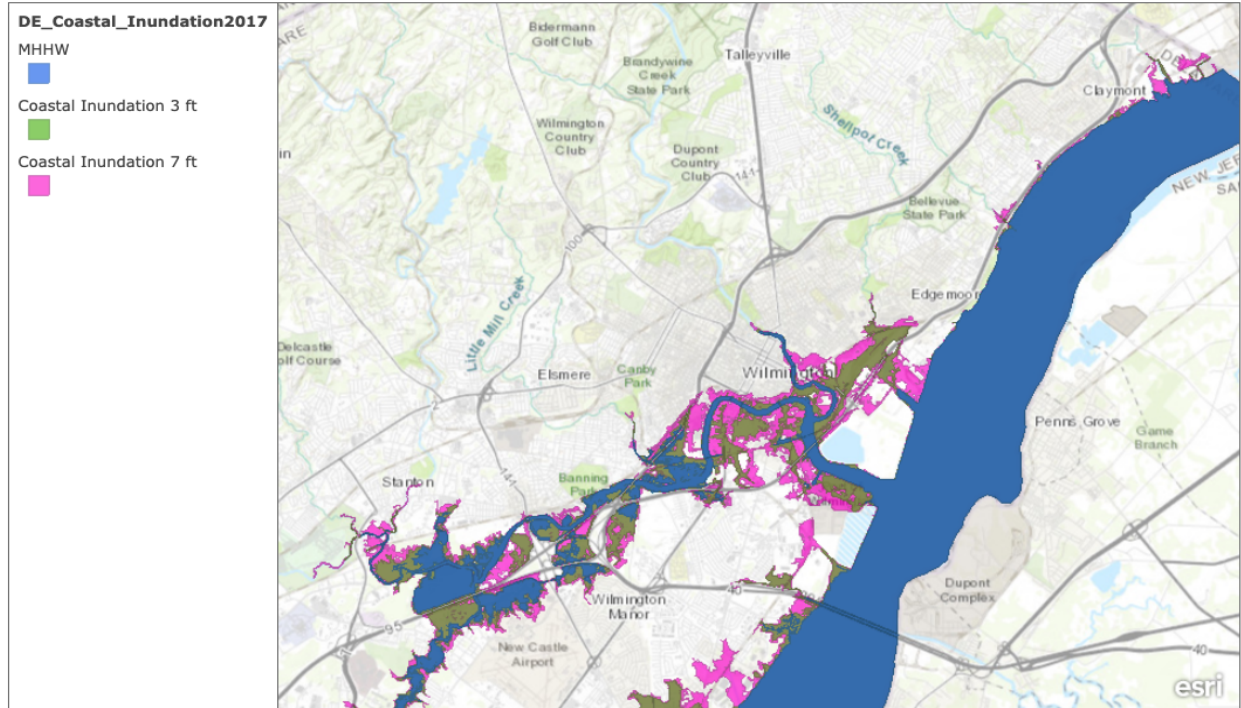
Series of coastal inundation maps For Delaware corresponding to water surfaces from the mean higher-high water (MHHW) level to 7 feet above MHHW, in 1-foot increments.

County of Chester, New Castle County, Delaware FirstMap, State of New Jersey, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS

Figure 9: Delaware 2017 Costal Inundation Map | Source: Firstmap.delaware.gov

Sea level rise (SLR) poses additional threats to the city's built environment and infrastructure. SLR of 3 feet above current mean high water is predicted to yield similar flooding as with nuisance flooding.

Should SLR increase by 7 feet above current mean high water, almost all of the areas south of the rail lines and west of I-495 are predicted to be under water, with serious impacts also seen at the Port of Wilmington.

Related, the Union of Concerned Scientists mapped the power generation facilities and subsystems at risk from storm surge associated with a Category 3 hurricane in the Delaware Valley as of 2012, with projections through 2070.[37] Many of the area's impacted facilities are located just outside of city limits, but it is clear that the city faces serious risk

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https://www.ucsusa.org/global-warming/science-and-impacts/impacts/lights-out-storm-surge-and-blackouts-us-east-coast-gulf-of-mexico#DelawareValley

of power infrastructure harm from storm surge in coming years. [NEXUS CONNECTION: WATER / ENERGY]

Climate-resilient infrastructure investments will be challenging for the city's low-income communities such as South Wilmington to afford. Similar challenges face the entire Delaware River Valley, including upstream in Philadelphia, although infrastructure governance remains fragmented across states, counties, cities, utilities, and private companies.

A database of possible funding options for resiliency projects was produced recently by University of Delaware staff.[38]

2.5 Governance overview

The Borough of Wilmington was originally chartered by the British in 1739 and was later incorporated as a city by the state of Delaware in 1832.[39] The original borough charter charged the burgesses (city leaders) with maintaining the peace; constructing and maintaining infrastructure such as roads, waterways, and wharves; designating and securing "markets and fairs" for provisioning residents; holding elections and town meetings; and constructing a courthouse.[40]

Today, the city's legal authority extends into all areas of city life and commerce as allowed in its charter:

> *Pursuant to 22 Del. C. ch. 8 (53 Delaware Laws, Chapter 260), the city shall have and exercise all express and implied powers and authority of local self-government and home rule, which, under the Delaware Constitution, it would be competent for the General Assembly to grant to the city by specific enumeration and which are not denied by general statute; and the city shall have complete powers of legislation and administration in relation to its municipal functions, including any additional powers and authority which may hereafter be granted to it.[41]*

The city of Wilmington has a mayor-council form of government, with the mayor as the chief executive and the 13 legislative (council) members all elected to 4-year terms.[42] The current mayor is Michael S. Purzycki, inaugurated in January 2017. [43]The current City Council President is Hanifa Shabazz. Chief of Staff to the Council is an alum, facilitating access.

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[38] https://www.bidenschool.udel.edu/research-public-service/ddfrc
[39] https://library.municode.com/de/wilmington/codes/code_of_ordinances?nodeId=ORCHBOWI
[40] Ibid.
[41] Municipal Code, Part 1, Subpart A, Article I, Sec. 1-101
[42] CAFR2017; https://library.municode.com/de/wilmington/codes/code_of_ordinances
[43] https://www.wilmingtonde.gov/government/office-of-the-mayor/about-mayor-purzycki

The city's vision statement is: "To Be a Thriving City, Where Communities Are Safe, Businesses Are Eager to Invest, and People Prefer to Live."[44]

2.5.1 Financing

The city had annual operating budget expenditures of $251.5 million in fiscal year (FY) 2019.[45] Of this amount, 64.5% were from the general fund, 30% were from the water/sewer fund, and the remainder were from special funds including state and federal grants. The city expects a surplus of $5.5 million in fiscal year 2019, nearly all of which is from the water/sewer fund. 46% of the city's revenues for FY2019 are collected from taxes and another 35% are from permits, fees, and fines. Approximately 17% of total revenues in FY2019 are intergovernmental transfers from county, state, or federal sources, including fees for county sewer service. Approximately 8.7% of total expenditures in FY2019 are for debt service.

2.5.2 Planning

The city planning department has updated its comprehensive plan, known as Wilmington 2028.[46] The update process has involved various options for citizen involvement, including interviews, a user survey,[47] public forums, and focus groups. A professional working on the update for the city is a graduate of our master's program, assisting with access.

Wilmington city identified approximately 40 neighborhoods[48] with unique historic, cultural, demographic, or economic characteristics. For planning purposes, the city recognizes twelve analysis areas built from census tracts for demographic analysis of U.S. Census Bureau data.[49] The city also recognizes 47 civic associations[50] operating within the city limits, some of which may serve as possible partners for this project.

Wilmington city has eight Neighborhood Planning Councils (NPCs), which provide an institutional forum for citizen participation in city governance. [51]The NPCs create and update neighborhood development and revitalization plans. Leaders of the NPCs meet

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[44] Annual Budget FY2019, p.22

[45] Annual Budget FY2019, p.v; pp.36-37

[46] https://www.wilmingtonde.gov/home/showdocument?id=8490

[47] Summary of 2017 survey results: https://www.wilmingtonde.gov/home/showdocument?id=6790

[48] https://www.wilmingtonde.gov/home/showdocument?id=442

[49] https://www.wilmingtonde.gov/about-us/about-the-city-of-wilmington/population-demographics

[50] https://www.wilmingtonde.gov/home/showdocument?id=366

[51]

https://www.wilmingtonde.gov/government/city-departments/department-of-planning-and-development/neighborhood-planning-councils

regularly and are responsible for overseeing two-way communication with residents and the city on topics of mutual interest.

A notable player in the area's governance is the WILMAPCO metropolitan planning organization, which covers New Castle County in Delaware and Cecil County in Maryland. This organization has been working to improve mobility and quality of life for residents and businesses within the city limits, including along the riverfront and improving pedestrian infrastructure along busy streets in town and for crossing the rivers, highways, and rail lines that cut through the city.[52] They have also been involved in the South Wilmington wetlands restoration project, described below.

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[52] http://www.wilmapco.org/wilmington-initiatives/

3 Water system

3.1 Basics

A map of the city's municipal water infrastructure is available here.[53]

3.1.1 Production

The primary source for drinking water in Wilmington city is the Brandywine Creek, which is a tributary of the Christina River.[54] "Originating in a spring located in the Welsh Hills near Honey Brook in Chester County, Pennsylvania, the creek has a drainage area of 320 square miles and flows 40 miles generally south and east to its confluence with the Christina River near the latter's outflow into the Delaware River."[55] A series of pumps, dams, raceways, and water mains have been constructed to withdraw water from the Brandywine.[56] "On an average day about 30 million gallons are taken from the Brandywine Creek for residential, commercial and industrial use."[57]

Concern about water quality led to vegetative buffers constructed around the city's surface waterways, such as what is now the Brandywine Park,[58] and later to regulations in 2009 establishing a source water protection area on lands bordering the Brandywine Creek.[59] The regulations prohibit installation of new underwater storage tanks; assist with erosion control; among other actions. A 2014 assessment of water quality in the Brandywine Creek watershed revealed most all segments of the creek and its tributaries in the Delaware portion were impaired and not meeting standards.[60]

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[53] "From Creek to Tap," http://cdm16397.contentdm.oclc.org/cdm/ref/collection/p16397coll17/id/0

[54] http://delawarewatersheds.org/piedmont/brandywine-creek/

[55] "From Creek to Tap," p.18

[56] Wilmington city's community water system is registered in the Federal Water Information System as ID DE0000663, comprised of 52 elements including two intakes, several pumping and booster stations, multiple reservoirs and storage tanks, two treatment plants, and the transmission and distribution lines.

[57] http://www.brandywineredclay.org/watershed-conservation/our-watersheds/

[58] "From Creek to Tap"

[59] (August 31, 2009 Monday). Mayor Baker Announces New Steps to Protect City Drinking Water. US State News. Retrieved from Nexis Uni.

[60] ttp://www.brandywineredclay.org/watershed-conservation/red-streams-blue/ and map: http://www.brandywineredclay.org/wp-content/uploads/2017/02/BrandywineRedClayAlliance_ImpairedStreams_04122016-1.jpg

3.1.2 Distribution

Treatment of the city's drinking water supply occurs at the Brandywine Filter Plant, which first began operating in 1894, and more recently at the Porter Filter Plant.[61] Treatment has expanded to include a series of screens, settling ponds, coagulants, sand filters, and membrane filters. The Brandywine Filter Plant processes 75 million gallons per day on average. [62]The city's system includes drinking water storage at the Hoopes Reservoir, Cool Springs Reservoir, and in multiple storage tanks throughout the area. Wilmington city's drinking water system received 11 violations since 2001, 4 of which were from contamination by coliform or cryptosporidium, and only 1 was considered a "major" violation.[63]

3.1.3 Consumption

Both municipal water production and sewage treatment have declined slightly over the past 10 years, on average (see Figure 6). The city has been replacing aging water and sewer lines to improve efficiencies within the system,[64] which may account for some of the most recent decline. The substantially higher sewage treatment than drinking water production results from sewage treatment performed under contract for New Castle County.[65]

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[61] "From Creek to Tap"

[62]

http://cleanwaterdelaware.org/wp-content/uploads/2015/08/Clean-Water-Task-Force-Report-w-appendices-1-thru-8-Final-4-18-2017.pdf

[63] U.S. Environmental Protection Agency, Water System Violation Report for PWS ID 'DE0000663.'

[64] CAFR2017, p.14

[65] Annual Budget FY2019, p.84
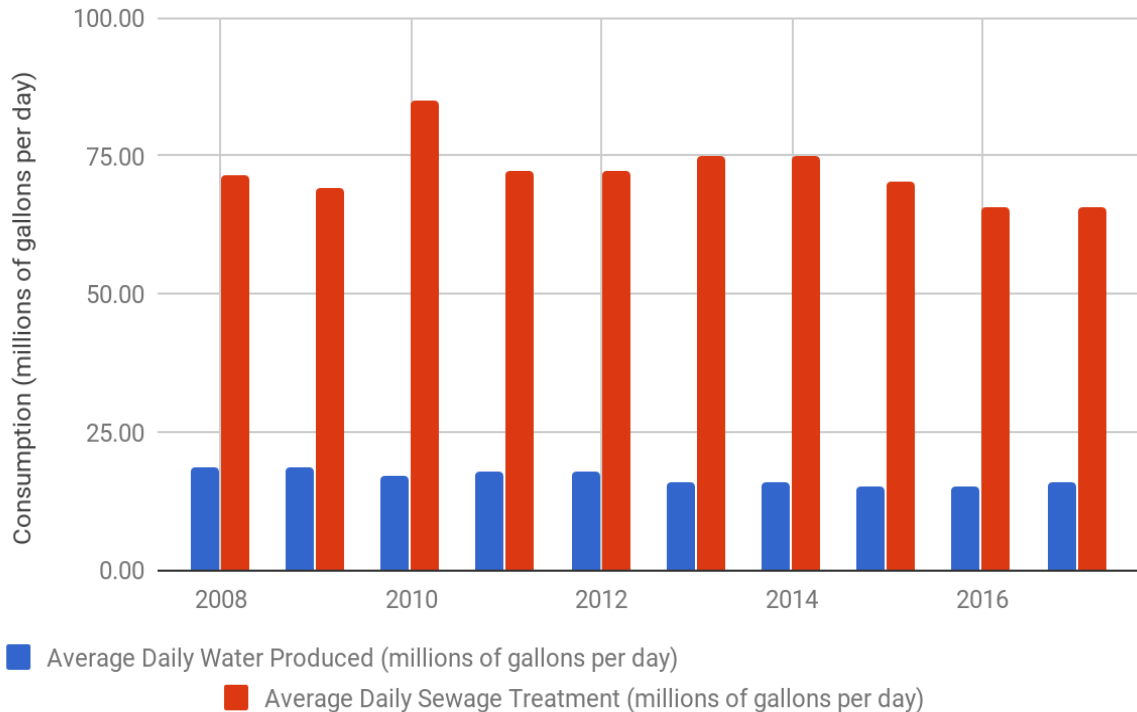
Figure 10: Water consumption in Wilmington city, DE, USA | Source: City of Wilmington, Comprehensive Financial Report 2017

Breakdowns of water consumed by sector (i.e., residential, commercial, industrial, agricultural) are not publicly available.

3.2 Governance

3.2.1 Primary Institution

Drinking water service for city residents was first provided by the Wilmington Spring Water Company in 1804 and their authority was transferred to the borough in 1810.[66] The state established a Board of Water Commissioners in 1883 to maintain and improve the city's water supply.[67]

Today, the city's Public Works Department provides water, sewer, and stormwater services for the entire municipality.[68] The department's mission "is to operate and maintain infrastructure and facilities, provide superior services for our customers, and

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[66] "From Creek to Tap"- p.10
[67] "From Creek to Tap"- p.12
[68] City Code Ch 45, Article 1, Sec. 45-1

promote environmental sustainability."[69] "To fulfill the [department of public works']
mission, contact is maintained with numerous State, Federal, and regional agencies
including DelDOT, DNREC, Delaware Solid Waste Authority, New Castle County Water
Resources Agency, New Castle Conservation District, Department of Public Health,
Delaware River Basin Commission, and the Environmental Protection Agency."[70]

Oversight of the water, sewer, and stormwater system is provided by a Citizens Advisory
Board.[71]

Operational funds are generated primarily from user charges to the city's Water and
Sewer Fund.[72]Water and sewer user charges are set by the City Council (the city's
legislative body) and user charges are collected by the city's Department of Finance.[73]

The city's combined sewer and stormwater system is governed by the Combined Sewer
Overflow (CSO) Final Long Term Control Plan, last updated in July 2015. The plan
attributes its nearly 92% "wet weather capture" to successful city-financed CSO projects
and parcel billing for stormwater, which incentivizes private investments.[74]

The city acts on behalf of the state environmental agency (the Department of Natural
Resources and Environmental Control, DNREC) in implementing the state and federal
government's stormwater management policies especially due to land disturbing activities
such as development.[75]

The city adopted a Source Water Protection Plan in 2010, which designates agricultural
areas upstream from the city in the Brandywine Creek Watershed as "priority protection
areas." Under this plan, the city pays farmers to employ management practices that
would reduce the sediment and contaminants entering the city's surface water supply,
thereby reducing energy demands for water treatment. Fifteen farms located on over
1,000 acres have so far been protected under this plan.[76] The primary contaminants of
concern for source water protection are nitrogen and phosphorus, which often result from
runoff of manure spread on fields. Land is expensive in the source water areas, though,
limiting the scope of the purchases that are available given limited funding. [NEXUS
CONNECTION: WATER, FOOD, ENERGY]

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[69] Annual Budget FY2019, p.217
[70] Annual Budget FY2019, p.217
[71] City Code Ch 45, Article 1, Sec. 45-5;
https://www.wilmingtonde.gov/government/boards-commissions-and-committees/wilmington-water-sewer-and-stormwater-citizens-advisory-board
[72] Comprehensive Annual Financial Report (CAFR) 2017, p.vi
[73] City Code Ch 45, Article 1, Sec. 45-2 and 45-3
[74] FLTCP, p.1
[75] City Code, Ch 11, Article 2, Sec 11-36
[76]
https://www.wilmingtonde.gov/government/city-departments/department-of-public-works/source-water-protection-plan

Wilmington has a city-wide goal to "Cultivate Positive Community Relationships." To meet this goal, the Department of Public Works projects hosting 20 educational events with 1,500 attendees for FY2019. The Department also plans to complete 10 streetscape programs within neighborhoods at a total cost of $150,000 in FY2019.[77]

3.2.2 Other Institutions

3.2.2.1   State - Drinking Water

The state of Delaware is responsible for regulating drinking water quality pursuant to the federal Safe Drinking Water Act. Its regulations "apply to all public water systems in the State of Delaware,"[78] which includes the city of Wilmington. The state also provides guidance for protecting private wells.

Delaware Health and Social Service's Division of Public Health - Office of Drinking Water is the lead state agency for drinking water. "The mission of the Office of Drinking Water is to protect the health of Delawareans by assuring [sic] safe drinking water through comprehensive monitoring, technical assistance and public education."[79]

The state received nearly $19 million in federal grants in 2009 for drinking water projects pursuant to the American Recovery and Reinvestment Act. Nearly half of that funding went to the city of Wilmington for upgrades to its filtration technology, including installation of solar panels at the Porter Filter Plant described below.[80]

3.2.2.2   State - Coastal Zone

The state of Delaware has restrictions on industrial development within 2 miles of the state's shoreline, pursuant to the Coastal Zone Act of 1971.[81]Facilities wishing to operate within the coastal zone must submit an application for a permit to be issued by the state's environmental agency DNREC. Decisions on the permit are made by the DNREC Secretary and appealable to the Coastal Zone Industrial Control Board.[82] Recent modifications to the law will allow redevelopment and industrial expansion at 14 sites within the coastal zone including several in and around the city of Wilmington.[83] One of the sites is slated for expansion of the Port of Wilmington. DNREC is currently engaged in updating its regulations of the coastal zone to match the new law.

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[77] Annual Budget FY2019, p.225
[78] State of Delaware Administrative Code, Title 16, Chapter 4462, Section 1.1
[79] https://www.dhss.delaware.gov/dph/hsp/odw.html
[80] https://www.dhss.delaware.gov/dph/hsp/files/arracert.pdf
[81] Delaware State Code Title 7, Chapter 70: http://delcode.delaware.gov/title7/c070/index.shtml
[82] https://dnrec.alpha.delaware.gov/coastal-zone-act/industrial-control-board/
[83] Coastal Zone Conversion Permit Act of 2017

3.2.2.3   State - Soil/Water Management

[NEXUS CONNECTION: WATER, FOOD (ENERGY?)]

3.2.2.4   Private

Operational management of the wastewater treatment system is presently provided under contract by the private company Veolia. The city's 20-year contract with Veolia expired at the end of FY 2018, and they are currently operating under a 1-year contract while the city requests new proposals.[84]

The city has been replacing small water meters, contracting with a private company and subcontractor (Itron and Grid One) to perform the installations.[85]

3.2.3 Connections

U.S. federal policies delegate substantial authority in water governance to state and local actors. For instance, under the Safe Drinking Water Act, the federal EPA sets drinking water standards and the local water systems implement those standards. In Wilmington, the local implementation includes the city's Public Works Department and a private vendor as described above. The state then oversees and manages federal money to update or expand drinking water infrastructure under allocations from the Drinking Water Revolving Fund.

Under the Clean Water Act, states are the responsible parties for implementing federal surface water standards, issuing permits to discharge, and developing plans to meet Total Maximum Daily Load requirements on state waterways. The city must comply with state regulations and has delegated authority from the state over regulating development that might impact stormwater and erosion.

3.3 Governance in practice

3.3.1 Ongoing

The city is a member of the New Castle County Water Resources Agency (WRA), which performs "regional water planning and management."[86] Other WRA members include the city of Newark, New Castle County, and the state of Delaware. The University of Delaware hosts and staffs the agency.

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[84] Annual Budget FY2019, p.vii

[85] https://www.wilmingtonde.gov/government/city-departments/public-works/water-meter-upgrade

[86] http://www.wrc.udel.edu/about-wra/

The city participates with other regional partners in the Christina Basin Clean Water Partnership.[87] The Partnership helps members to plan and implement voluntary projects to meet the Christina Basin total maximum daily load (TMDL) requirements under the federal Clean Water Act[88]. A multi-state TMDL was set for the Christina Basin in April 2005. The Basin includes the Brandywine Creek, Red Clay Creek, White Clay Creek, and the Christina River watersheds. The Christina Basin Pollution Control Strategy reflects the implementation plans for the Delaware portion of the Christina Basin, which includes the city of Wilmington as well as the suburban areas in New Castle County. The strategy was developed through an engaged-stakeholder consensus-building process, leading to recommendations in stormwater, open space, wastewater, agriculture, and education.[89] The Delaware state lead for the Partnership is the WRA at the University of Delaware.[90] [NEXUS CONNECTION: WATER, FOOD]

3.3.2 Projects

The city collaborated with the state Department of Health and Social Services (the Division of Public Health, and the Division of Historical and Cultural Affairs) on plans for the recent rehabilitation of the Brandywine Filter Plant.[91] The involved agencies recognized that the rehabilitation would influence designated historic districts and invoked federal requirements under section 106 of the National Historic Preservation Act. The resulting plans were subject to review by the Wilmington Design Review and Preservation Commission. Funding for the rehabilitation was secured from the U.S. Environmental Protection Agency's Drinking Water State Revolving Fund in 2008[92] and managed by the state.

The city's Source Water Protection Plan was developed in 2010 with contributions from the state of Delaware's environmental agency (DNREC), the University of Delaware's Water Resources Agency, the Chester County (PA) Conservation District, the Chester County (PA) Water Resources Agency, and two local non-profit organizations - the

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[87] http://www.wrc.udel.edu/public-service/christina-basin-clean-water-partnership/; organization chart: http://www.wrc.udel.edu/wp-content/uploads/2016/09/CBCWP_orgchart.pdf

[88] Christina Basin Pollution Control Strategy (CBPCS), November 2011

[89] Ibid.

[90] http://www.wrc.udel.edu/public-service/christina-basin-clean-water-partnership/

[91] "From Creek to Tap"

[92] $19M per CAFR2017, p.62

Brandywine Conservancy[93] and the Brandywine Valley Association (now: the Brandywine Red Clay Alliance).[94]

The city is currently finishing the design phase of the South Wilmington Wetlands Park as part of the South Wilmington Wetland Restoration and Conservation Project.[95] The wetlands park will assist with stormwater management in this high flood-risk area, remediate 25 acres of contaminated land, and provide a public amenity and access to the waterfront from the Southbridge neighborhood.[96] The site was selected through an community-engaged planning process in 2006, which resulted in the South Wilmington Special Area Management Plan and South Walnut Urban Renewal Plan.[97] Project partners include WILMAPCO, the Southbridge Civic Association, the Nature Conservancy, and the state's environmental agency DNREC. Oasis Design Group and RK&K Engineering (private companies) created the master plan for the site and Brightfields, Inc. (a private company) provides brownfield remediation.[98] The current city lead is located in the Office of Economic Development although the Public Works Department is closely involved.

One instance in which the city of Wilmington was <u>not</u> involved directly is with the state's Clean Water and Flood Abatement Task Force, chaired by state Senator Bryan Townsend.[99]

3.4 Data governance

The city's comprehensive annual financial report for each fiscal year since 2008 includes information on the aggregate capacity and amount of water produced (and also sold) and sewage treated by the municipal system.[100] The data are not disaggregated by smaller geographies such as neighborhoods or census tracts, or by consumption sector.

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[93] "The Brandywine Conservancy protects and conserves the land, water, natural, and cultural resources of the Brandywine-Christina watershed." Source:
https://www.brandywine.org/conservancy/about/our-mission-approach

[94] "The mission of the Brandywine Valley Association is to promote the restoration, preservation, conservation and enjoyment of the natural resources of the Brandywine Valley through education programs, environmental studies and projects, and technological advocacy." Source:
https://conservationtools.org/organizations/33-Brandywine-Valley-Association

[95]
https://www.wilmingtonde.gov/government/city-departments/public-works/south-wilmington-wetland-park-481

[96] CAFR2017, p.xvi

[97] http://www.wilmapco.org/wilmington/2015.04.26_WilmingtonFederalRequestFactSheet.pdf

[98] http://www.oasisdesigngroup.com/south-wilmington-wetlands-park/

[99]
http://cleanwaterdelaware.org/wp-content/uploads/2015/08/Clean-Water-Task-Force-Report-w-appendices-1-thru-8-Final-4-18-2017.pdf

[100] https://www.wilmingtonde.gov/government/city-departments/department-of-finance/financial-reports

The city's annual water quality report includes information on contaminants (metals, bacteria, sediment, etc.) found in the city's water supply, as required by the federal Environmental Protection Agency.[101] Downloadable data by monitoring station are available from March 2000 to October 2017.[102] A summary of aggregate water quality trends in the Brandywine and Christina watersheds (which feed Wilmington city) is available for 1995-2015.[103]

The city's drinking water compliance sampling data is publicly available online. Various tools are available under the DHSS's Office of Drinking Water (ODW). The Drinking Water Watch tool enables users to view drinking water data from any public water system in Delaware. Similarly, the ODW also keeps a record of public drinking water consumer information.[104]

Monitoring information from the CSO system is collected in real-time for adaptive management and performance measurement.[105]

The partnership for Delaware Estuary collects data and produces several reports on Delaware's water resources ranging from freshwater mussel stocking for water quality enhancement to coastal resiliency projects. It also publishes the State of Estuary Report, a massive undertaking, the latest one being published in 2017, following 2 years of collaboration among environmental scientists in Delaware, New Jersey, and Pennsylvania. "The purpose of this 379-page assessment is to provide readers with insight into the status and trends of select natural resources in the Delaware Estuary's Watershed, home to approximately 9 million people. The Partnership worked closely with the Delaware River Basin Commission, state and federal agencies, universities, and its 21-member Science and Technical Advisory Committee to share data and select ~50 key Indicators. Indicators are measures used to gauge environmental conditions, and were carefully chosen based on the data available and its ability to help readers understand current conditions and future needs. "[106]

As part of its city-wide goal to increase accountability, the Public Works Department has a contract with Cityworks to manage reports of issues needing resolution in the city, including flooding. Citizen requests are submitted by phone or online.[107] Citizens can also

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[101] Reports from 2002 through 2016 available as PDF format at
https://www.wilmingtonde.gov/government/city-departments/department-of-public-works/water-quality-reports

[102] http://demac.udel.edu/waterquality/

[103] http://www.wrc.udel.edu/wp-content/uploads/2017/10/BrandywineChristinaWaterQualityTrendsfrom1995_2015.pdf

[104] https://www.dhss.delaware.gov/dhss/dph/hsp/odw.html

[105] FLTCP, p.28

[106] http://www.delawareestuary.org/data-and-reports/state-of-the-estuary-report/

[107] https://www.wilmingtonde.gov/government/city-departments/public-works/submit-a-request-for-service

use the "Report It, Resolve It" smartphone application.[108] The Department projects it will receive 16,000 work orders through the Cityworks system in FY2019, of which nearly 97% are expected to be completed in Cityworks.[109] The Department first began using Cityworks in 2007 and has since expanded functionality, including GIS integration through ESRI.[110] It is not clear whether we could get access to this data in a usable form for our purposes.

The state of Delaware's Open Data portal includes downloadable datasets on well permits, advisories on recreational water bodies, and storm water runoff associated with construction activities.[111]

Data on drinking water affordability is collected by the University of Delaware's WRA. Data are communicated by publishing reports and peer-reviewed articles, and through conferences, meetings, and seminars.[112]The data collected are made publicly available. The main users of the collected data are nonprofits organizations involved in water-related advocacy.

Several water-related data needs were articulated in interviews, including:
- Economic valuation of waterways in Delaware watersheds generally;
- Information on Christiana Riverfront visitorship and valuation;
- Information on recreational boating use and valuation downstate, especially areas that might be impacted by dredging.

Additionally, interviewees noted that available water data are highly fragmented.[113] There is a need for the standardization of water data collection and reporting. There is also a need for communication and marketing of existing data products to make citizens and other potential data users aware of existing resources.

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[108] https://www.citysourced.com/blog/wilmington-de-launches-report-itresolve-it-app/

[109] Annual Budget FY2019, p.224

[110] https://www.cityworks.com/2013/02/cityworks-cuts-cost-at-wilington-delaware/

[111] https://data.delaware.gov/Energy-and-Environment/Well-Permits/2655-qn8j; https://data.delaware.gov/Energy-and-Environment/Storm-Water-Notices-of-Intent/3s4n-3up9; https://data.delaware.gov/Energy-and-Environment/Recreational-Water-Advisories/ever-58ni

[112] Interview 5, 18

[113] Interview 5

4 Energy system

4.1 Basics

4.1.1 Production

4.1.1.1   Conventional

Calpine Energy has three electricity generating plants located within Wilmington, including the Christiana (petroleum; 50 MW), Edge Moor (natural gas; 725 MW), and Hay Road (natural gas; 1136 MW) facilities.[114]

These plants, and others in and around the city, emit substantial conventional and toxic air pollution that affect Wilmington city residents. New Castle County lies in a federal nonattainment area for ozone (the 8-hour standard) in 2018.[115]

According to a recent report by Environment America[116], Wilmington has one of the highest numbers of smog days in the northeast (97 days in 2015) and one of the highest in the nation for elevated particulate matter pollution (212 days in 2015). These frequencies are likely to increase in the future with higher temperatures exacerbating the formation of particulate matter and changing wind patterns also likely to increase the number of days with stagnant air. The records do not necessarily account for highly sensitive regions – such as proximate to highways, airports or industrial areas; and carbon monoxide, air toxics, or oxides of nitrogen were not monitored.

4.1.1.2   Renewable

4.1.1.2.1 Solar

[NEXUS CONNECTION: WATER, ENERGY]

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[114] PolicyMap; original data from the Energy Information Administration

[115] https://www.epa.gov/green-book/green-book-data-download

[116] Ridlington E., and Madsen T., 2017, "Our Health at Risk. Why are millions of Americans still breathing unhealthy air?"
https://environmentamerica.org/sites/environment/files/reports/Our%20Health%20at%20Risk%20vAM%20web.pdf

The Wilmington Housing Authority installed 1.15 MW solar photovoltaic panels at the Southbridge Solar Park in summer 2018, on a lot that had been vacant since 2005[117]. The solar park is managed by Ecogy Energy and the energy produced offsets use at WHA properties.

A 1-MW privately-owned solar photovoltaic facility is located on Hay Road near the Calpine Edge Moor and Hay Road facilities and owned by Laurel Capital Partners.[118]

According to the Open PV project, a total of 111 solar panels with nearly 1-MW capacity were installed in the City of Wilmington from 2004 to 2015.[119] Sixteen installations were registered during this time on commercial properties, with more than 680 kW installed and a median size of 33 kW. Thirty-seven installations were registered on residential properties, totaling 162 kW installed and with a median size of 4.3 kW.

4.1.1.2.2 Wind

The Port of Wilmington is advocating along with state lawmakers and Delmarva Power for the development of offshore wind along the Delaware shoreline. The Port handles the import of wind power components intended for facilities throughout the country. Delaware had a failed offshore wind project (Bluewater Wind) in 2011. Two new projects appear slated to proceed in the nearby (federally-owned) Outer Continental Shelf, although neither as of now would benefit Delaware residents.[120] [NEXUS CONNECTION: WATER, ENERGY]

[NEXUS CONNECTION: WATER, ENERGY]

4.1.1.2.3 Barriers

Workshop participants[121] noted several barriers to expansion of renewable technologies, especially solar, in the city, including a lack of consumer awareness of the benefits of solar; insufficient financial incentives to install renewable energy technology; a lack of financial incentives for landlords to install such technologies when renters pay energy bills; a lack of overall building envelope efficiency in old buildings, requiring weatherization first; and extensive building vacancy and absentee ownership.

The building efficiency problem and need for weatherization first was echoed in subsequent interviews.[122]

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[117] https://www.wilmingtonde.gov/Home/Components/News/News/2977/225?npage=8

[118] PolicyMap; original data from the Energy Information Administration

[119] https://openpv.nrel.gov

[120] https://www.wind-watch.org/news/2017/05/24/delaware-loses-offshore-wind-farms-to-maryland/

[121] Wilmington ULL1, 4/6/19.

[122] Interviews 2 and 3.

4.1.2 Distribution

Wilmington does not have its own municipal energy utility; rather, electricity and natural gas are distributed by an investor-owned utility, Delmarva Power & Light.

Customers may elect to use an alternative electricity supplier under the state's 1999 electricity restructuring law.[123] For customers not electing alternative suppliers, electricity is supplied to Delmarva by PJM Interconnection. In FY2017, PJM's regional grid was powered 34% by nuclear, 34% by coal, 26% by natural gas, 5.8% renewables (mostly wind), and the remainder from oil and other fossil fuels.[124]

Delmarva must comply with the state's Renewable Energy Portfolio Standards Act (REPSA) of 2005, which requires an increasing share of renewable energy until reaching 25% by 2025 (and 3.5% solar). Delmarva currently meets the RESPA's interim goals through purchasing electricity sourced from wind and solar (such as from the Porter Filter Plant SRECs); and from fuel cells (such as at the Bloom Energy facility on the University of Delaware campus).[125]

The city is engaged in a public-private partnership with Delmarva to extend both gas and water mains to an industrial customer, saving the city the cost of performing the excavations for the water main extension.[126] Delmarva is also engaged in replacing gas meters throughout the city to conserve energy.[127]

The city collects franchise fees on electricity and natural gas, priced at 2% of gross sales and estimated at less than 1% of city revenues in FY2019.[128]

4.1.3 Consumption

4.1.3.1 Municipal

The city adopted a Climate Sustainability Plan in April 2008 that included a goal to reduce the city's energy use 20% by 2020 (from businesses; from residents; from city

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[123] https://depsc.delaware.gov/customer-electric-choice/

[124] https://www.delmarva.com/SiteCollectionDocuments/Delmarva%20Fuel%20Mix%20Insert.pdf

[125] https://www.delmarva.com/MyAccount/MyBillUsage/Pages/DE/Electric/REPSA.aspx

[126] City of Wilmington Water Quality Report 2016,
http://www.ccrwilmingtonde.com/2016_City_of_Wilmington_Water_Quality_Report.pdf

[127]

https://www.wilmingtoncitycouncil.com/wp-content/uploads/2018/08/Strategic-Planning-Process-August-2018-Progress-Report.pdf

[128] Annual Budget FY2019, p.59

operations).[129] The city's Department of Public Works also has an objective to "reduce the annual carbon footprint by 5% at City facilities."[130]

The city has since applied for and received federal Energy Efficiency and Conservation Block Grant (EECBG) funds to implement its associated Energy Efficiency and Conservation Strategy.[131] For instance, the city invested in a retrofit of its traffic lighting system in 2009-2010, with support from EECBG and state funds.[132] Recently, the city's Department of Public Works made operational improvements in its water/sewer system that resulted in approximately 20% electricity savings (~$205,500).[133]

The city spends approximately $1.2 million on electricity purchases for municipal use.[134] Their procurement firm estimates an increase in electricity prices of approximately 1.3% per year through FY2022.[135] Electricity costs increased in FY2019 for the city also due to an increase in the state-sanctioned tariff rate on street lighting.[136]

4.1.3.2   Buildings

The city is home to a number of energy star rated buildings, including the courthouse, several office buildings and stores, and multiple school buildings.[137]

4.1.3.3   Residential

Approximately half of households in Wilmington city use utility-provided gas to heat their homes, as of 2016. Another third is estimated to use electricity to heat their homes. Since 2000, a substantial share of city residents has changed from heating with oil or kerosene to electricity.[138] Further electrification would work in favor of the state's climate policy goals and reduce air pollution in the city.

Average residential electricity costs are high in Wilmington (15% higher than the national average) and are concerning given the low median household income of city residents (61% less than the median US household).[139] Average costs are high, in part, due to flat

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[129] https://www.wilmingtonde.gov/home/showdocument?id=222, Appendix 6

[130] Annual Budget FY2019 p.230

[131] https://gaia.lbl.gov/people/mwbeck/public/EECBG/Wilmington/DE-City-Wilmington-Strategy.pdf

[132] Annual Budget FY2019- p.64

[133] Annual Budget FY2019, p.35

[134] Estimated costs: $1.22 million FY2019; $1.68 million FY2010- source: Annual Budget FY2019, p.64

[135] Ibid.

[136] Annual Budget FY2019, p.220

[137] https://www.energystar.gov/index.cfm?fuseaction=labeled_buildings.locator

[138] PolicyMap, citing data from the U.S. Census Bureau

[139] https://www.electricitylocal.com/states/delaware/wilmington/

transmission and generation fees that are not related to the electricity used in the home.[140]

4.1.3.4   Transportation

The state's Energy Plan 2009-2014 includes recommendations for expanding bicycle facilities, transit-oriented development, and making "complete streets" improvements in the city of Wilmington to decrease the use of motorized transport and thereby reduce transport energy.[141] Workshop participants identified a desire for an all-electric bus fleet during their visioning exercise.[142]

4.2 Governance

4.2.1 Primary Institution

Energy in Wilmington city is primarily governed by the private company Delmarva Power, which is an investor-owned utility under the Exelon Corporation (NYSE: EXC). Its electric service area includes all of New Castle County and Wilmington city, and its natural gas area includes most all of northern New Castle County.[143] Gary Stockbridge has been the President of Delmarva Power since 2005.[144]

Delmarva's stated values include: "We are dedicated to safety. We actively pursue excellence. We innovate to better serve our customers. We act with integrity and are accountable to our communities and the environment. We succeed as an inclusive and diverse team."[145]

Delmarva corporate environmental policy statement notes: "We are committed to sustaining our ecosystems and natural resources through pollution prevention and continually improving our environmental performance. We will: • Promote a corporate culture in which we are accountable to our communities and the environment and in which full compliance with environmental laws and regulations is the minimum level of acceptable performance; • Balance meeting future energy needs and contributing to

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[140] Mordock, Jeff. (2016, July 3). "High electric bills roil Delaware residents, businesses." Delaware News Journal.
https://www.delawareonline.com/story/news/2016/07/03/high-electric-bills-roil-delaware-residents-businesses/86151894/

[141] The Governor's Energy Advisory Council (2009, March 26). Delaware Energy Plan 2009-2014.

[142] Wilmington ULL1, 4/6/19.

[143] https://www.delmarva.com/AboutUs/Pages/CompanyInformation.aspx

[144] https://www.delmarva.com/AboutUs/Pages/RegionalLeadership.aspx

[145] https://www.delmarva.com/AboutUs/Pages/LeadershipValues.aspx

economic growth with delivering sustainable solutions that are clean, affordable, reliable and provide customers the choices they expect; and • Engage our stakeholders and our employees to preserve, restore and enhance habitats and biodiversity."[146] The policy also commits the company to operate an Environmental Management System in compliance with ISO 14001 standards.

As an investor-owned utility, most details of Delmarva's governance remain private.

4.2.2 Other Institutions

The city's Department of Public Works is the purchaser of electricity for municipal operations.

Delmarva's electricity distribution in Delaware is regulated by the Delaware Public Service Commission (PSC)[147], according to Title 26, Chapter 10 of the Delaware State Code.[148] The PSC must certify installations for participation in the SREC auction.[149]

The state's environmental agency DNREC oversees a Weatherization Assistance Program (WAP), which is free to participants and includes an energy assessment of a property plus financial assistance with energy efficiency and weatherization actions. New Castle County and city of Wilmington residents can apply through the Wilmington city office.[150] Additional information is available at Energize Delaware's Wilmington Community Energy Office, housed at Catholic Charities.[151]

The Delaware Sustainable Energy Utility (DESEU, a non-profit organization) facilitates the SREC auctions and monitoring for Delmarva and other purchasers.[152] The DESEU also provides various financial incentives for city residents, businesses, schools, churches, and non-profit organizations (i.e., rebates, loans) to improve energy efficiency investments.[153] Efforts are underway to expand access to weatherization through grants to members of community groups from the DESEU. The DESEU is engaged routinely in providing information where and when requested about energy efficiency and renewable energy alternatives to community groups.

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[146] https://www.delmarva.com/SiteCollectionDocuments/corporate-environmental-policy.pdf

[147] https://depsc.delaware.gov/public-service-commission

[148] http://delcode.delaware.gov/title26/c010/index.shtml

[149] https://dnrec.alpha.delaware.gov/climate-coastal-energy/renewable/portfolio-standards/

[150] https://dnrec.alpha.delaware.gov/climate-coastal-energy/sustainable-communities/weatherization/

[151] https://www.energizedelaware.org/community-energy-center-locations

[152] http://www.dnrec.delaware.gov/News/Pages/Wilmington-ranked-No-3-city-in-US-for-solar-energy.aspx

[153] https://evogov.s3.amazonaws.com/media/50/media/166251.pdf

Given that energy production and transmission facilities carry a risk for chemical releases, the city of Wilmington's Local Emergency Planning Committee (LEPC) prepares and implements emergency response plans for chemical releases under the federal Emergency Planning and Community Right to Know Law of 1986.[154]

4.3 Governance in practice

4.3.1 Ongoing

The state's Renewable Energy Task Force provides guidance and recommendations for implementing the state's Renewable Portfolio Standards. The task force does not include a representative specifically from the city of Wilmington, although Delmarva is represented.[155]

The state's Energy Efficiency Advisory Council likewise provides guidance for improving energy efficiency offerings throughout the state. The council also does not include a representative specifically from the city of Wilmington, although a standing sub-committee on Low Income programs includes two at-large members from New Castle County and one at-large member specifically representing low-income residential interests.[156]

4.4 Data governance

Delmarva's latest Integrated Resource Plan filed with the PSC contains details on its aggregate operations.[157] Delmarva must also report aggregate information to the PSC for small generators (less than 1 megawatt) that are inter-connected to the grid.[158]

All utilities must report certain sales and production information to the U.S. Energy Information Administration. The most relevant data source for sales in utility service areas is from the EIA-861 series.[159] This dataset is not disaggregated by county, zip code, or other small area geography, but does include sales, revenues, number of net metering customers, incentives provided, etc., annually for Delmarva Power (separated by its DE and MD operations).

Delmarva Power is a member of the Edison Electric Institute (EEI) trade association, which has data and analysis available for purchase.[160]

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[154] http://dnrec.delaware.gov/SERC/LEPC/Pages/CityofWilmingtonLEPC.aspx

[155] https://dnrec.alpha.delaware.gov/climate-coastal-energy/renewable/renewable-energy-taskforce/

[156] https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/energy-efficiency-advisory-council/

[157] https://depsc.delaware.gov/wp-content/uploads/sites/54/2017/03/DPL-Public-IRP-113016.pdf

[158] https://depsc.delaware.gov/electric-regulation

[159] https://www.eia.gov/electricity/data/eia861/

[160] http://www.eei.org/about/members/uselectriccompanies/Pages/default.aspx

The state of Delaware's Open Data portal includes a dataset of all grants issued to Delmarva customers under the state's Green Energy program since 2002.[161] The portal includes all WAP grants issued statewide since 2014 by city, county, zip code, and includes information about the property and the services provided.[162] Data on grants for the state's Alternative Fuels and Electric Vehicle Charging Stations are also available.[163]

The U.S. Environmental Protection Agency's Facility Registration System contains data on the location and emissions of all facilities that must obtain federal air or water pollution permits, as well as brownfields and facilities reporting to the Toxic Release Inventory (TRI).[164] This data, plus monitoring data on conventional air pollutants like ozone and particulate matter, are also available through the state's Open Data portal.[165]

⇒ The biggest gap in data availability has to do with energy consumption information by sector and small-area geography such as neighborhoods or census tracts. It is possible that this data could be purchased from vendors such as Platts or EEI.

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[161] https://data.delaware.gov/Energy-and-Environment/Green-Energy-Program-Grants/nsgd-n2gb

[162] https://data.delaware.gov/Energy-and-Environment/Grants-for-Weatherization-Services/bggt-57c5

[163] https://data.delaware.gov/Energy-and-Environment/State-Rebates-for-Alternative-Fuel-Vehicles/8z8z-di7f and https://data.delaware.gov/Energy-and-Environment/Electric-Vehicle-Charging-Equipment-Rebates/a9zd-p6sk

[164] https://www.epa.gov/frs/epa-state-combined-csv-download-files

[165] https://data.delaware.gov/Energy-and-Environment/Toxics-Release-Inventory/9bws-2xkb and https://data.delaware.gov/Energy-and-Environment/Air-Quality-Monitoring-Network/b6hy-ss9q

5 Food system

5.1 Basics

5.1.1 Production

Farming is an integral aspect of Delaware's economy. "Agriculture is Delaware's largest single land use, with 41 percent of Delaware's land in farming. Delaware has about 2,450 farms. More than 115,000 acres of Delaware farmland is permanently preserved for agriculture."[166] About 90 percent of farms are either sole or family proprietorships or family-owned corporations.

The Delaware Center for Horticulture (DCH) has been playing an active role in promoting urban farming. Led by the late Wilmington City Councilman and neighborhood activist Eric Robinson and the 11th Street Bridge community, "The DCH facilitated the development of Wilmington's first urban farm in the spring of 2009. Consisting of 600 sq. ft. of intergenerational community garden space and 1,400 sq. ft. of commercial growing space, the E. D. Robinson Urban Farm at 12th & Brandywine supports a local food system providing residents with fresh fruits and vegetables while beautifying the local landscape."[167]

Another community gardening undertaking in Wilmington is the West Side Urban Agriculture Initiative. "It was launched in the year 2010, as a partnership between West End Neighborhood House's Bright Spot Ventures, West Side Grows Together, Public Allies Delaware, the Delaware Department of Agriculture, and Barclays Bank, in collaboration with many local community groups and the City of Wilmington."[168] Over 300 community members are involved in this community garden. A farmer's market created by one of the partners, Bright Spot Ventures, draws dozens of vendors and customers every week. Known as the Cool Springs Farmers market, this community gardening project has been a source of employment for the locals and raises awareness on employment opportunities and entrepreneurship to youth aging out of foster care. Bright Spot Ventures have also developed an urban farm to grow vegetables for sale. The West Side Urban Agriculture Initiative has also partnered with the Food Bank of Delaware to

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[166]

https://www.delawareonline.com/story/life/did-you-know/2014/11/12/delaware-agriculture-z/18899007/

[167] https://www.thedch.org/what-we-do/community-gardens/urban-farming

[168] The West Side Urban Agriculture Initiative Overview:
https://www.dropbox.com/s/ya8er2yuk6iac34/West%20Side%20Urban%20Agriculture.pdf?dl=0

create a Community Supported Agriculture (CSA) that "promotes food security among low-income families by providing access to fresh fruits and vegetables to more than 200 low-income families."[169]

The Urban Gardening Initiative is another program in Wilmington to mitigate food insecurity. It is a nonprofit organization started by Meghan Chen, a senior at Newark Charter School. It's mission is to, "inspire and empower youth to achieve urban sustainability though a gardening-based educational program."[170] It involves holding workshops at various high schools to educate the youth on sustainability and urban gardening. From what started from a high school, the organization now has extensive list of partners including the Sierra Club, the Nature Conservancy, the Delaware Center for Horticulture, Newark Natural Foods, Wilmington Green Box, the University of Delaware, the New Castle County Conservation District, the Delaware Nature Society, West Side Grows Together and the Delaware Community Foundation. Funding from the gardening comes from a variety of sources such as the Delaware Community Foundation, the New Castle County Conservation District, fundraising events and private donors, both individual and corporate.[171] The initiative now has more than 40 chapters from at least 16 states and eight countries, including India and the Philippines.[172]

Urban gardening has been on a rise in Wilmington. DCH alone has helped start 40 community gardens across New Castle County.[173] Many of these community gardens are established by transforming abandoned parking lots. Community gardens are also on the rise in east Wilmington and some community gardens such as Conscious Connections also use advanced hydroponic technologies.[174]

Second Chances Farm is another instance of hydroponic technology used for agricultural production in Wilmington. It is an indoor vertical farming establishment in the city where exclusively returning citizens that were previously incarcerated are hired at a livable wage in an effort to prevent recidivism and train a new generation of "agri-preneurs".[175] The establishment is a commercial scale for profit company and the first of its kind in Delaware. Vertical farming does come with a hefty initial capital investment but has the capacity to produce year-round high-quality produce and is said to consume less energy. As per their website, it delivers fresh greens four times a month at a cost of $99 for the whole month to its customers. Considering Wilmington's average income this is not an inexpensive price tag. While Second Chances Farm may not help a lot in mitigating food

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[169] The West Side Urban Agriculture Initiative Overview: https://www.dropbox.com/s/ya8er2yuk6iac34/West%20Side%20Urban%20Agriculture.pdf?dl=0

[170] https://www.theurbangardeninitiative.org/our-impact.html

[171] https://www.delawarepublic.org/post/urban-garden-initiative-finds-fertile-ground-effort-attack-food-deserts

[172] https://www.delawarepublic.org/post/urban-garden-initiative-finds-fertile-ground-effort-attack-food-deserts

[173] https://www.thedch.org/what-we-do/community-gardens/our-gardens-farms

[174] http://djph.delamed.org/V4_I2/PPH013.pdf

[175] www.secondchancefarm.com

insecurity issues in Wilmington, it provides employment opportunities to the community members and have been overall received favorably by the city government and locals alike.

The city prohibits residents from keeping farm animals including chickens, pigs, and goats within city limits, except at zoos and schools, at the farmer's market, at the port temporarily for import/export, and for a few other narrow exceptions.[176] Traditionally, these regulations were established to prevent nuisance from noise, smell, and waste of the farm animals.

5.1.2 Distribution

Storage- Food storage continues to be an issue in the city especially for the produce grown through community gardens. There are not many necessary resources and infrastructure to store produce leading to a lot of food waste. There is also a lack of energy efficient and cost-effective storage mechanism.[177]

5.1.2.1   Access to Food

"Of the 17 supermarkets with a Wilmington address, 71% (12) of the supermarkets are located in the greater Wilmington-area suburbs, which are predominantly White, while 29% (n=5) are located in areas with significant concentrations of minority residents. In contrast to supermarkets, the majority of small grocery/corner stores are located in minority communities. Eighty-five percent (n=53) of all small grocery/corner stores are located within the urban center of Wilmington. Only 15% (n=9) are located in the outlying Wilmington-area."[178]

As per various interviews with key stakeholders in Wilmington, access to healthy food was identified as a primary food related problem. Even with increasing community garden endeavors, storing food especially in food deserts has been a consistent problem in the city. Stakeholders identified Wilmington's main problem to be food desert with access to public transportation to grocery stores being very limited. [179] Problems pertaining to limited public transportation to food establishments seemed most prominent in the Northeastern part of the city. The price of healthy food being higher was also mentioned as a major barrier affecting the health of the citizens.

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[176] City of Wilmington code, Chapter 3, Article I, section 3-14.

[177] Interview 7,9

[178] Moss S. Food access in Wilmington, Delaware: A spatial analysis (Master's thesis: Urban Affairs and Public Policy) University of Delaware; Newark: 2015

[179] Interview 2,3,4,7,8,11

While access to food has been identified as a food related problem, lack of education on healthy food preparation has also been identified as an existing issue. In one such instance,[180] the term "education deserts" or the lack of education or time to understand the need of fresh fruits and vegetables and its impact on health and knowledge about healthy food, was also identified as a key issue. This can be traced back to the city's poverty as the interviewee stated that that the citizens often struggle with day-to-day survival needs and have very limited time for healthy meal preparation.

5.1.2.2   Food Trucks

Food trucks are an integral part of food distribution and food culture in Wilmington, Delaware. In 2015, the City of Wilmington passed a legislation to establish a pilot Mobile Food Truck Program. "The pilot program establishes a number of permanent parking spots on city streets, where food trucks will be able to reserve a parking spot and conduct their business."[181]

Allowable food truck locations have been determined by the Commissioner of the Department of Public Works. Various signs have been installed throughout the city to make the drivers aware of the restrictions on the parking spots. Three of the locations will be available for reservation from 7:00 a.m. - 3:00 p.m., and one location will be available in the evening from 6:00 p.m. - 1:00 a.m. The process of reserving the spot is fairly simply. Before reserving a spot, the interested person must obtain a Mobile Food Service Establishment License which is free of cost. Once the license is obtained, one can reserve a spot online through Lotmom.com and pay $22 a day and a small transaction fee for the website.[182]

5.1.3 Consumption

"3 in 10 adults in Delaware do not eat fruits or vegetables daily."[183]

5.1.3.1   Morbidity

In 2007, the national diabetes rate was 8%, compared to 9.2% in New Jersey and 8.7% in both Delaware and Pennsylvania. Wilmington has a higher than the national average diabetes rate of 8.4%, indicating that the overall consumption pattern of the Wilmington population could be improved.[184] In the same year, "Wilmington also has a higher than the national average obesity rate. Nationwide, about 62.9% of the population is either

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[180] Interview 8

[181] https://www.wilmingtonde.gov/business/mobile-food-truck-pilot-program

[182] https://www.wilmingtonde.gov/business/mobile-food-truck-pilot-program

[183] The West Side Urban Agriculture Initiative Overview:
https://www.dropbox.com/s/ya8er2yuk6iac34/West%20Side%20Urban%20Agriculture.pdf?dl=0

[184] Greater Philadelphia Food System Study

overweight or obese. Comparatively, about 63.7% of Wilmington's population suffers from obesity. While healthy eating has been a growing pattern in the Philadelphia metropolitan division, it has been decreasing in Wilmington."[185]

5.1.3.2   Food Security

Food security is a matter of concern for Delaware residents, especially in recent years. As of 2014, the number of state residents receiving supplemental food assistance (i.e., food stamps, SNAP) has nearly tripled from about a decade ago, compared to a relatively small increase of 14 percent in population. Also, in the same year 152,000 Delawareans – 17 percent of the population relied on government assistance for food. This figure is up from about 51,000 a decade ago.[186] "The state's food stamp rolls grew faster in the past decade, by 196 percent, than the national average of 124 percent."[187] And it far surpassed increases in neighboring Pennsylvania and New Jersey.[188]

 A census tract is considered low access if at least 500 people or 33% of the population in the tract are at least one mile from a supermarket or large grocery store (or ten miles if the tract is in a rural area).[189] According to a report published by the University of Delaware's Institute for Public Administration, 61% of Delawareans live in census tracts with no grocery store, and 27% live in census tracts with only one grocery store.[190]

Beginning in 2013, the Food Bank of Delaware partnered with the Wilmington Farmers Market at Cool Spring Park to offer a CSA available for purchase using SNAP benefits. The Supplemental Nutrition Assistance Program (SNAP) "is a food supplemental program that enables low-income families to buy a variety of food that is the basis for better nutrition. Benefits are issued electronically to the family's Delaware Food First card each month. This is an Electronic Benefits Transfer (EBT) card. The Food Supplement Program recipient uses this card at local grocery stores to access his/her food benefit."[191]

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[185] Greater Philadelphia Food System Study

[186] https://www.delawareonline.com/story/news/local/2014/03/08/food-stamp-use-increasing-in-delaware/621855/

[187] https://www.delawareonline.com/story/news/local/2014/03/08/food-stamp-use-increasing-in-delaware/621855/

[188] https://www.delawareonline.com/story/news/local/2014/03/08/food-stamp-use-increasing-in-delaware/6218559/

[189] United States Department of Agriculture. (2017). Food & Nutrition Assistance. Retrieved from https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/

[190] Jacobson, E., O'Hanlon, J., & Clark, A. (2011). Access to healthy foods in the built environment. Institute for Public Administration. Retrieved from www.ipa.udel.edu/publications/HealthPolicyIssueBrief3.pdf

[191] https://dhss.delaware.gov/dhss/dss/foodstamps.html

5.1.3.3   Food Prices

In terms of the Customer Price Index (CPI), the Philadelphia metropolitan division has seen a slower increase in food price as compared to cities like Boston and New York. As per the report published by Bureau of Labor Statistics on August 2018, the Consumer Price Index for All Urban Consumers (CPI-U) for Philadelphia-Camden-Wilmington increased up by 0.3 percent from June to August. It was also noted that the recent advance was led by an increase in the all items less food and energy index (0.3 percent). "The food index also increased by 0.9 percent, while the energy index declined down by 0.9 percent."[192]

As per the report, also states that "following a 0.2-percent decrease from April to June, the food index increased 0.9 percent over the last two months. Prices were higher for both food at home (1.1 percent) and food away from home (0.7 percent) since June. Within the food at home component, prices were higher for various items including breakfast cereal and carbonated drinks, while prices were lower for items including frozen and freeze- dried prepared foods. Over the year, the food index increased 0.8 percent. Prices for food away from home rose 1.1 percent, and those for food at home increased 0.6 percent."[193]

5.1.3.4   Waste

Wilmington experienced a massive failure in waste management at an industrial composting site located near the Port of Wilmington. Developed by the Peninsula Compost Group, the site was established with a capacity to receive 600 tons of separated organic material per day from government institutions, schools, and grocery stores from across the state. The facility commenced its services in 2009 composting about 200 tons of waste per day. Due to the lack of anticipated waste receival, the facility experienced immense economic pressure. Between 2012 and its closure in fall 2014, several complaints were filed pertaining to odor, and plastic and glass contamination in the compost. The odor especially permeated throughout the neighborhoods and businesses regardless of the existence of a buffer area around the plant. In 2014, DNREC refused to renew the operating permit.[194] The facility was shut after "reportedly missing penalty payment, waste removal and site cleanup deadlines and orders."[195]

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[192] ttps://www.bls.gov/regions/mid-atlantic/news-release/consumerpriceindex_philadelphia.htm

[193] ttps://www.bls.gov/regions/mid-atlantic/news-release/consumerpriceindex_philadelphia.htm

[194]

https://ilsr.org/failure-wilmington-compost-facility-underscores-locally-based-diverse-composting-infrastructure/

[195] https://www.delawareonline.com/story/news/local/2015/01/29/compost-plant-shutdown/22540935/

Workshop participants noted the need for renewed attention to organic waste disposal in the city, especially from its restaurants and other food establishments.[196] Participants articulated the need to connect excess food from restaurants and grocery stores that would otherwise be disposed with the food bank or other charities for low-income residents.[197]

5.2 Governance

5.2.1 Primary Institution

Food is fundamentally a decentralized system in Wilmington. Most governance of the system is private, through producers and distributors. Multiple federal and state agencies subsidizing food production or consumption to some degree, and multiple non-profit organizations operate to improve nutrition support especially for low-income populations. Few organizations target Wilmington city directly. No one institution in the area appears to coordinate efforts.

5.2.2 Other Institutions

5.2.2.1   Federal

The United States Department of Agriculture (USDA), Food & Nutrition Service (FNS), is the federal agency responsible for overseeing the Food Supplement Program. The eligibility criteria for this program requires the stipulated food benefit household. "A food benefit household is defined as a group of people who purchase and prepare food together."[198] Spouses and children under the age of 22 who live with their parents are considered as a food benefit household. US citizens and eligible aliens may apply for the program based on their income level and the number of people in their household.

"The Child and Adult Care Food Program (CACFP) is a USDA, federally-funded program administered by States, that provides reimbursement for meals served in child and adult day care institutions, also in family or group day care homes."[199] The nutritious meals provided leads to overall wellness and growth of children as well as contributes to better health amongst the older population. "Nationwide through CACFP, more than 3.3 million children and 120,000 adults receive nutritious meals and snacks each day as part of the care they receive. In Delaware, as of October 2014, over 923,000 meals were served in

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[196] Wilmington ULL1, 4/6/19.

[197] Wilmington ULL1, 4/6/19.

[198] https://www.benefits.gov/benefit/1240

[199]
https://www.wilmingtonde.gov/government/city-departments/parks-and-recreation/food-services-program

child care centers, adult day care centers, and in day care homes. In addition, At-Risk After-school suppers had over 3,200 in average daily attendance."[200] The CACFP provides services to various places from homes to day care centers, after-school program, and emergency shelters.

Similar to CACFP, the Summer Food Service Program (SFSP) is a USDA, federally-funded program administered by the states. However, it only operates in the summer months when the school is not in session. "Free meals, that meet Federal nutrition guidelines, are provided to all children, 18 years old and under, at approved SFSP sites in areas with significant concentrations of low-income children. "In Delaware, during the summer of 2016, over 720,000 meals (breakfast, lunch, snack, and supper) were served at over 350 statewide locations."[201] The program endeavors to provide students who have access to free or reduced-price meals during school sessions to have access to nutritious food during the summer break when the school is not in session.

The Special Supplemental Nutrition Program for Women, Infant and Children (WIC) is a USDA, federally-funded nutrition program that is also administered in the state of Delaware. Its main objective is to help pregnant women, new mothers, and young children learn more about nutritious food and staying healthy. WIC provides "nutritious food to supplement diets, information on staying healthy, breastfeeding support, and referrals to other healthcare, welfare, and social services."[202]

5.2.2.2   State - Agriculture

Delaware Department of Agriculture is the primary state government agency that provides various services ranging from educational programs for the consumers and farmers as well as dealing with matters pertaining to food products inspection. It facilitates the farm to school program, which aims to establish an integrated sustainable network that will enhance health and empower Delaware children to consume local products by means of a strong collaboration involving schools, farmers, and the communities they serve.[203] It assists farmers with grants and loans for "farming purposes, assists in farmland preservation where landowners can voluntarily sell the development rights for their farm through a permanent conservation easement among other services."[204] "The agency also works closely in providing the state with pesticide regulatory programs, which is

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[200]

https://www.wilmingtonde.gov/government/city-departments/parks-and-recreation/food-services-program
[201]

https://www.wilmingtonde.gov/government/city-departments/parks-and-recreation/food-services-program
[202] https://www.dhss.delaware.gov/dhss/dph/chca/dphwichominf01.html

[203] https://agriculture.delaware.gov/communications-marketing/farm-to-school/

[204] https://agriculture.delaware.gov/grants-loans/

educationally based equitably enforced, and protective of the environment, crops, property, and the health and welfare of all citizens."[205]

Delaware Council on Food and Farm Policy led by the Delaware Department of Agriculture is the state's new initiative to enable access to resources which allows residents to navigate challenges associated with securing nutritious and local food options, promoting healthy lifestyle as well as minimizing deficiency and vulnerability within communities.[206] It is a collective endeavor combining on the ground learning and government resources, connecting Delaware grown products within the community. This collaborative effort brings together "growers, producers, community members, businesses, non-profit leaders, public health advocates and individuals committed to advancing Delaware's top priorities surrounding food and farming."[207] Under this initiative, the council and DDA aims to "explore policy barriers, replicate program successes, and discover pressing challenges and opportunities that will support economic prosperity for the farming community and ensure healthy, affordable food for residents."[208]

5.2.2.3   State - Education

The Delaware Department of Education, Nutrition Programs Office, administers several federally-funded programs that provide healthy meals to students. The National School Lunch Program (USDA administered), School Breakfast Program (USDA administered), Child and Adult Care Program (USDA administered), Summer Food Service Program (USDA administered), Fresh Fruit and Vegetable Program, and Special Milk Program (USDA administered). These programs are administered to prevent childhood hunger as well as obesity and provide access to healthy meals to the children. The program works by reimbursing organizations like schools, after-school programs, and daycare centers (see prior section on Federal).

5.2.2.4   Non-Profit Organizations

The Food Bank of Delaware aims to provide nutritious food to Delawareans in need and facilitate long-term solutions to the problems of hunger and poverty through community education and advocacy. [209] It is a member of Feeding America and is a statewide nonprofit organization. The Food Bank of Delaware provides various services ranging

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[205] https://agriculture.delaware.gov/pesticide-management/

[206] https://news.delaware.gov/2018/08/28/delawares-council-farm-food-policy-advise-secretary-agriculture/

[207] https://news.delaware.gov/2018/08/28/delawares-council-farm-food-policy-advise-secretary-agriculture/

[208] https://news.delaware.gov/2018/08/28/delawares-council-farm-food-policy-advise-secretary-agriculture/

[209] https://www.fbd.org/about/

from children's nutrition programs, senior nutrition, school pantry, mobile pantry, among others. It works in partnership with 536 hunger relief program partners located throughout the state. These networks include food pantries, soup kitchens, emergency shelters, after-school programs, senior centers, and other feeding programs.[210]

Currently, the Food Bank has also been partnering with various community garden initiatives to help mitigate some of the food insecurity issues in Delaware. For instance, it has been working with Conscious Connections, an urban farming in the eastside community to develop a Produce Enterprise Center in order to create a food collection and distribution facility to service the specialty crop market in Delaware and the surrounding area. It aims to do so by providing a connection between commercial enterprises, institutions, consumers, and fresh fruit and vegetables growers of any scale.[211]

The Produce Enterprise Center will be a revenue generating extension of the Food Bank Delaware. It will make use of its existing supply chain infrastructure to "mitigate startup risks and overcome the market barriers to entry typically faced by an emerging food hub or distributor. The project will utilize dedicated staff and existing fleet and warehouse resources to conduct sales outreach and facilitate transactions between wholesale produce customers and specialty crop growers during Delaware's nine month productive season."[212] This center aims to create a more sustainable food distribution system and includes clean room for repacking bulk produce and value added processing for greater marketability, multiple temperature and climate controlled produce refrigeration units, setting up infrastructures that facilitates spacious new warehouse facility and qualified employees, as well as linkages to Food Bank Delaware's Culinary Enterprise Program for cross-functionality and revenue source.[213]

The Fruits and Vegetables Growers Association of Delaware (FVGAD) is a non-profit organization working to promote and encourage improvements in the production and marketing of all phases of the fruit and vegetable industry. It also promotes the increased consumption of fruits and vegetables as a part of a healthy diet and supports nutrition programs at providing increased access to fruits and vegetables to children. It seeks to "educate about the broad health benefits of fruits and vegetables. With increasing obesity and diabetic rate in the state, the organization attempts to encourage healthy eating habits in the state. Its membership consists of over 100 local fruit and vegetable growers, their families, employees, crop consultants, industry personnel, produce buyers,

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[210] https://www.fbd.org/partners/

[211] http://djph.delamed.org/V4_I2/PPH013.pdf

[212] http://djph.delamed.org/V4_I2/PPH013.pdf

[213] http://djph.delamed.org/V4_I2/PPH013.pdf

processors, suppliers, university and extension staff."[214] FVGAD participates in the farm to school initiative in Delaware.

Another nonprofit that has been active in the Wilmington food scene is the Food Trust, a nonprofit based in Philadelphia, Pennsylvania. It has been working with select corner stores across the city in an initiative called the Wilmington Healthy Corner Stores Network Program. Corner stores are the backbone of Wilmington's food supply chain and are an integral source of food especially for those who live in designated food deserts far away from conventional grocery stores and supermarkets and low-income residents without access to cars or public transportation. It is based on the Food Trust Healthy Corner Store Initiative, an initiative to increase the availability and awareness of healthy foods in corner stores through a multifaceted approach (thefoodtrust.org). It aims to increase store's capacity to sell and market healthy market items in order to improve healthy options in the community, offer training and technical assistance to the store owners in order to successfully sell healthy food items at their stores, assist with marketing, and ultimately provide equipment (shelving refrigerators and display shelves) to stock and display healthy products. The Wilmington Healthy Corner Store Program has run since 2015 and focused mostly on improving corner stores' inside environments. 20 stores in Wilmington participated in this program. As a result of this initiative, 71% of the enrolled stores sustained or increased their healthy food inventory at 2 years follow up. The initiative also provided spaces for local producers to sell their produce reducing the carbon footprint.

Wilmington Healthy Corner Stores Network Program collaborated with various community partners which showcases the effort of civic engagement. Some of its primary partners are Nemours Health and Prevention Services, Delaware Department of Agriculture (DDA), Delaware Extension, Kenny Family ShopRite and Christiana Care. The Food Trust is also working with local partners such as the Food Bank of Delaware, Center for Horticulture in order to continue to build local capacity to promote long-term sustainability of the initiative.[215]

5.3 Data governance

Food related data in the city is very decentralized. Data from the Census Bureau, USDA, maps of community garden and youth garden in the city, and data from the Urban Food and Farm Coalition are some of the popular resources for food related data for key stakeholders. WILMAPCO also collects and maps primary data and secondary data from USDA for a city level analysis. Data from DELCOT and DART also used to study food desert and access to transportation to food establishments in the city. There is a severe lack of data on the food production, consumption and distribution in the city level.

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[214] https://delawarefruitvegetable.wordpress.com/

[215] Personal Correspondence

Social media especially Facebook is increasingly being used to generate data (e.g., complaints regarding food establishments) and disseminate data collected. Phone calls, pamphlet, and surveys also being used to collect data. Similarly, public workshops, newsletters, health fairs, health education events organized in community centers, farmer's markets, community gardens, are also important tools for data collection and distribution.

Relevant data ranging from food desert, maps, access to public transportation, data on food inspection on food establishments throughout the state is publicly available online. Most data are published in the form of reports.

Appendix 1: Indicators

Indicator	Wilmington city	Delaware state	Share of DE
Population, 2000	72,664	783,600	9.3%
Population, 2010	70,851	897,934	7.9%
Population, 2016	71,502	934,695	7.6%
% White, 2016	33.8%	69.2%	
% Black, 2016	57.7%	21.7%	
% Hispanic or Latino (any race), 2016	12.2%	8.8%	
Housing Units, 2000	32,138	343,072	9.4%
Housing Units, 2010	32,820	405,885	8.1%
Housing Units, 2016	33,859	417,927	8.1%
Voting Age Population, 2016	52,299 (46% male, 54% female)	689,653 (47% male, 53% female)	7.6%
Area, land area (sq miles), 2000	10.85	1,953.56	0.5%
Area, land area (sq miles), 2010	10.90	1,948.54	0.5%
Population density, 2000 (psm)	6,698.1	401.1	16.7x
Population density, 2010 (psm)	6,497.6	460.8	14.1x
Housing density, 2000 (psm)	2,962.4	175.6	
Housing density, 2010 (psm)	3,009.9	208.3	

Sources: 2016 data from American Community Survey 5-year estimates; 2000 and 2010 data from Decennial Census -- all from factfinder.census.gov