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DRAFT

Social and Economic Factors Affecting the Attainment of Aquatic Life Uses in the Delaware River Estuary

Technical Report No. 2022-X

Managing, Protecting and Improving
the Water Resources of the
Delaware River Basin since 1961

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UNITED STATES OF AMERICA

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1. INTRODUCTION AND BACKGROUND

This report documents the process and results of an evaluation of the social and economic factors affecting the attainment of aquatic life uses in the Delaware River Estuary as required by Resolution No. 2017-4.

On September 13, 2017 the Commissioners of the Delaware River Basin Commission (DRBC) adopted Resolution No. 2017-4. That resolution recognized that evidence supports further study on the inclusion of propagation as a designated use in Zones 3 and 4 and the upper portion of Zone 5 of the Delaware River Estuary and identified additional studies to be undertaken in pursuit of such goal. The resolution directed the Executive Director to initiate DRBC rulemaking to revise the designated aquatic life uses consistent with the results of the studies and the objectives and goals of the federal Clean Water Act.

Included in the list of studies to be completed is an evaluation of the social and economic factors affecting the attainment of uses, as described in the U.S. Environmental Protection Agency's (EPA) water quality standards regulations at 40 CFR 131.10(g)(1)-(6). That regulation describes the factors that a state may consider in developing a use attainability analysis, including if meeting a use would cause substantial and widespread economic and social impact. While a use attainability analysis is typically performed by a state seeking to remove a use, an action not considered by Resolution No. 2017-4, it is apparent that the Commissioners intended for DRBC to utilize that framework in evaluating the social and economic impact of new proposed uses and associated effluent limits. The goal of this evaluation is to provide information on the social and economic impact of possible alternative uses for consideration and deliberation in rulemaking.

DRBC commissioned a Nitrogen Reduction Cost Estimation Study completed by Kleinfelder and published in 2021. In this study, Kleinfelder developed planning level cost estimates for the achievement of four new levels of effluent ammonia and total nitrogen concentrations for the Tier 1 wastewater treatment plants discharging to the Delaware River Estuary. Tier 1 facilities comprise 95% of the cumulative point discharge load for ammonia, TKN, and BOD5 based on the data set collected between 2011 and 2015.

More information is available at
https://www.nj.gov/drbc/library/documents/WQAC/082417/yagecic_point-source-monitoring.pdf.

During 2022, DRBC became aware that DELCORA sought to increase their permitted flow from 50 million gallons per day (MGD) to 70 MGD. DRBC commissioned Kleinfelder to develop an addendum to the 2021 report with new cost estimates for DELCORA reflecting the new proposed permitted flow.

The Tier 1 Utilities are:

- Camden County Municipal Utilities Authority (CCMUA)
- City of Trenton Sewer Utility
- Delaware County Regional Water Quality Control Authority (DELCORA)
- Gloucester County Utilities Authority (GCUA)
- Hamilton Township – Water Pollution Control Authority

- Lower Bucks County Joint Municipal Authority (LBCJMA)
- Morrisville Municipal Authority
- Philadelphia Water Department (PWD): NE, SE and SW Water Pollution Control Plants
- Willingboro Municipal Utilities Authority
- City of Wilmington, Department of Public Works

The ammonia effluent levels for Tier 1 Utilities and annualized treatment upgrade costs including operations and maintenance (in million $, 2019 dollars) are shown in Table 1 below:

Table 1: Annualized cost in 2019 (million $ / year) for new effluent concentrations

Utility	New Effluent Concentration			
	Ammonia 10 mg/L	**Ammonia 5 mg/L**	**Ammonia 1.5 mg/L**	**Total Nitrogen 4 mg/L**
Wilmington	6	20	26	49
CCMUA	12	15	18	35
City of Trenton	0.1	2	3	6
Hamilton Twp WPCF	3	4	4	7
Willingboro WPCF	0	0	2	3
DELCORA	4	11	14	27
Morrisville	2	2	3	5
LBCJMA	2	2	2	5
GCUA	3	4	5	11
PWD	32	50	84	179

This analysis follows several nationally published guidance documents and conducts a sensitivity analysis on the cost of treatment to each plant. To better describe cost burdens across each service area, individual indicators are mapped by census tract for each utility.

2. GUIDANCE AND APPROACH

Two primary guidance documents were utilized to implement the evaluation of social and economic factors affecting the attainment of uses. These were:

- EPA. ***Proposed 2022 Clean Water Act Financial Capability Assessment Guidance***. February 2022. https://www.epa.gov/system/files/documents/2022-02/2022-proposed-fca_feb-2022.pdf.

- AWWA et al. ***Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector***. April 17, 2019. https://www.awwa.org/Portals/0/AWWA/ETS/Resources/DevelopingNewFrameworkForAffordability.pdf?ver=2020-02-03-090519-813.

The EPA 2022 proposed guidance replaced a 2021 draft guidance document. However, we received feedback during the performance of this project from the regulated community that we should consider metrics and evaluations from the 2021 EPA proposed guidance where it differed from the 2022 proposed guidance. Therefore, we have also considered:

- EPA. ***2021 Financial Capability Assessment Guidance*** (800B21001). January 2021. https://www.epa.gov/sites/default/files/2021-01/documents/2021_fca_guidance_-_january_13_2021_final_prepub.pdf.

In particular, two indicators in the 2021 guidance were removed from the 2022 guidance. These were the Lowest Quintile Residential Indicator and the Poverty Indicator Score. They are included here.

In the remainder of this document, we refer to the 3 guidance documents by abbreviated names. EPA's Proposed 2022 Clean Water Act Financial Capability Assessment Guidance is referred to as "EPA 2022" and the superseded version is referred to as "EPA 2021." The AWWA et al document entitled Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector is referred to as "AWWA 2019."

The assessments and tools in the guidance documents were originally intended for use by utilities in documenting the impact of compliance with new Clean Water Act limits so that utilities could coordinate appropriate compliance periods with regulators. As a regulatory entity, our use of these same tools serves a different function. Instead, we are using these available tools to evaluate the social and economic factors affecting the attainment of uses and communicate that to decision makers in their deliberations regarding the highest attainable dissolved oxygen condition. Some metrics and tools in the guidance documents work well for this alternative use, but others do not. Specifically, the *New Framework* guidance includes an approach to cash flow forecasting, which we determined to be outside the scope of our task.

The Residential Indicator and Financial Capability Index have been used to assess household affordability and ability of the utility and community within the service area to assume increased revenue and financing to cover increased costs. AWWA 2019 expanded the indicators based on the inadequacy of the median household income to relate the economic distress in various income groups. Several indicators have been included in this analysis to better gauge impacts on economically disadvantage communities and to account for the differences in water affordability in the utility service areas.

The total list of indicators considered and presented in this document include:

- Household Burden Indicator (AWWA 2019)
- Poverty Prevalence Indicator (AWWA 2019)
- Household Affordability Score (AWWA 2019)
- Lowest Quintile Residential Indicator (EPA 2021)
- Poverty Indicator Score (EPA 2021)
- Residential Indicator Score (EPA 2022)

Financial Capability Indicators:

- Debt Indicators Summary Bond Rating Score (EPA 2022)
- Net Debt as a Percentage of Full Market Property Value (EPA 2022)

Socioeconomic Indicators:

- Service Area Unemployment Rate with Comparison to National Average (EPA 2022)
- Service Area Median Household Income with Comparison to National Average (EPA 2022)

Financial Management Indicators:

- Property Tax Revenue as a Percent of Full Market Property Value (EPA 2022)
- Property Tax Revenue Collection Score (EPA 2022)

The DRBC-commissioned study by Kleinfelder (2021), titled Nitrogen Reduction Cost Estimation Study, was used to estimate the costs in this analysis to individual households of the four effluent treatment levels. The capital costs are wastewater plant specific developed using national cost estimating criteria (Association for the Advancement of Cost Engineering - Level 4), generated from general plant estimates and national indexes, and are considered budgetary capital cost estimates in 2019 dollars. Debt service on capital cost assumes a bond term of 30 years at an interest rate of 5%. The costs include a 25-year operating period, individual plant capital costs, adjustment factors, operations, maintenance, and present and annualized costs. The total annualized cost is the sum of the debt service corresponding to the plant specific capital cost plus the annual operations and maintenance cost.

Of all the indicators listed above, two allow direct relative comparison of different effluent treatment scenario costs with each other and with the baseline condition before any additional effluent treatment cost. These two indicators are:

- Household Affordability Score (AWWA 2019); and
- Residential Indicator Score (EPA 2022)

Results of those two indicators are provided in the main body of this text. All other indicators including intermediate indicators need to evaluate the Household Affordability Score and the Residential Indicator Score are provided in Appendix A.

2.1 COVID-19 IMPACT AND 5-YEAR WINDOW

The onset of COVID-19 substantially impacted many communities' economic indicators. One example of this is the time series for national unemployment rate, as shown in Figure 1 below. The long-term impact of COVID-19 is uncertain.

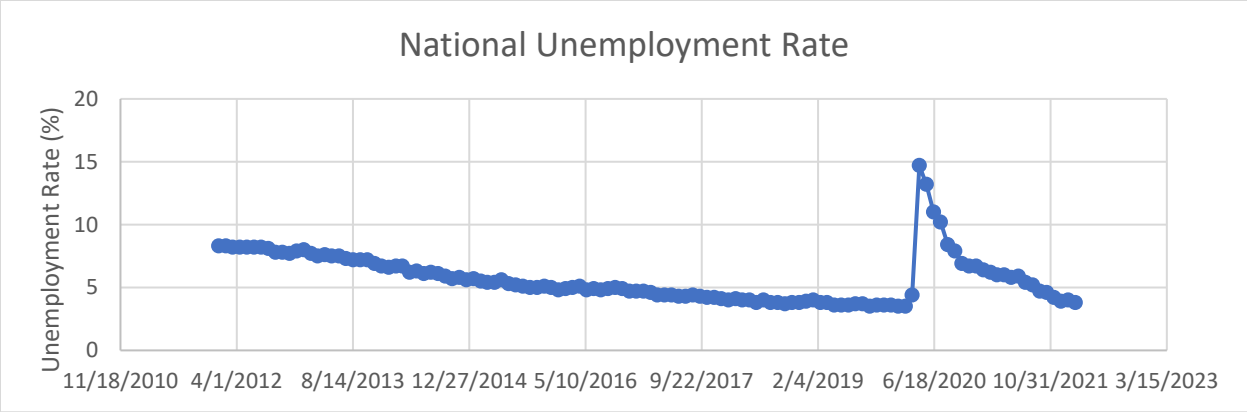

Figure 1: National* unemployment *rate and impact of COVID-19

Initial efforts in socio-economic evaluation utilized data from the American Community Survey through 2019, prior to the onset of COVID-19. In March of 2022, the U.S. Census Bureau released a new 5-year American Community Survey through the year 2020. This data set at least includes the onset of COVID-19. We expect, therefore, that this data set is more representative of current population characteristics than the pre-COVID-19 data set.

2.2 DATA & INFORMATION SOURCES

Information to compute the indicators in the guidance documents comes primarily from two sources:

1. U.S. Census Bureau
2. The Tier 1 Utilities

U.S. Census Bureau data is from the American Community Survey representing the 5-year period through the year 2020.

Data was downloaded by census tract. According to the U.S. Census Bureau, census tracts are small, relatively permanent statistical subdivisions of a county or statistically equivalent entity. Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people. The spatial size of census tracts varies widely depending on the density of settlement.

We compared the spatial extent of sewer service areas to the census tracts to map the composition of sewer service area by the census tracts that make up that area. Where a tract straddled the boundary of a sewer service area, we weighted the population of the tract by the proportion of the spatial area within the sewer service area. In other words, a tract that was 25% within the service area received a 25% weighting, while a tract that was 100% within the service area received a 100% weighting.

Census data is distributed among multiple tables. An index of the census tables, characteristics used from each table, and corresponding code and Table Key (field) for this project is presented in Table 2 below.

The current set of data tables used were downloaded between March 17, 2022, and June 4, 2022 from https://data.census.gov/cedsci/advanced.

Table 2: Census table index

Table	Characteristic	Code	Table Key
DP03	Population 16 years and over	POP16	DP03_0001E
DP03	Median Household Income	MHI	DP03_0062E
DP03	Percent Food Stamp/SNAP benefits	ASSIST	DP03_0074PE
DP03	Unemployment Rate	UNEMP	DP03_0005PE
S1101	Average Household Size	AVHHSIZE	S1101_C01_002E
S0101	Median Age	MEDAGE	S0101_C01_032E
S1701	Population for Whom Poverty Status is Determined (Estimate Value)	POVSTATUS	S1701_C01_001E
S1701	Population for Whom Poverty Status is Determine: Below poverty level estimate	BPL	S1701_C02_001E
S1701	All individuals with incomes below the following poverty levels: 150% (Estimate value)	IBPL150	S1701_C01_040E
S1701	All individuals with incomes below the following poverty levels:200% (Estimate Value)	IBPL200	S1701_C01_042E
B19080	Lowest Quintile Upper Limit	LQUL	B19080_001E
B25002	Number of Occupied Housing Units	HH	B25002_002E
B25002_5YO	Number of Occupied Housing Units from 5 Year Old Survey	HH5YO	B25002_002E
S2201	Percent households receiving food stamps/SNAP	ASSIST_S22	S2201_C04_001E
B19082	Quintile Share of Aggregate Income: Lowest Quintile	LOQUINTAGG	B19082_001E

In addition to the census data, DRBC obtained supplemental information from each of the Tier 1 wastewater utilities. Utilities provided (where applicable) information on water, wastewater, and stormwater billing rates, taxes, operation and maintenance expenses, debt service, bond ratings, debt, and related information.

2.3 ASSUMPTIONS AND ESTIMATIONS

Specific assumptions and estimations associated with computing indicators are described below.

2.3.1 Gallons Per Capita Per Day

A 2018 Rutgers University Report (Van Abs, 2018) entitled "Water Needs through 2040 for New Jersey Public Community Water Supply System" prepared for the New Jersey Department of Environmental Protection estimated that residential demand for water varied by housing density. Communities with lower housing density (and more lawn and associated landscape) demonstrated a higher per person water demand. The summary annual average gallons per capita per day from that report is reproduced here in Table 3.

Table 3: Average annual residential per capita demands by housing density

Housing Density	Weighted Average (gallons)
High	40.89
Medium	60.79
Low	87.10

That same report classified housing density according to the following housing units per acre:

- High: ≥ 5 units per acre
- Medium: > 2 < 5 units per acre
- Low/Rural: ≤ 2 units per acre

We computed the occupied housing units per acres land area for each census tract to estimate the categorical assignment of High, Medium, or Low-density housing resulting in the classifications shown in Figure 2 below.

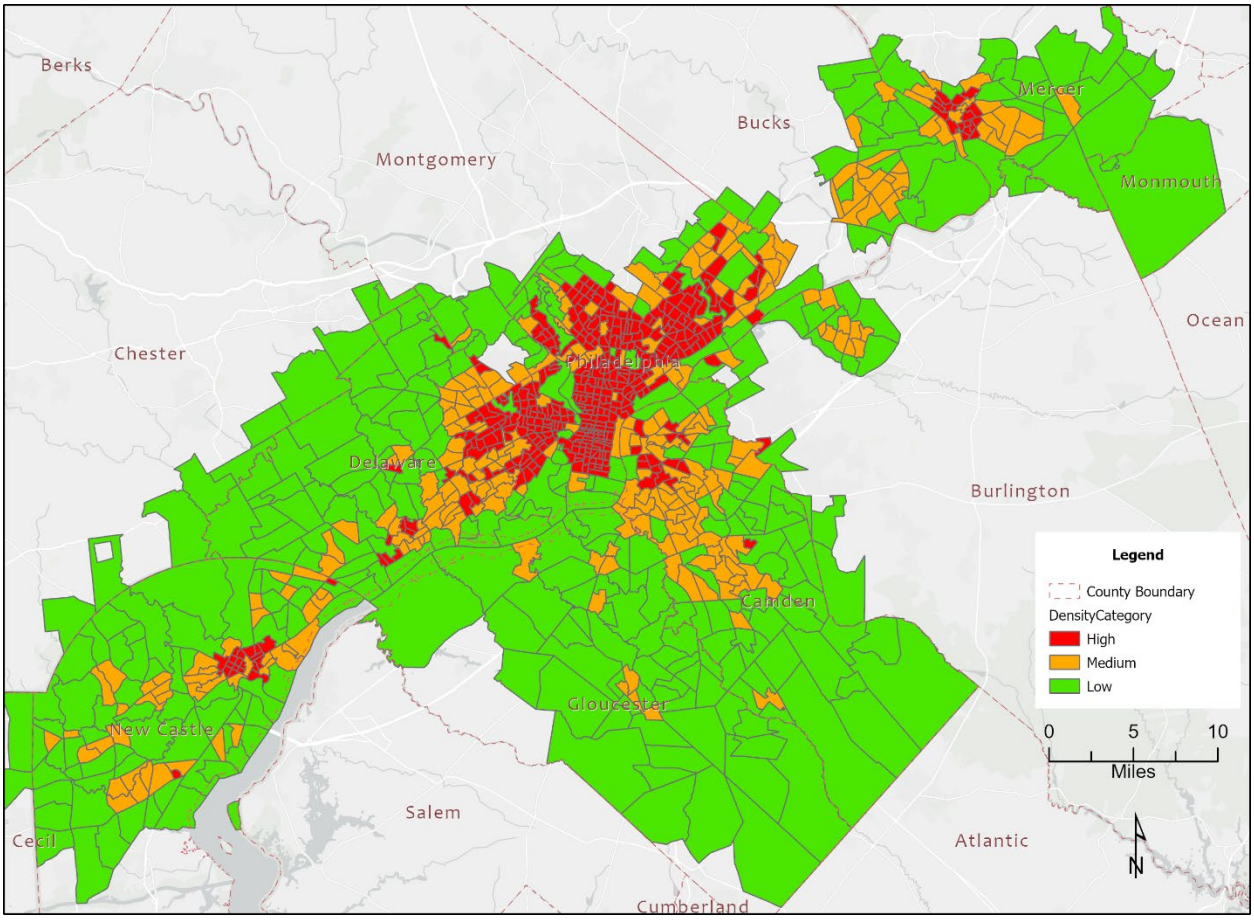

Figure 2: Estimated housing density categories for each census tract

From these categorical housing density assignments, and the associated per capita water demands shown in Table 3, we computed the population weighted average gallons per capita per day based on housing density (PWGPCD) for each sewer service area, as shown in Table 4 below.

Table 4: Population weighted average gallons per capita per day based on housing density

Utility Name	PWGPCD
CCMUA	57.20264
City of Trenton	49.89075
DELCORA	56.58199
GCUA	64.75537
Hamilton Twp WPCF	59.64895
LBCJMA	52.75745
Morrisville	62.3803
PWD	50.21654
Willingboro WPCF	56.51461
Wilmington	61.37455

2.3.2 Total Cost of Water

For a household, the annual total cost of water would be equal to the annual billing for drinking water, wastewater treatment and sewer, and stormwater.

The volume of water used per year per household is estimated to be the service area specific PWGPCD X 2.65 individuals per household x 365 days per year. Consistent with other DRBC programs, we assumed a 10% consumptive use rate, resulting in per capita wastewater production equal to 0.9 * PWGPCD. Stormwater fees (where applicable) are assumed to be a fixed monthly fee disconnected from water usage. Other monthly fixed billing rates were also considered, as provided by the utility or estimated from published rates.

Some utilities are full-service water utilities, providing both drinking water and sewer and wastewater services. Other utilities provide only the wastewater and sewer services, with drinking water provided and billed by a separate drinking water provider or multiple providers within the utility service area. Estimated annual representative costs for drinking water are shown in Table 5 below. For utilities with multiple separate drinking water providers within the utility service area, we estimated the representative cost of drinking water using population served and published fixed and per gallon rates from the drinking water provider, where available. Although any individual household may pay more or less for drinking water, these values are estimated to be a reasonable indication of representative drinking water cost.

Table 5: Cost unit rates by service area

SSA name	Water ($/gallon)	Wastewater ($/gallon)	Stormwater ($/household/month)	Notes
Wilmington	$0.0082	$0.0060	$7.32	All estimated from data provided by the utility
PWD	$0.0062	$0.0045	$15.04	All provided by the utility
CCMUA	$0.00907	$0.00979	$0	All provided by the utility
City of Trenton	$0.0078	$0.00585	$0	Estimated on behalf of Trenton from partial data provided by the utility
Hamilton Twp WPCF	$0.00996	$0.00717328	$0.858455	Wastewater provided by utility. Stormwater estimated from data provided by utility. Water rate estimated from GIS analysis of water suppliers and available published rates.
Willingboro WPCF	$0.007952	$0.00634	$0	All provided by the utility
DELCORA	$ 0.00953	$0.0159	$1.40	Wastewater and stormwater estimated from data provided by utility. Water rate estimated from GIS analysis of water suppliers and available published rates.
Morrisville	$0.00963	$0.00746	$0	All provided by the utility
LBCJMA	$0.00323	$0.00539	$0	All provided by the utility, adjusted for units
GCUA	$0.005066	$0.003272	$0	Wastewater and stormwater provided by utility. Water rate estimated from GIS analysis of water suppliers and available published rates.

Altogether, we estimated the annual Total Cost of Water (Drinking Water + Wastewater & Sewer + Stormwater + Other Associated Fees) per household in each service area as shown in Figure 3. This Total Cost of Water represents the baseline, prior to any increased cost associated with new effluent limits for ammonia or total nitrogen.

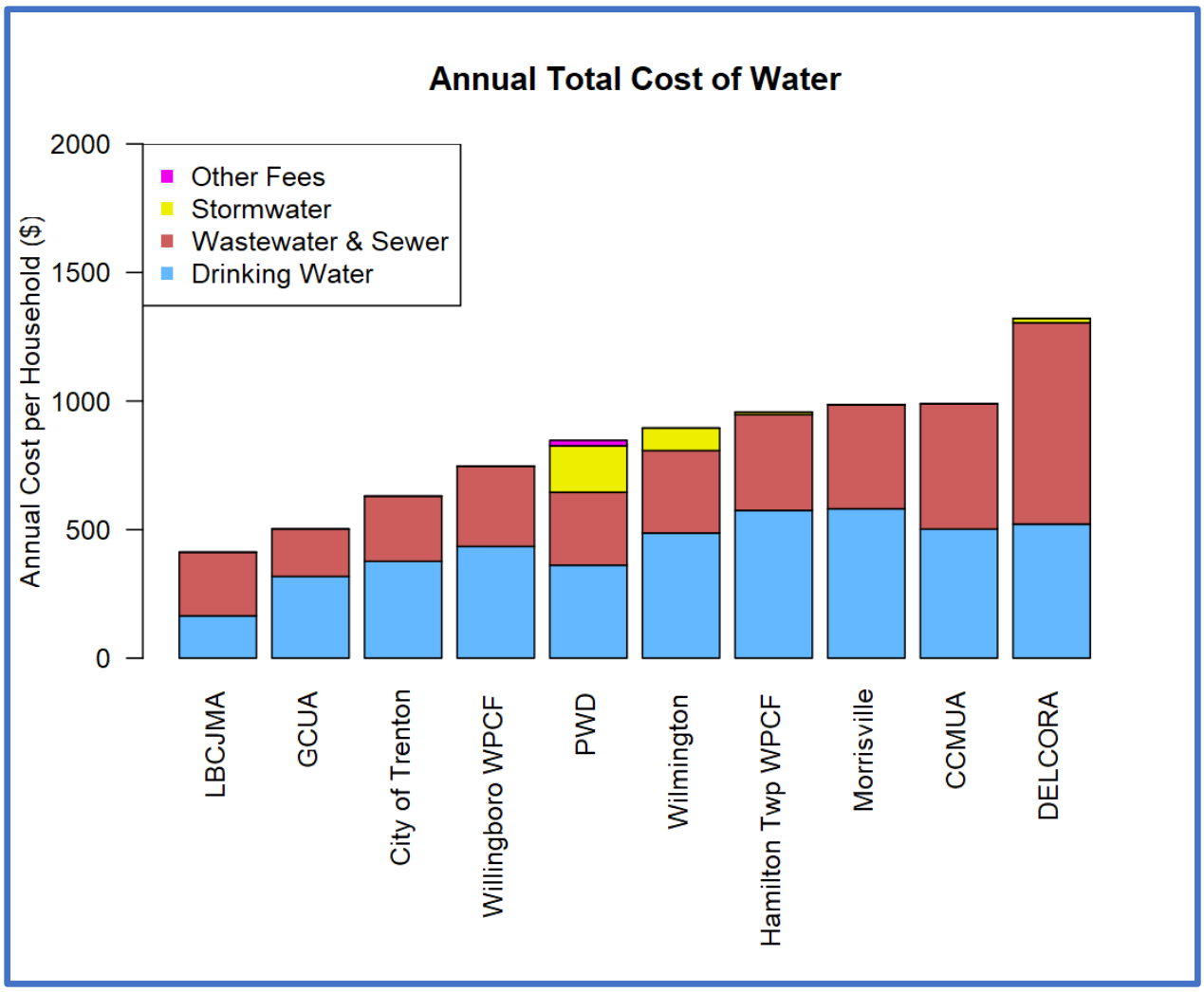

Figure 3: Estimated annual total cost of water by service area and water service

2.3.3 Residential Share of new WWTP Costs

Early in the coordination for this report, utilities indicated that the allocation of additional cost among commercial, industrial, and residential users was unknown. In the absence of other utility-specific information, we assumed that the residential share of new WWTP costs would be 100%. This is certainly overly conservative, but it provides a worst-case evaluation of the residential impact of these new costs.

We anticipate that individual utilities will have options for distributing additional costs among commercial, industrial, and contract customers. Later in this report, we estimate and evaluate the contribution of

sewage flow from residential users to attempt distinguish residential and non-residential (i.e., commercial, industrial and contracted) customers for each utility.

2.4 EXCEPTIONS, CAVEATS, AND SPECIAL CASES

We attempted to estimate indicators for each utility so the estimates are comparable. However, there are some circumstances that should be noted that may impact results.

2.4.1 Status of CSO Programs

The utilities that have combined sewer overflow (CSO) programs (PWD, CCMUA, Wilmington, DELCORA, and to a lesser degree Trenton), are in different stages of their CSO reduction programs. Some utilities (such as DELCORA) reported the anticipated increased costs for addressing CSOs in their wastewater rates. Other utilities have not incorporated those costs into their rates yet but will do so in the future.

2.4.2 DELCORA

DELCORA's total service area includes a Chester City subarea and a Model Area subarea with substantially different values for the requested data. However, additional cost associated with improved effluent nitrogen concentrations would apply at the treatment plant (not to individual subareas of the service area). To appropriately estimate the impact of these possible effluent improvements, we needed to combine the two subareas into one representative service area. We used the equivalent households for each subarea to estimate approximate percentage that each subarea contributed to the total service area.

2.4.3 Taxing Authority

Some indicators are not applicable due to the legal and institutional framework the utility operates under. For example, CCUMA does not have taxing authority. Therefore, the indicators including taxes or the percent debt to property value ratio are not indication of capacity to increase revenue.

2.5 QUALITY MANAGEMENT APPROACH

Estimation of each indicator for each service area for all effluent scenarios is computationally intensive. To minimize error, we employed several cross-checks.

- A subset of computations was independently manually produced by a separate staff member and compared with the scripted results. If differences were observed, the source of difference was identified and resolved. When no differences were noted, the results of the comparison were documented.
- For the largest and most complicated utilities, we presented draft results prior to development of the report. We specifically sought and received feedback regarding areas where our estimations

differed from the expectations of the utilities themselves. Pre-report meetings were held with Wilmington, DELCORA, PWD, CCMUA, and Trenton.

- DRBC retained the Environmental Finance Center at the University of Maryland to perform a technical review of the resulting work.

3. INDICATOR RESULTS

The following section documents the computation of the indicators and the results.

3.1 COST PER HOUSEHOLD

The first step in computing many of the indicators is to estimate the Cost Per Household for new wastewater treatment resulting in the effluent levels from Table 1. This is accomplished by dividing the annualized cost from the Kleinfelder (2021) report by the number of households in the service area and adding that cost to the baseline cost. Estimated annual cost per household for both baseline conditions (prior to new wastewater treatment) and the four new effluent levels estimated in the Nitrogen Reduction Cost Estimation Study by Kleinfelder are shown in Table 6 below and represented in Figure 4.

Table 6: Estimated annual baseline and new wastewater treatment cost per household

Utility Name	Baseline*	Ammonia 10 mg/L	Ammonia 5 mg/L	Ammonia 1.5 mg/L	TN 4 mg/L
CCMUA	$989.34	$1,084.01	$1,107.68	$1,131.35	$1,265.47
City of Trenton	$630.48	$635.04	$721.69	$767.29	$904.11
DELCORA	$1,321.54	$1337.4	$1,365.17	$1,377.07	$1,428.63
GCUA	$502	$557.05	$575.4	$593.75	$703.85
Hamilton Twp WPCF	$957.26	$1,081.24	$1,122.57	$1,122.57	$1,246.56
LBCJMA	$412.37	$537.25	$537.25	$537.25	$724.58
Morrisville	$986.15	$1,172.48	$1,172.48	$1,265.64	$1,451.96
PWD	$847.55	$914.27	$951.81	$1,022.7	$1,220.77
Willingboro WPCF	$746.49	$746.49	$746.49	$920.98	$1,008.22
Wilmington	$895.2	$944.78	$1,060.47	$1,110.05	$1,300.12

*Baseline: Drinking Water + Wastewater & Sewer + Stormwater + Other Associated Fees

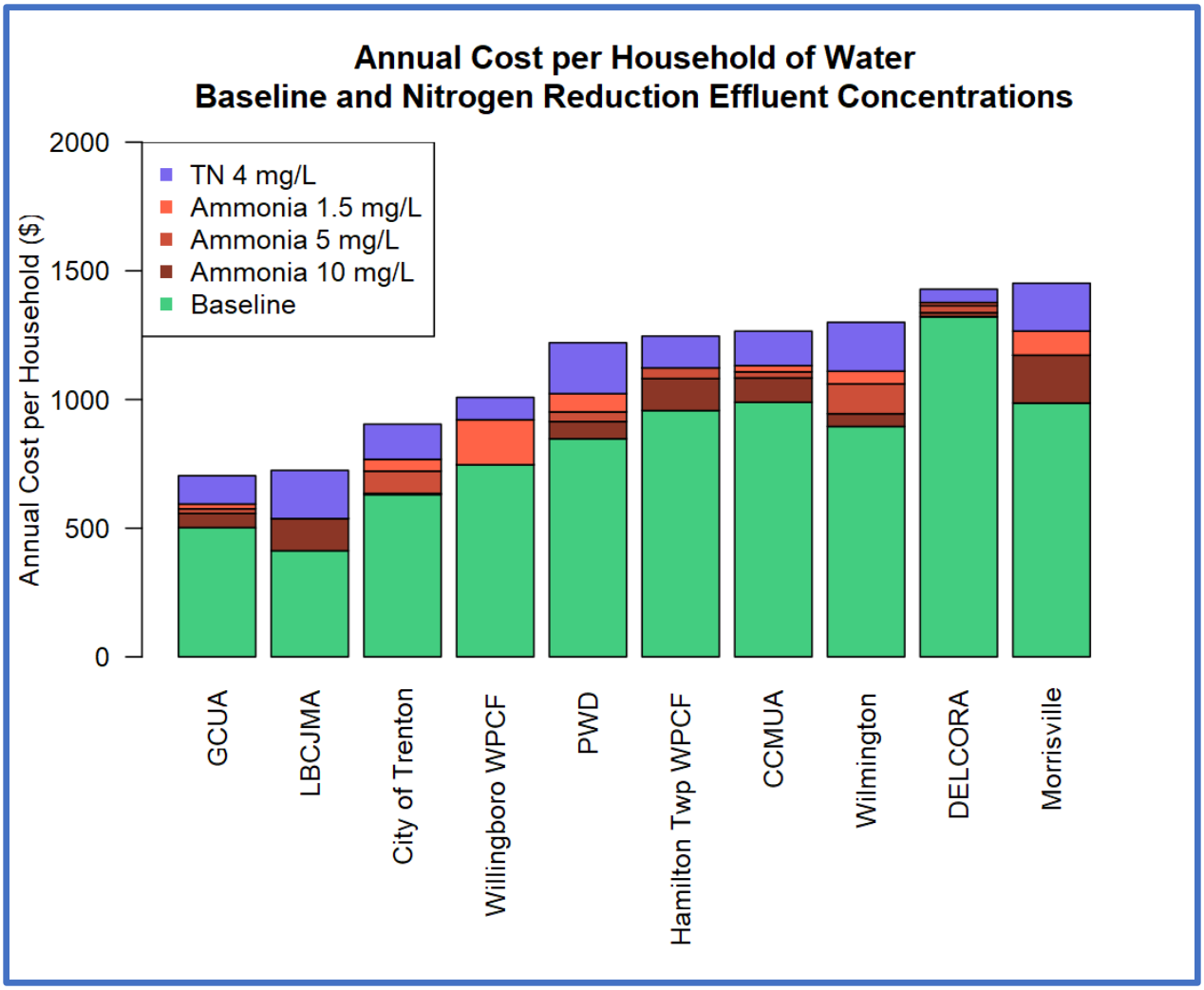

Figure 4: Baseline and new wastewater treatment cost per household

3.2 HOUSEHOLD AFFORDABILITY SCORE

The household affordability score is described in the AWWA 2019. It combines two indicators, the Household Burden Indicator (HBI), which changes relative to the Cost Per Household shown in Appendix A, and the Poverty Prevalence Indicator (PPI) which is independent of the Cost Per Household.

HBI and PPI are interpreted as a range of financial impact to households as shown in the matrix shown in Table 7 below. Generally, the higher the percent poverty and higher the percent total water cost to the low income quintile, the higher the burden on the low income households in the service area. The Benchmark for Household Affordability Score, has possible outcomes of:

- Low Burden;
- Moderate Low Burden;
- Moderate High burden;
- High Burden; or
- Very High Burden.

Table 7: Benchmarks for household affordability from AWWA 2019

HBI - Water Costs as a Percent of Income at LQI	PPI - Percent of Households Below 200% of FPL		
	>=35%	20% to 35%	<20%
>=10%	Very High Burden	High Burden	Moderate-High Burden
7% to 10%	High Burden	Moderate-High Burden	Moderate-Low Burden
< 7%	Moderate-High Burden	Moderate-Low Burden	Low Burden

Resulting Household Affordability Benchmarks for each service area and effluent scenario are shown in Table 8 below.

Table 8: Household affordability score

Utility Name	Baseline	Ammonia 10 mg/L	Ammonia 5 mg/L	Ammonia 1.5 mg/L	Total Nitrogen 4 mg/L
CCMUA	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
City of Trenton	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden
DELCORA	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
GCUA	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
Hamilton Twp WPCF	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
LBCJMA	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
Morrisville	Low Burden	Low Burden	Low Burden	Low Burden	Low Burden
PWD	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	Moderate-High Burden	High Burden
Willingboro WPCF	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden
Wilmington	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden	Moderate-Low Burden

3.3 RESIDENTIAL INDICATOR

The Residential Indicator (RI) is described in the EPA 2022 Guidance. To calculate the RI, the baseline and baseline plus the New Wastewater Treatment Cost (cost per household or CPH) is compared to the median household income (MHI) of a utility's service area (Appendix A). This calculation produces the percentage of median household income spent on water and/or wastewater. The low financial impact indicates that utilities may be in good position to afford compliance. Mid and high financial impact scores indicate that the average costs per household (based on MHI) may produce an economic hardship in compliance. This indicator is used with the Financial Capability indicators to further describe a utility's position to absorb increased costs of compliance. This result is scored with three possible financial impact categories as shown below:

- Low (CPH less than 1 % of MHI)
- Mid-Range (CPH 1 to 2% of MHI)
- High (CPH greater than 2% of MHI)

Residential Indicator Results for each service area and each scenario are shown in Table 9 below.

Table 9: Residential indicator score

Utility	Baseline	Ammonia 10 mg/L	Ammonia 5 mg/L	Ammonia 1.5 mg/L	Total Nitrogen 4 mg/L
CCMUA	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
City of Trenton	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	HIGH
DELCORA	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
GCUA	LOW	LOW	LOW	LOW	LOW
Hamilton Twp WPCF	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE
LBCJMA	LOW	LOW	LOW	LOW	LOW
Morrisville	LOW	LOW	LOW	MID-RANGE	MID-RANGE
PWD	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	HIGH
Willingboro WPCF	LOW	LOW	LOW	MID-RANGE	MID-RANGE
Wilmington	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE	MID-RANGE

3.4 EVALUATION OF SELECT PWD ALTERNATIVES

PWD is one utility with three separate wastewater treatment facilities (Northeast, Southeast, and Southwest). In the previous section, results were shown for scenarios where all three PWD facilities were set at the same effluent level (10, 5, or 1.5 mg/L ammonia, or 4 mg/L TN). However, it would be possible that different effluent levels could be selected for the different facilities. In this section, we evaluate a selected subset of these alternative. For each of three wastewater treatment facilities, there are five possible states (the four effluent limits defined in the Kleinfelder report plus the current condition with no change in effluent concentration), so the total number of possible arrangements is 5^3, or 125. Of these, we evaluated the following possible arrangements:

- **PWD_Alt1**: PWD-Southwest at 1.5 mg/L of Ammonia, with PWD-Southeast and PWD-Northeast at 5 mg/L ammonia
- **PWD_Alt2**: PWD-Southwest at 1.5 mg/L of Ammonia, with PWD-Southeast and PWD-Northeast at 10 mg/L ammonia
- **PWD_Alt3**: PWD-Southwest at 1.5 mg/L of Ammonia, with no change (Base case) to PWD-Southeast and Northeast

Not all indicators are directly impacted by the level of cost associated with new effluent requirements. Unemployment rate and median household income, for example, are independent of effluent cost and would not change in response to alternative effluent arrangements. Only the indicators which could change in response to alternative effluent combinations were considered. These include:

- Household Affordability (National Framework)
- Residential Indicator (EPA)

Results of the three alternative PWD scenarios, along with the baseline and new wastewater treatment level results for Household Affordability and Residential Indicator are shown in Table 10 below. The scored results for the Household Affordability and Residential Indicators were not different than for the baseline or for Ammonia at 10 through 1.5 mg/L. Only the Total Nitrogen at 4 mg/L yielded a score indicating a higher level of impact.

Table 10: Results of PWD alternative scenarios for household affordability indicator and residential indicator

Scenario	Household Affordability	Residential Indicator
Baseline	Moderate-High Burden	MID-RANGE
Ammonia 10 mg/L	Moderate-High Burden	MID-RANGE
Ammonia 5 mg/L	Moderate-High Burden	MID-RANGE
Ammonia 1.5 mg/L	Moderate-High Burden	MID-RANGE
Total Nitrogen 4 mg/L	**High Burden**	**HIGH**
PWD_Alt1	Moderate-High Burden	MID-RANGE
PWD_Alt2	Moderate-High Burden	MID-RANGE
PWD_Alt3	Moderate-High Burden	MID-RANGE

3.5 SENSITIVITY ANALYSIS

During review of the draft Nitrogen Reduction Cost Estimation Study by Kleinfelder, EPA and other commentors questioned the assumed 5% interest rate for calculating the debt service. They noted that Clean Water State Revolving Fund (CWSRF) historical interest rates in PA, NJ, and DE were lower than the assumed rate. In addition, they questioned the assumed 30-year repayment period, observing that shorter repayment periods are common.

To address these concerns, DRBC agreed to perform a Monte Carlo analysis to estimate the distribution of annualized costs under uncertainty. Monte Carlo analysis is a tool for estimating the distributions of computed values under uncertainty by repeatedly sampling plausible values from input distributions and applying them to equations for estimating the desired output. The resulting output distribution provides a sense of the likelihood of different possible output values. Because the Monte Carlo analysis was performed prior to the amended estimation for DELCORA's higher permitted flow, it considers the permitted flow associated costs from the original 2021 Kleinfelder report.

We performed 10,000 iterations for each facility and each wastewater treatment level solving the following equation for the annualized cost (A) using the present worth value (P) provided in the Kleinfelder report. In this equation, the uncertain variables are the interest rate (i) and the repayment period (n).

$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

We sampled with replacement the state-specific historic CWSRF rates from 1991 through 2020 for each facility and sampled with replacement repayment periods of 20, 25, or 30 years yielding 10,000 alternative annualized costs for each facility and effluent level.

From these distributions, we selected the median annualized cost for 1.5 mg/L Ammonia for each facility for comparison with the Kleinfelder annualized costs.

Table 11: Comparison of median monte carlo computed and published annualized costs for 1.5 mg/L ammonia

Utility Name	Median Monte Carlo Annualized Cost	Kleinfelder Annualized Cost
CCMUA	15.754	18
Wilmington	20.71	26
DELCORA	8.139	10
GCUA	4.846	5
Hamilton	3.714	4
LBCJMA	2.287	2
Morrisville	2.273	3
Trenton	2.681	3
Willingboro	1.587	2
PWD	69.806	84

We then re-computed key indicators using the Monte Carlo-computed annualized costs in place of the Kleinfelder estimated annualized costs and compared the indicator results. Of all the indicators considered elsewhere in this report, Household Affordability Indicator and Residential Indicator are responsive to effluent cost. No change in score was noted for any facility at the 1.5 mg/L Ammonia effluent level. Results are shown in Tables 11, 12, and 13.

Table 12: Household affordability indicator comparison for monte carlo computed and published ammonia 1.5 mg/L costs

Utility Name	Household Affordability based on Published Ammonia 1.5 mg/L Cost	Household Affordability based on MC Median Ammonia 1.5 mg/L Cost
CCMUA	Moderate-Low Burden	Moderate-Low Burden
City of Trenton	Moderate-High Burden	Moderate-High Burden
DELCORA	Moderate-Low Burden	Moderate-Low Burden
GCUA	Low Burden	Low Burden
Hamilton Twp WPCF	Low Burden	Low Burden
LBCJMA	Low Burden	Low Burden
Morrisville	Low Burden	Low Burden
PWD	Moderate-High Burden	Moderate-High Burden
Willingboro WPCF	Moderate-Low Burden	Moderate-Low Burden
Wilmington	Moderate-Low Burden	Moderate-Low Burden

Table 13: Residential indicator comparison for monte carlo computed and published ammonia 1.5 mg/L costs

Utility Name	Residential Indicator based on Published Ammonia 1.5 mg/L Cost	Residential Indicator based on MC Median Ammonia 1.5 mg/L Cost
CCMUA	MID-RANGE	MID-RANGE
City of Trenton	MID-RANGE	MID-RANGE
DELCORA	MID-RANGE	MID-RANGE
GCUA	LOW	LOW
Hamilton Twp WPCF	MID-RANGE	MID-RANGE
LBCJMA	LOW	LOW
Morrisville	LOW	LOW
PWD	MID-RANGE	MID-RANGE
Willingboro WPCF	MID-RANGE	MID-RANGE
Wilmington	MID-RANGE	MID-RANGE

3.6 TRACT LEVEL MAPPING OF SELECTED INDICATORS

Although we have computed the preceding indicators by total service area for each utility, it is evident that within that service area, there are communities which are more resilient and less resilient to increased service costs. Tract-level computation and mapping of the indicators demonstrates unequal impact.

Figures 5 and 6 below show tract level mapping of the indicators Household Affordability for Ammonia 1.5 mg/L and Residential Indicator for Ammonia 1.5 mg/L respectively. A more complete collection of tract level indicator mapping is included in Appendix C.

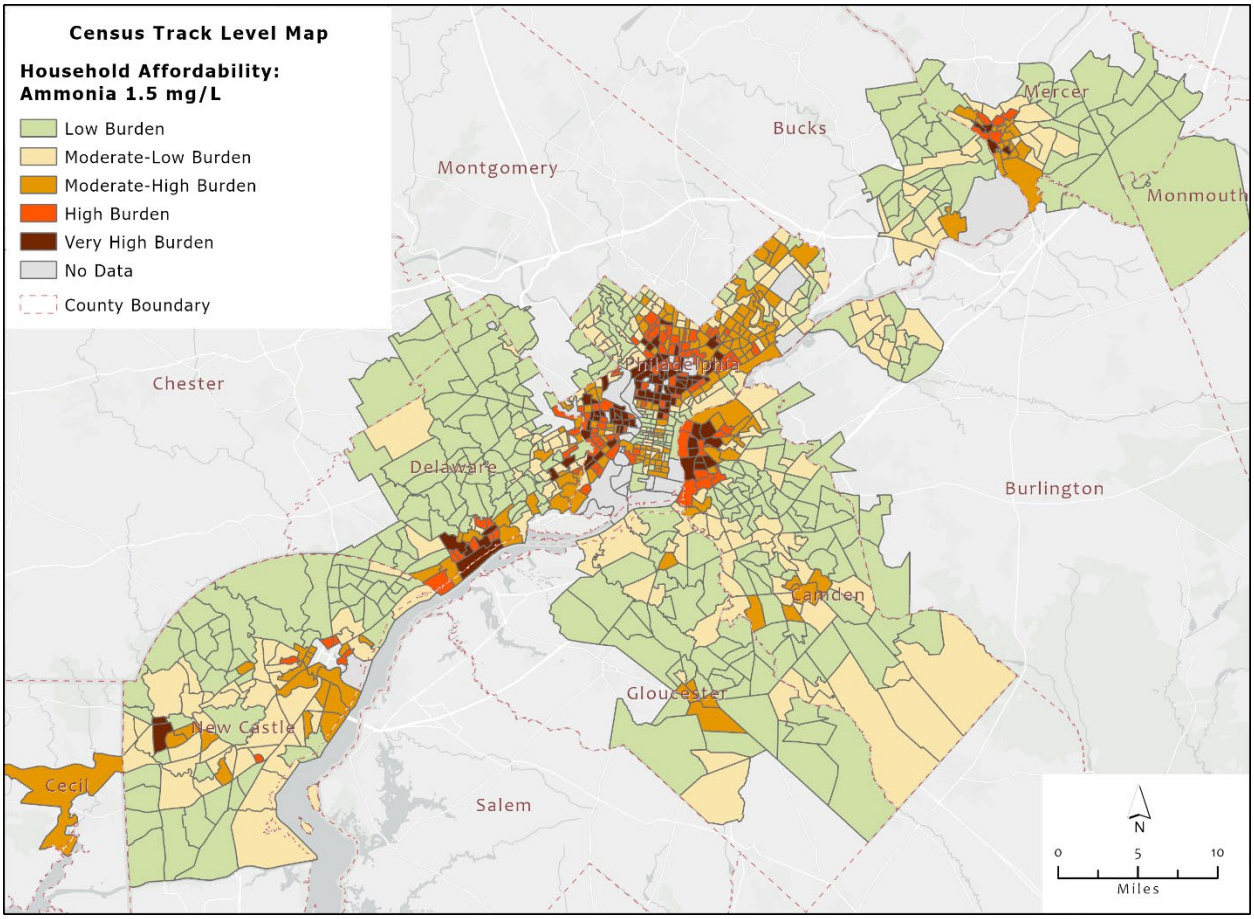

Figure 5: Tract level mapping of household affordability for ammonia 1.5 mg/L

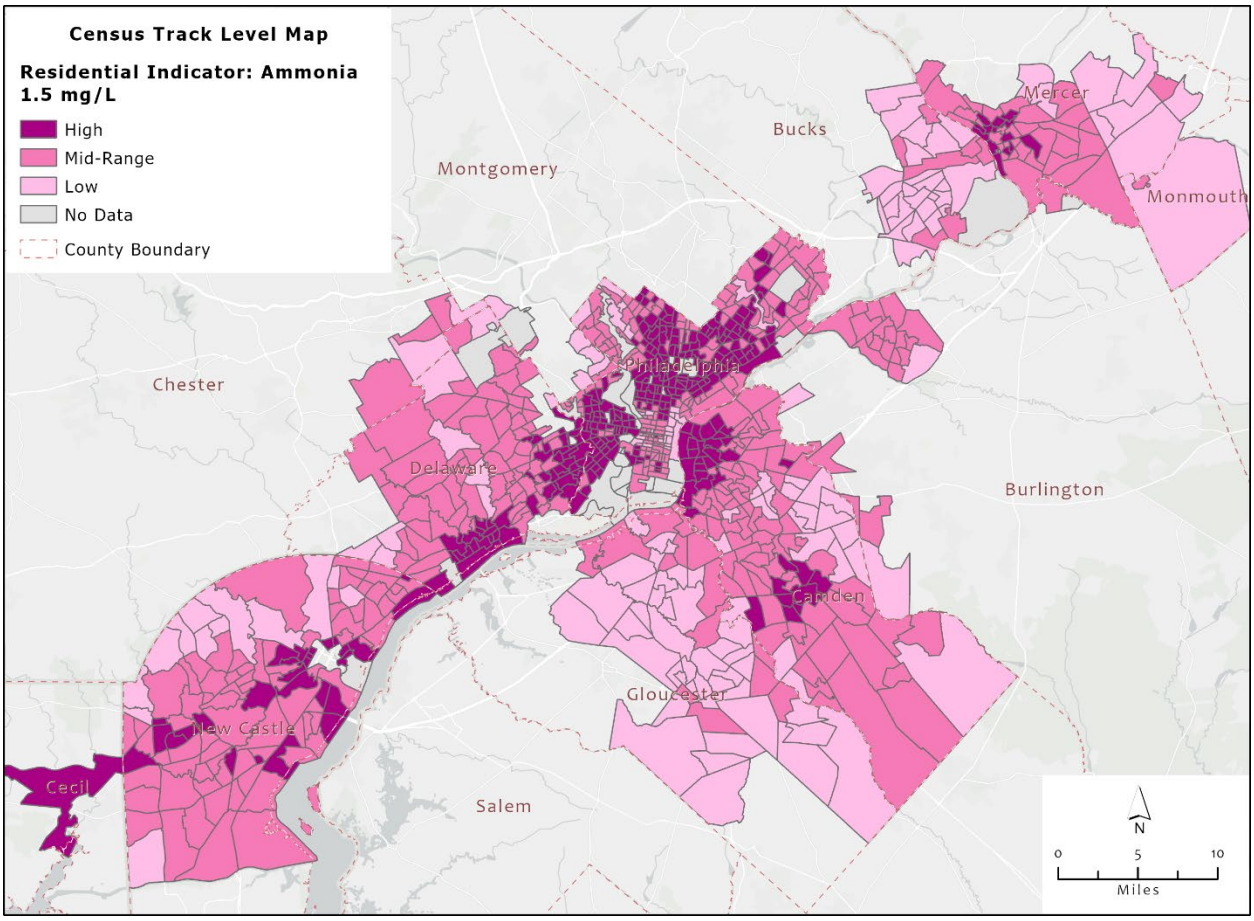

Figure 6: Tract level mapping of residential indicator for ammonia 1.5 mg/L

4. ESTIMATED PROPORTION OF NON-RESIDENTIAL WASTEWATER FLOW

Previously we stated that we assumed that 100% of the cost of new wastewater treatment would be borne by residential ratepayers within the service area and noted that this assumption was highly conservative. It would, therefore, be informative to know how conservative. In other words, it would be useful to estimate the proportion of wastewater from sources other than residential ratepayers in the service area.

We attempted to evaluate this by comparing an estimated volume of wastewater flow from residential customers to observed wastewater flow discharged by each utility. To better assess the proportion of wastewater flow for each utility coming from non-residential sources such as industries, businesses, and

contract sources outside the utility service area, we compared a representative low flow discharge value to the estimated sewage produced by the population served (Figure 7). The first step in this process was to identify a representative low flow value of effluent discharged in million gallons per day with minimal impact from combined sewage or infiltration and inflow.

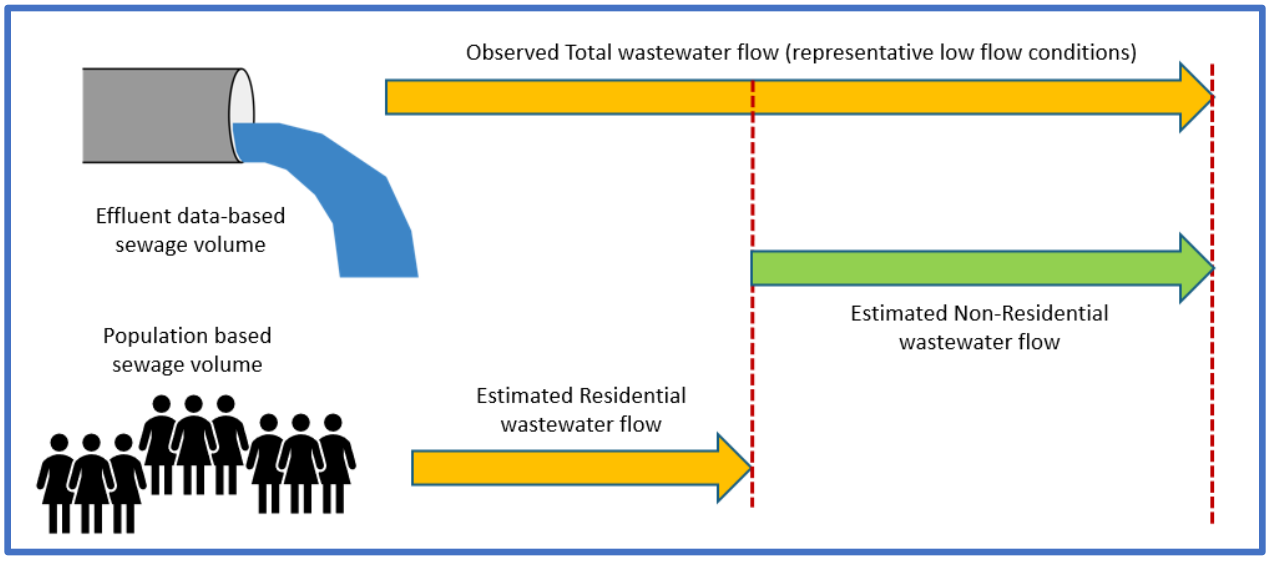

Figure 7: Conceptual illustration, estimated proportion of non-residential wastewater flow

To minimize the impact of stormwater and infiltration and inflow (I&I) on our comparison, we defined a representative low flow for each wastewater utility. Utilities submitted daily effluent flow rates for the periods from 2018 through 2019 (with some including 2020) and for the period 2012, all in support of model calibration. We plotted these results compared to the number of days since last rainfall greater 0.1-inch as measured at the gage at Philadelphia International Airport. We adapted a method outlined in an EPA Guide for Estimating Infiltration and Inflow to identify days where rainfall impact was least likely. We considered effluent discharge rates to be representative of low flow when:

- At least seven days had elapsed since the last daily rainfall total in excess of 0.1-inch *between* August 1st and September 15th (assumed to be seasonal low ground water); and
- All days when at least 14 days had elapsed since the last daily rainfall total in excess of 0.1-inch.

We used the median of the effluent discharge for the low flow days for each wastewater treatment facility as shown in Figure 8. The bright red points show daily effluent volumes for days greater than or equal to seven days since the last rainfall event greater than 0.1 inches *and* occurring within the assumed seasonal low ground water period (August 1st through September 15th). Dark red dots show daily effluent volumes for days greater than or equal to 14 days since the last rainfall event. The facility representative low flow is the median of bright and dark red dots discharge values. Figure 8 below illustrates this analysis for the

PWD Southwest plant. All other plants' plots can be found in Appendix D. We observe that in all cases, the bright and dark red dots demonstrate some consistency, lending credibility to the idea that in these instances short-term rainfall effects are minimized.

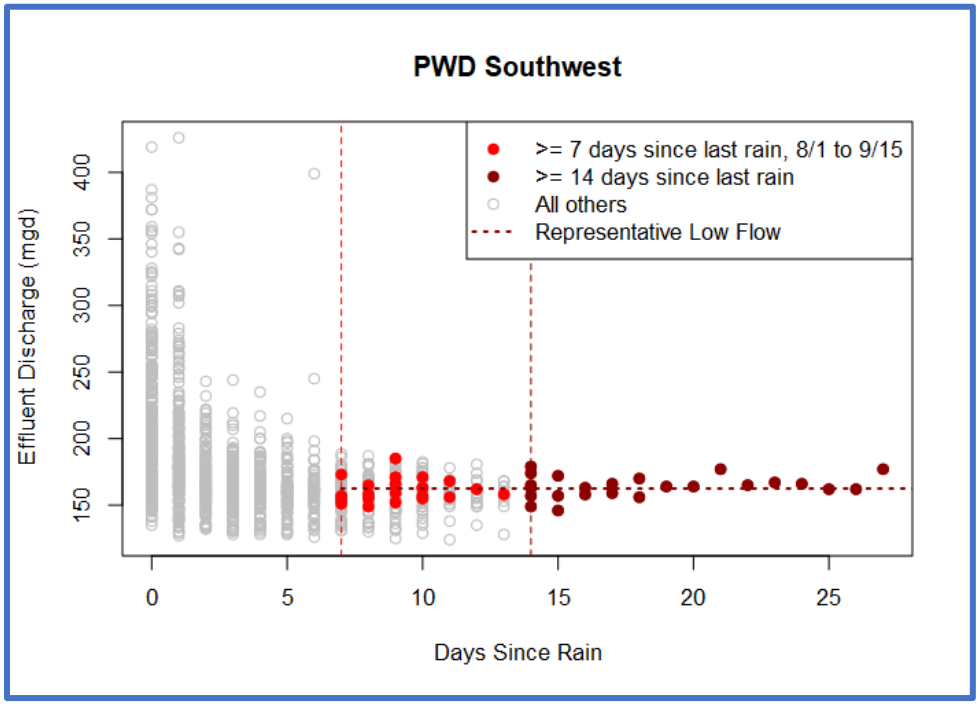

Figure 8: Representative low flow effluent discharge, PWD Southwest

We then estimated the daily volume of wastewater produced by residential customers by using the population served, as indicated by U.S. census tract data, multiplied by the population weighted average gallons per capita per day based on housing density (PWGPCD) for each sewer service area, multiplied by 0.9 to account for 10% assumed consumptive use, and converted to million gallons per day. In all cases, the representative observed low flow was substantially higher than the estimated volume based on population served. We called the difference non-residential flow and computed its percentage of the total representative low flow, as shown in Figure 9.

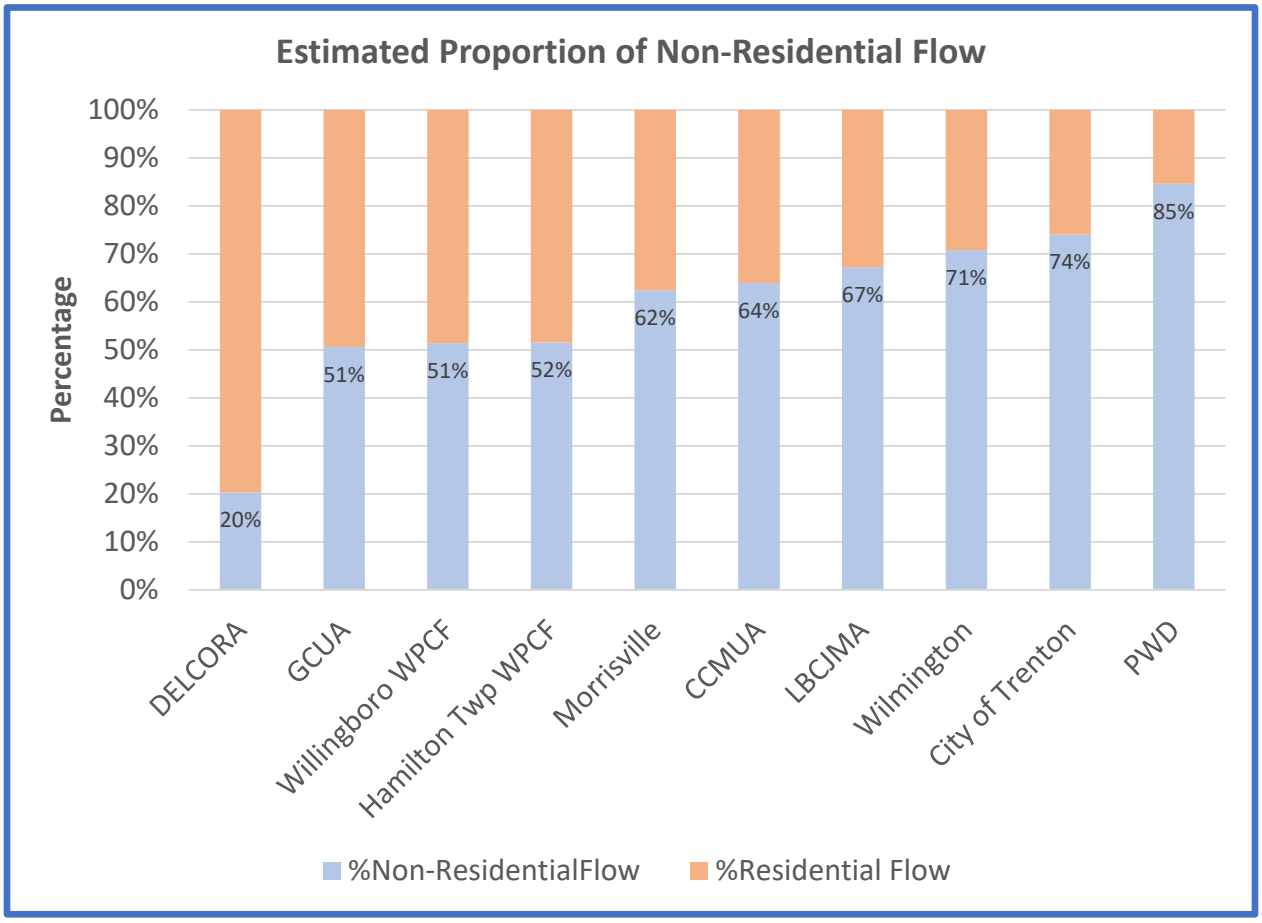

Figure 9: Estimated proportion of non-residential flow by utility

The non-residential wastewater flow could be comprised of several component inflows including:

- Remaining I&I
- Commercial inflow
- Industrial inflow
- Contract wastewater originating outside the service area

It is important to note that we do not know the relative proportion of each of these possible non-residential sources, therefore we do not know how much of that proportion would be available to alternative distribution of costs associated with additional wastewater treatment.

5. INTEGRATION WITH ANALYSIS OF ATTAINABILITY

The analysis of attainability will recommend scenarios for load reduction that may include a combination of different effluent levels yielding the highest attainable dissolved oxygen condition. We will utilize Residential Indicator (RI) and Household Affordability (HA) indicator presented here previously to compare the burden categories to current conditions and to different scenarios presented.

See the Analysis of Attainability for recommended scenarios and their resulting burden categories.

6. COST AND AFFORDABILITY MITIGATION RESOURCES

Cost and affordability mitigation resources are available at the utility level, community level, and household level. Final costs to taxpayers or rate payers will depend upon many factors including many federal, state, and local programs that influence affordability for utilities, communities, or individuals.

A partial listing of cost funding and affordability mitigation resources along with links to more information is included in Appendix F.

APPENDIX A – ADDITIONAL METRICS AND DETAILS

A.1 HOUSEHOLD BURDEN INDICATOR

Household Burden Indicator (HBI) is described in the New Framework Guidance and represents the total annual basic water sector household costs (represented in this document by the total cost of water for baseline and baseline plus new wastewater treatment costs) divided by the upper boundary of the lowest quintile of income (LQUL). The HBI represents the percentage of income that the average annual total water sector bill has on the 20th percentile income household. This intermediate value is not scored directly but is considered along with the Poverty Prevalence Indicator (PPI) to compute the Household Affordability Score. The HBI Results are shown in Table A-1.

Table A-1: Household burden indicator percentage

Utility Name	Baseline	Ammonia 10 mg/L	Ammonia 5 mg/L	Ammonia 1.5 mg/L	TN 4 mg/L
CCMUA	3.73	4.09	4.18	4.27	4.78
City of Trenton	4	4.03	4.58	4.87	5.74
DELCORA	4.29	4.34	4.43	4.47	4.64
GCUA	1.27	1.41	1.46	1.5	1.78
Hamilton Twp WPCF	3.13	3.53	3.67	3.67	4.08
LBCJMA	0.99	1.3	1.3	1.3	1.75
Morrisville	2.38	2.83	2.83	3.05	3.5
PWD	5.05	5.45	5.67	6.09	7.27
Willingboro WPCF	1.8	1.8	1.8	2.22	2.42
Wilmington	2.83	2.99	3.36	3.51	4.12

A1.1 Special Processing Note for LQUL

LQUL data is available from the American Community Survey (ACS) and represents the 20th percentile of income for the underlying population of the area for which it is summarized, whether by tract, county, or other spatial area. As a quantile of an underlying distribution, LQUL introduces a computational challenge. Specifically, aggregation of quantiles especially those more distant from the median, introduces error beyond that associated with counts or central tendencies. This can be observed by comparing the population weighted mean LQUL for all the tracts in a county versus the LQUL reported for the county

itself. Differences in the estimated and reported LQUL value for the same area demonstrate the inherent limitation of estimation of quantiles by aggregation.

The ideal solution would be to compute the 20th percentile of income from the full population income distribution associated with each service area. Unfortunately, this data is unavailable. Therefore, we are limited to using inexact estimation methods.

To minimize the likelihood of an inflated estimate of LQUL for a service area, we considered two different estimates and selected the lower value estimate for each service area. The two different estimates are:

- The population weighted mean LQUL for each tract in the service area; and
- The LQUL reported for the county within which the majority of the service are resides.

A.2 POVERTY PREVALENCE INDICATOR

Poverty prevalence indicator is described in the New Framework Guidance document and represents the service area population below 200% of the Federal Poverty Level (IBPL200) divided by the population for whom poverty status is determined (POVSTATUS). Both inputs are available from the ACS. The PPI measures the prevalence of "low-income" individuals across a community. Using the number of individuals 200% above the poverty limit captures the percentage of individuals that are at the upper limit of a federal poverty limit. The 2022 poverty guideline is $13,590 and 200% is $27,180. Poverty thresholds (Census Bureau) and poverty guidelines (Department of Health and Human Services) are used to determine how many people are in poverty and how to determine eligibility of types of federal and state assistance.

The population weighted PPI for each service area is shown in Table A-2 below. As with HBI, this indicator is not scored directly but is considered in the development of the Household Affordability Score.

Table A-2: Poverty prevalence percentage

Utility Name	PPI
CCMUA	25.94
City of Trenton	52.22
DELCORA	20.3
GCUA	17.69
Hamilton Twp WPCF	18.47
LBCJMA	16.7
Morrisville	11.9
PWD	43.49
Willingboro WPCF	23.5
Wilmington	22.66

A.3 BOND RATING

The EPA Guidance Document includes an indicator for Bond Rating, considering the most recent general obligation bond rating, revenue bond rating for water and/or sewer, and the presence of bond insurance. Bond rating is one way to assess financial capability because a higher bond rating means future borrowing may be affordable due to reasonable interest rates. More detail on the score by rating service and bond category is available in the EPA 2022 Guidance. The summary bond rating score is shown in Table A-3 below.

Table A-3: Summary bond rating score

Utility Name	Summary Bond Rating
Wilmington	Strong
PWD	Strong
CCMUA*	Insufficient Data
City of Trenton	Strong
Hamilton Twp WPCF	Strong
Willingboro WPCF	Insufficient Data
DELCORA	Strong
Morrisville	Insufficient Data
LBCJMA	Insufficient Data
GCUA	Strong

Not every utility issues bonds or provides information on bonds. These were listed as Insufficient Data in the Summary Bond Rating Score Table.

A.4 NET DEBT AS A PERCENTAGE OF FULL MARKET PROPERTY VALUE

EPA includes several indicators that are not equally applicable across all service areas. One of these is the Net Debt as a Percentage of Full Marker Property Value. The net debt is assessed because it is typically repaid by assessing property taxes in the service area. It also indicates the ability to issue more debt. If the score is weak that indicates that the debt may be high compared to the property values in the service area. The value of this indicator is limited because not all service areas have taxing authority.

This indicator is scored as shown below, although as indicated, results were Not Applicable (N/A) for several utilities:

- Weak (Above 5%)
- Mid-Range (2 to 5 %)
- Strong (Below 2%)

Table A-4 below shows results for the Net Debt as a Percentage of Full Marker Property Value indicator.

Table A-4: Net debt as a percentage of full market property value

Utility Name	Net Debt as a Percentage of Full Marker Property Value	Benchmark
CCMUA	Insufficient Data	
City of Trenton	Insufficient Data	
DELCORA	0.073301	Weak
GCUA	Insufficient Data	
Hamilton Twp WPCF	0.030867	Mid-range
LBCJMA	Insufficient Data	
Morrisville	0.567208	Weak
PWD	0.044514	Mid-range
Willingboro WPCF	Insufficient Data	
Wilmington	0.474709	Weak

A.5 UNEMPLOYMENT RATE

The EPA 2022 Guidance includes an indicator comparing the service area unemployment rate to the national average unemployment rate. In this context, we considered the unemployment rate reported in the ACS for all census tracts nationwide. This is different than the unemployment rate issued by the Bureau of Labor Statistics and widely reported, but the ACS national average unemployment rate allows for a direct comparison to service areas using the same data set and the same 5-year window.

The ACS data includes unemployment information for Puerto Rico. Based on the EPA guidance, we interpreted that the data for Puerto Rico should be excluded for the development of the national average.

The resulting service area unemployment rate is scored with three possible outcomes as shown below:

- Weak (More than 1 percentage point above the National Average)
- Mid-Range (± 1 percentage point of the National Average)
- Strong (More than 1 percentage point below the National Average)

Figure A-1 below shows the service area unemployment rate with comparison to the national average for the same window.

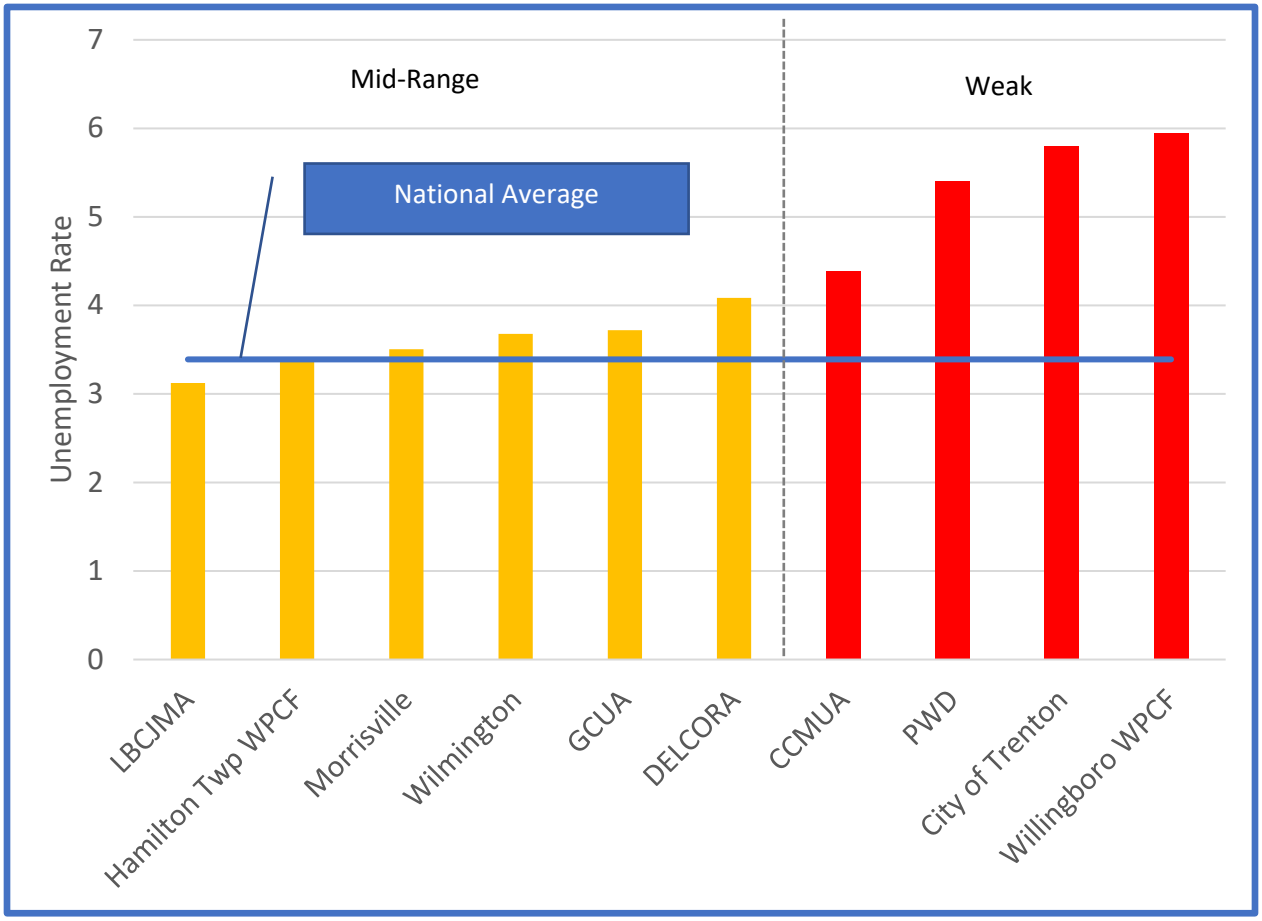

Figure A-1: Service area unemployment rate with comparison to national average

A.6 MEDIAN HOUSEHOLD INCOME

For Median Household Income (MHI), the EPA 2022 Guidance includes an indicator comparing the service area MHI to the national average. As with the previous indicator, we considered the MHI reported in the ACS for all census tracts nationwide, and again excluded data from Puerto Rico.

The resulting service area MHI is scored with three possible outcomes as shown below:

- Weak (More than 25% below the National Average)
- Mid-Range (± 25% of the National Average)
- Strong (More than 25% above the National Average)

EPA guidance allows the use of adjusted MHI. Because both the national average and service area MHI values are estimated from the same ACS survey, no adjustment was made.

Figure A-2 below shows the service area unemployment rate with comparison to the national average for the same window.

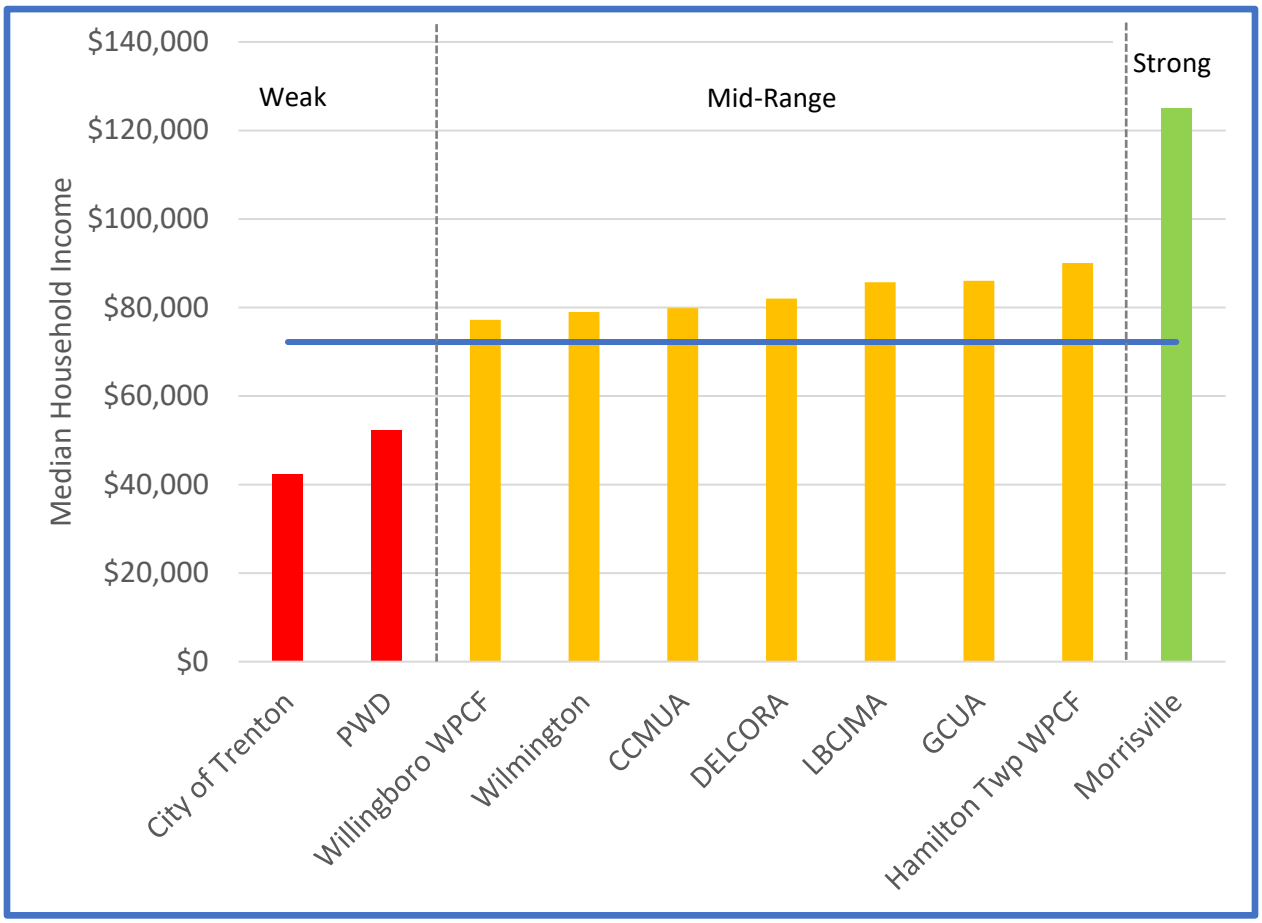

Figure A-2: Service area median household income with comparison to national average

A.7 PROPERTY TAX REVENUE AS A PERCENT OF FULL MARKET PROPERTY VALUE

This indicator is used to evaluate financial management of the utility indicating funding capacity based on the wealth of the community. It is also intended to reflect the level of revenue collected in reference to the value of real property in the community. If the revenue to property value is low, that indicates the possibility of additional revenue collection for future cost of compliance. As indicated on a previous indicator, EPA's Property Tax Revenue as a Percent of Full Market Property Value indicator is not equally applicable across all service areas. For many service areas, property tax revenue is disconnected from utility funding streams and some service areas indicated that full market property value is not applicable to their utility.

This indicator is scored as shown below, although as indicated, results were Not Applicable (N/A) for several utilities:

- Weak (Above 4%)
- Mid-Range (2 to 4 %)
- Strong (Below 2%)

Table A-5 below shows results for Property Tax Revenue as a Percent of Full Market Property Value indicator.

Table A-5: Property tax revenue as a percent of full market property value

Utility Name	Property Tax Revenue as a Percent of Full Market Property Value	Rating
CCMUA	Insufficient Data	
City of Trenton	Insufficient Data	
DELCORA	0.502729	Strong
GCUA	Insufficient Data	
Hamilton Twp WPCF	3.049009	Mid-range
LBCJMA	Insufficient Data	
Morrisville	Insufficient Data	
PWD	0.411235	Strong
Willingboro WPCF	Insufficient Data	
Wilmington	1.960943	Strong

A.8 PROPERTY TAX REVENUE COLLECTION RATE

The second financial management indicator is property tax revenue collection rate. This indicates the efficacy of the tax collection and may indicate how acceptable the tax levels are to the community. It is a comparison of the property tax revenue collected to the property taxes levied.

The following scores are used to assess the rate:

- Weak (Below 94%)
- Mid-Range (94% to 98%)
- Strong (Above 98%)

Results of the property tax revenue collection indicator are shown in Table A-6 below:

Table A-6: Property tax revenue collection score

Utility Name	Property Tax Collection Score
Wilmington	Mid-Range
PWD	Strong
CCMUA	Insufficient Data
City of Trenton	Insufficient Data
Hamilton Twp WPCF	Strong
Willingboro WPCF	Insufficient Data
DELCORA	Mid-Range
Morrisville	Insufficient Data
LBCJMA	Insufficient Data
GCUA	Insufficient Data

A.9 LOWEST QUINTILE RESIDENTIAL INDICATOR (EPA 2021)

The Lowest Quintile Residential Indicator was described in the superseded EPA 2021 guidance. Although superseded, this is one of the two indicators noted as missing from the 2022 guidance by national water resources groups.

Lowest Quintile Residential Indicator relates an estimated lowest quintile household size to median household size and scales the Clean Water Act costs (total cost of water here) according to that ratio. This scaled cost is then compared to the upper limit of lowest income quintile (LQUL) to determine cost as a percentage of low-income. Scores are assessed as:

- Low Impact (Less than 1%)
- Mid-Range Impact (1% to 2%)
- High Impact (Above 2%)

Results of the Lowest Quintile Residential Indicator are shown in Table A-7 below.

Table A-7: Lowest quintile residential indicator (EPA 2021)

Utility Name	Baseline	Ammonia 10 mg/L	Ammonia 5 mg/L	Ammonia 1.5 mg/L	Total Nitrogen 4 mg/L
CCMUA	High Impact	High Impact	High Impact	High Impact	High Impact
City of Trenton	High Impact	High Impact	High Impact	High Impact	High Impact
DELCORA	High Impact	High Impact	High Impact	High Impact	High Impact
GCUA	Low Impact	Low Impact	Mid-Range Impact	Mid-Range Impact	Mid-Range Impact
Hamilton Twp WPCF	High Impact	High Impact	High Impact	High Impact	High Impact
LBCJMA	Low Impact	Low Impact	Low Impact	Low Impact	Mid-Range Impact
Morrisville	Mid-Range Impact	Mid-Range Impact	Mid-Range Impact	High Impact	High Impact
PWD	High Impact	High Impact	High Impact	High Impact	High Impact
Willingboro WPCF	Mid-Range Impact	Mid-Range Impact	Mid-Range Impact	Mid-Range Impact	Mid-Range Impact
Wilmington	Mid-Range Impact	High Impact	High Impact	High Impact	High Impact

This indicator results in a high level of impact in more circumstances than other indicators considered. It is worth noting that there are two assumptions built into this indicator that probably do not hold for all utilities and communities. First, the indicator assumes that a 2018 national ratio of lowest quintile household size to median quintile household size of 70.2% is applicable to all communities. Given the wide differences in housing density, this seems unlikely across all utilities and communities considered here. Second, this indicator assumes that household total cost of water scales between median and low-income households in the same manner as household size described above.

As discussed previously, the lowest of either the population weighted or representative county LQUL was used in this computation.

A.10 POVERTY INDICATOR SCORE (EPA 2021)

The Poverty Indicator Score also was part of superseded EPA 2021 guidance included here. The Poverty Indicator Score compares five census data values to national averages of those same values and develops intermediate scores for each of the five data values and a Benchmark summarizing all five. The five census values used for comparison are:

- Percentage of population with income below 200% of the Federal Poverty Level (IBPL200)
- Percentage of population with income below the Federal Poverty Level (BPL)

- Upper limit of Lowest Income Quintile (LQUL)
- Lowest Quintile Income as a Percentage of Aggregate Income (LOQUINTAGG)
- Percentage of population receiving food stamps/SNAP benefits (ASSIST_S22)

Each facility-level census value is evaluated based on whether it is within 25% of the national average for the same value and scored as either Strong (3 points), Mid-Range (2 points), or Weak (1 point). The average of those scorings is then assessed using the following rubric:

- Low Impact (above 2.5)
- Mid-Range Impact (2.5 to 1.5)
- High Impact (Below 1.5)

Poverty Indicator Score assesses community conditions independent of total cost of water and costs for additional wastewater treatment. Results of the Poverty Indicator Score are shown in Table A-8 below.

Table A-8: Poverty indicator score (EPA 2021)

Utility	IBPL200	BPL	LQUL	LOQUINTAGG	ASSIST_S22	Summary Benchmark
Wilmington	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Strong	**Mid-Range Impact**
DELCORA	Strong	Strong	Mid-Range	Mid-Range	Mid-Range	**Mid-Range Impact**
CCMUA	Mid-Range	Mid-Range	Mid-Range	Mid-Range	Mid-Range	**Mid-Range Impact**
Willingboro WPCF	Strong	Strong	Mid-Range	**Weak**	Mid-Range	**Mid-Range Impact**
Hamilton Twp WPCF	Mid-Range	Strong	Mid-Range	Mid-Range	Strong	**Mid-Range Impact**
PWD	**Weak**	**Weak**	**Weak**	Strong	**Weak**	**High Impact**
GCUA	Strong	Strong	Mid-Range	Mid-Range	Strong	**Low Impact**
City of Trenton	**Weak**	**Weak**	**Weak**	Strong	**Weak**	**High Impact**
Morrisville	Strong	Strong	Strong	Mid-Range	Strong	**Low Impact**
LBCJMA	Strong	Strong	Mid-Range	Mid-Range	Mid-Range	**Mid-Range Impact**

In previous sections we indicated that as a quantile, computation of facility LQUL presented challenges, and required an alternative to reduce the likelihood of an inflated LQUL. Here, however, since average LQUL is being assessed both at the facility level and nationally, we interpret that it is being used as a numeric metric rather than a descriptive characteristic of community income. As such, we followed the guidance as written and did not consider an alternative value for LQUL.

APPENDIX B – REFERENCES

CCMUA, Environmental Management System (http://www.ccmua.org/index.php/green-initiatives/enviromental-managment-system/).

DRBC, Resolution No. 2017-4 (Sept. 13, 2017) (https://www.nj.gov/drbc/library/documents/Res2017-04_EstuaryExistingUse.pdf).

Environmental Finance Center Network, Funding Tables, Funding Sources by State or Territory (presents Environmental Finance Center funding sources by state) (https://efcnetwork.org/resources/funding-tables/).

EPA, Integrated Planning for Municipal Stormwater and Wastewater (last updated Aug. 4, 2022) (https://www.epa.gov/npdes/integrated-planning-municipal-stormwater-and-wastewater).

EPCOR Utilities Inc., Shared Outcomes, Priority Actions and Design Principles (https://www.epcor.com/products-services/infrastructure/construction-projects/gold-bar-wastewater-treatment-plant/Documents/Goldbar-Workshop-3-Outcomes%20and%20Principles-Handout-Final.pdf).

Global Environment & Technology Foundation & EPA, EMS Case Studies in the Public Water Sector (Nov. 2005) (https://ocw.un-ihe.org/pluginfile.php/3163/mod_resource/content/1/EMS-Water_Sector_-_USEPA_-2005.pdf).

PG Environmental, Asset Management Programs for Stormwater and Wastewater Systems: Overcoming Barriers to Development and Implementation (prepared for EPA) (Mar. 6, 2017) (https://www.epa.gov/sites/default/files/2018-01/documents/overcoming-barriers-to-development-and-implementation-of-asset-management-plans.pdf).

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APPENDIX C – SCRIPT INDEX

Computations in the report were performed by scripted analyses using the R programming language, drawing data from individual data tables. All scripts and data tables are available upon request.

Scripts should be run in a specific sequence, as the table resulting from one script may be required as input for another script.

An index of scripts, their sequence, and function is provided below.

Sequence	Script Name	Process
1	MakeCombinedCensusTableV2	Opens each of the national census data tables. Retains the indicators of interest for each table and only the tracts that map to one of the utility service areas of interest. Outputs a file called "FullAssembledCensusDataV2.csv" to be used by subsequent scripts.
2	BaselineAnnualCostWater_V2	Compute the baseline annual cost of water with no additional effluent improvement. Output table also includes the population weighted gallons per capita per day based on housing density in the service area (PWGPCD). Script also computes and outputs Housing Density By Tract.
3	MakePopulationServed	Compute the population served based on the sewer service area and census data.
4	MakeCostPerHousehold	Compute the cost per household for all scenarios. This provides the cost per household estimate that would come from EPA worksheet 1, but as described in the report, is (we believe) a more direct method for computing this value.
5	Compute.HouseholdBurdenIndicator.V2.NF	Uses the "FullAssembledCensusDataV2.csv" file and Cost Per Household from previous script to compute the population weighted Household Burden Indicator as described in the National Framework guidance document.
6	Compute.PovertyPrevalenceIndicator.V2.NF	Uses the "FullAssembledCensusDataV2.csv" file to compute the population weighted

		Poverty Prevalence Indicator as described in the National Framework guidance document.
7	Interpret.HouseholdAffordabilityMetrics.V2.NF	Uses the Household Burden Indicator computed by Script 2 and the Poverty Prevalence Indicator computed by Script 3 to bin each effluent scenario cost by level of burden as described in the National Framework guidance document.
8	Compute.ResidentialIndicator.EPA.Worksheet2	Computes the Residential Indicator and assigns the Residential Indicator Rating as described in EPA, Worksheet 2. Also computes and outputs the tract level residential indicator scores for mapping.
9	PlotCostPerHousehold	Plot the stacked bar chart of cost per household for baseline and effluent nitrogen reduction scenarios.
10	Compute.NetDebt.EPA	Compute and rate net debt as a percent of full market property value using supplied data from the utilities (EPA Worksheet 4). Where utilities supplied insufficient data for computations, benchmark is presumed Strong.
11	ComputeNationalValues	Compute population weighted national values of Median Household Income, Unemployment, and percent Food Stamp / SNAP benefits. Script does not count values listed for Puerto Rico. National values are needed for comparison to service area values.
12	Compute.MHI.UNEMP.ASSIST.EPA	Compute population weighted Median Household Income, Unemployment, and percent Food Stamp / SNAP benefits per service area.
13	Compute.PropertyTaxasPercentFMPV	Compute and rate property tax revenue as a percent of full market property value using supplied data from the utilities (EPA Worksheet 7). Where utilities supplied insufficient data for computations, benchmark is presumed Strong.
14	Compute.PropertyTaxCollectionRate	Computes and scores the property tax revenue collection rate.

15	Compute.LQRIB.EPA2021	Computes and scores the Lowest Quintile Residential Indicator from the EPA 2021 Guidance.
16	Compute.PovertyIndicatorScore.EPA2021	Computes and scores the Pverty Indicator from the EPA 2021 Guidance.
17	Compute.TractLevel.HBI	Compute the tract level household burden indicator for each scenario using the tract level data. This is a supplementary script for tract level mapping.
18	TractLevel.HouseholdAffordabilityMetric	Compute the tract level household affordability scoring for each scenario. This is a supplementary script for tract level mapping.

APPENDIX D – TRACT LEVEL MAPPING OF SELECTED INDICATORS

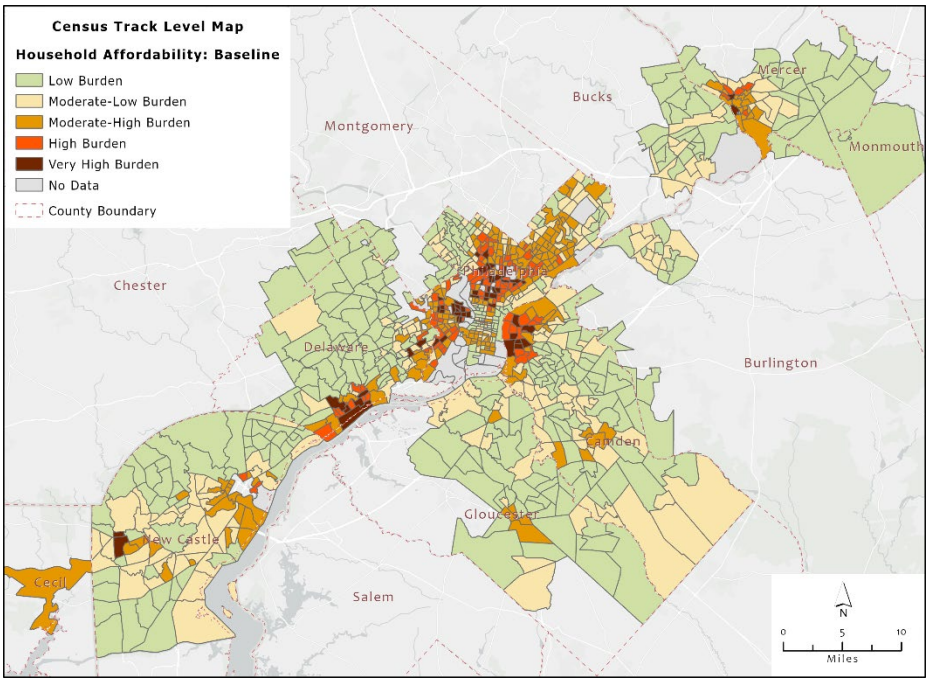

Figure D-1: Tract level map, household affordability, baseline

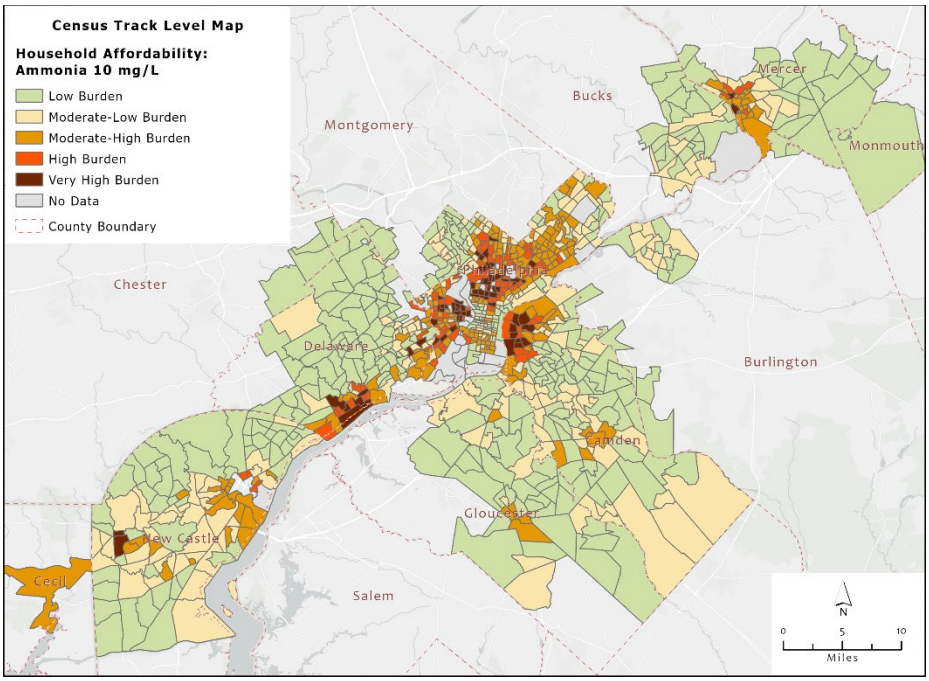

Figure D- 2: Tract level map, household affordability, ammonia at 10 mg/L

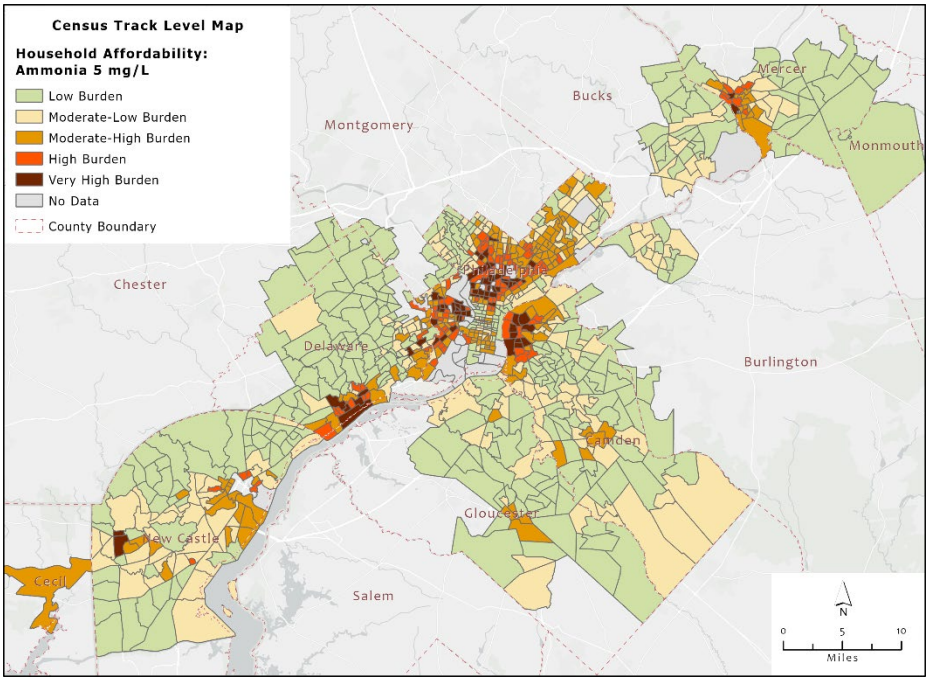

Figure D- 3: Tract level map, household affordability, ammonia at 5 mg/L

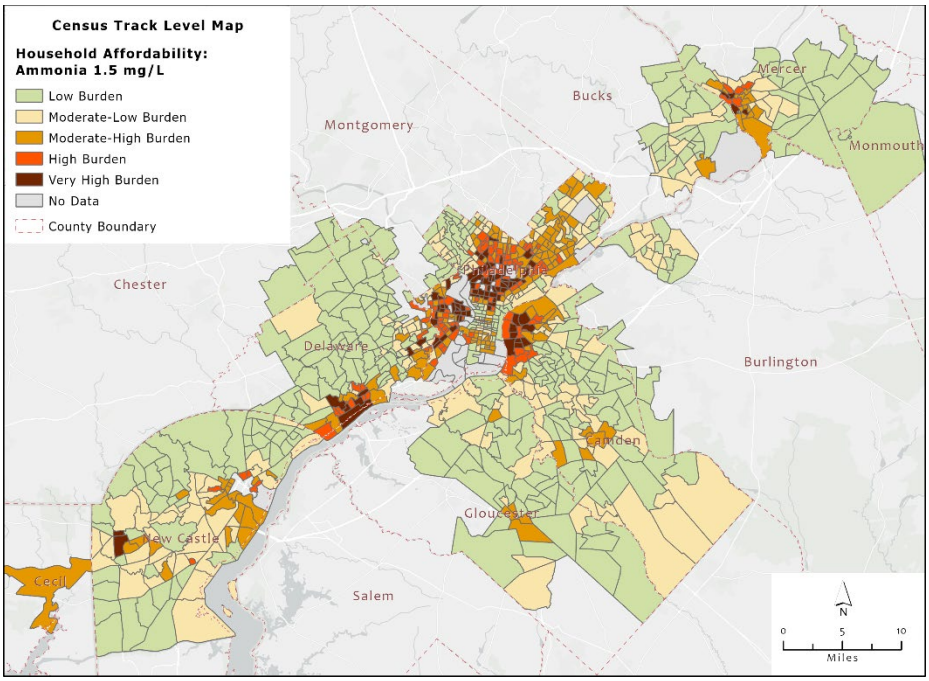

Figure D- 4: Tract level map, household affordability, ammonia at 1.5 mg/L

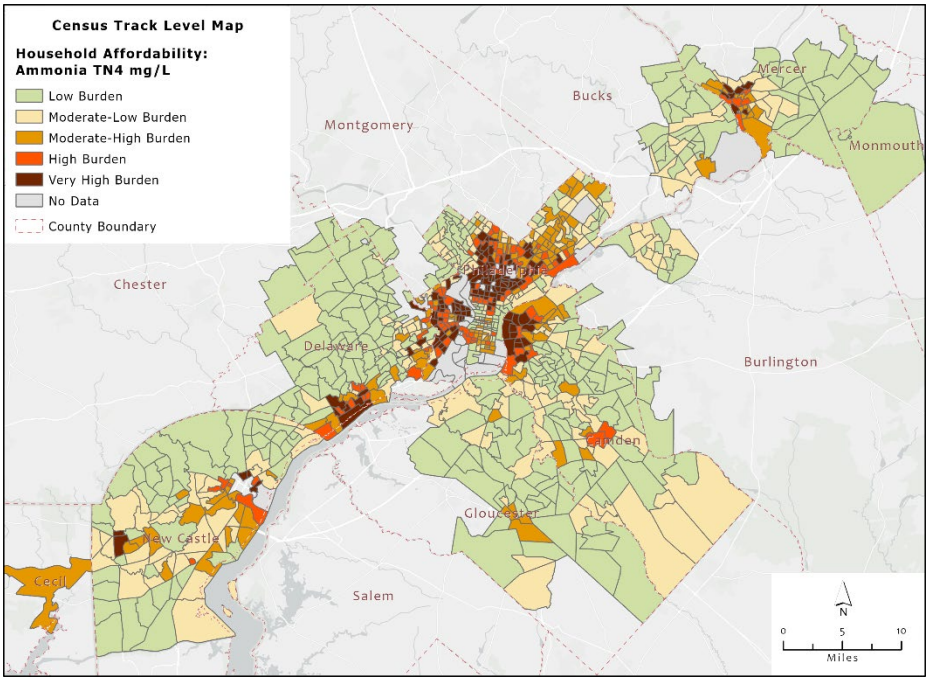

Figure D- 5: Tract level map, household affordability, TN at 4 mg/L

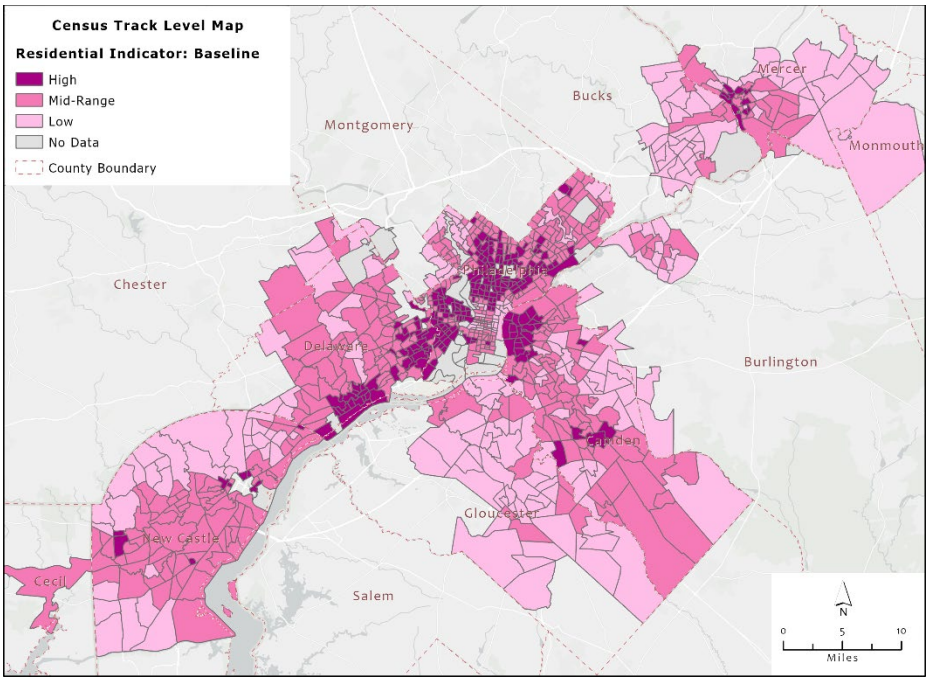

Figure D- 6: Tract level map, residential indicator, baseline

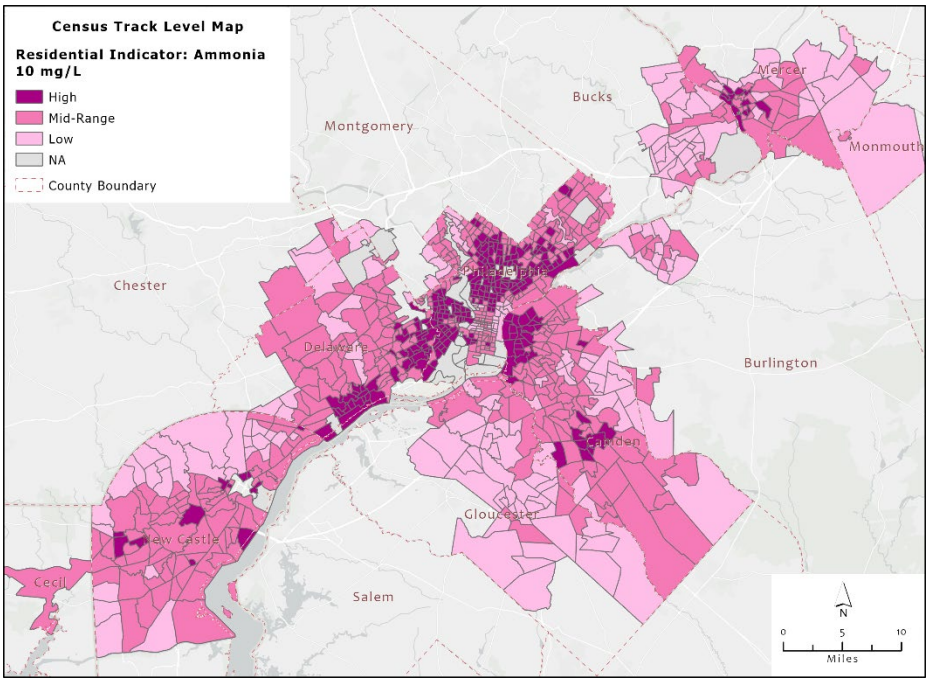

Figure D- 7: Tract level map, residential indicator, ammonia at 10 mg/L

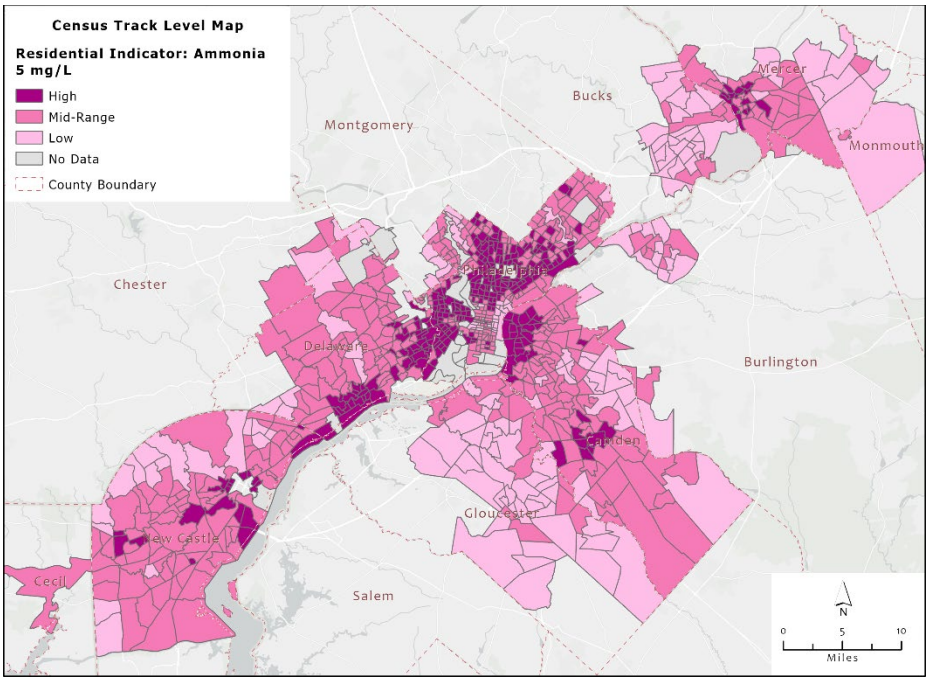

Figure D- 8: Tract level map, residential indicator, ammonia at 5 mg/L

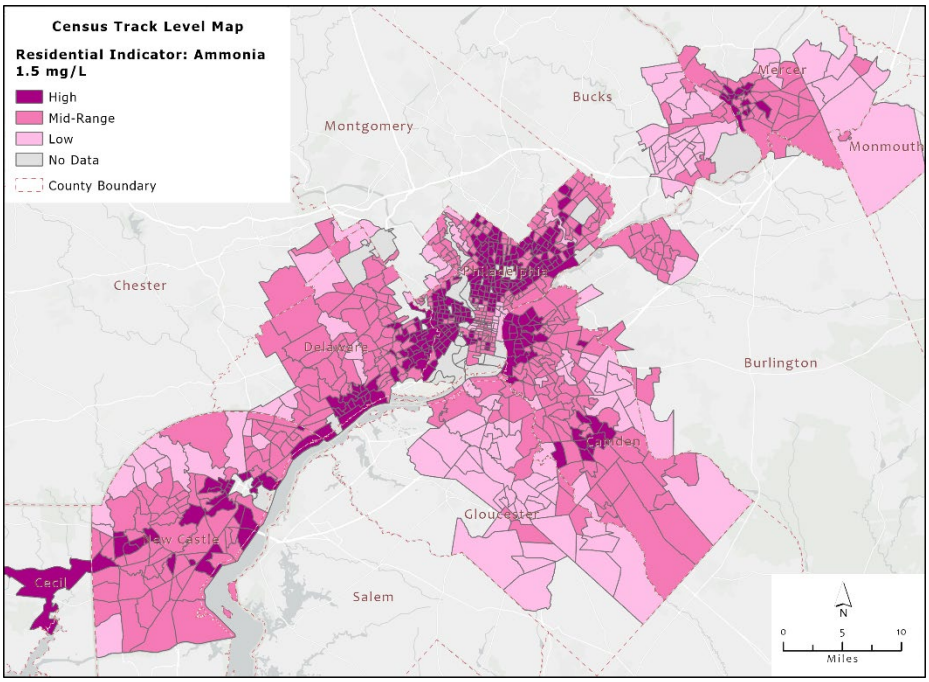

Figure D- 9: Tract level map, residential indicator, ammonia at 1.5 mg/L

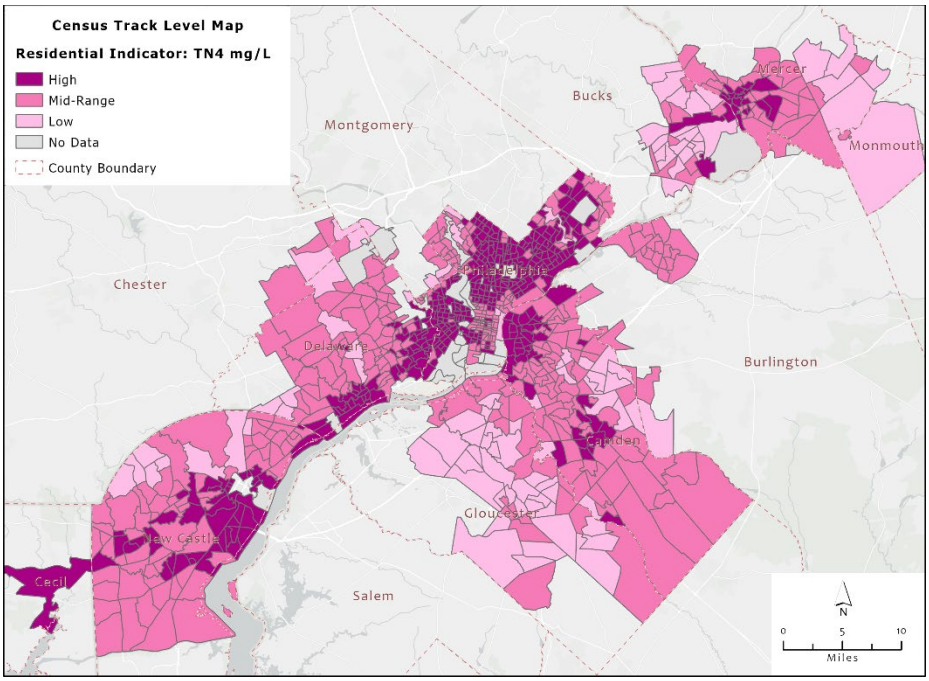

Figure D- 10: Tract level map, residential indicator, TN at 4 mg/L

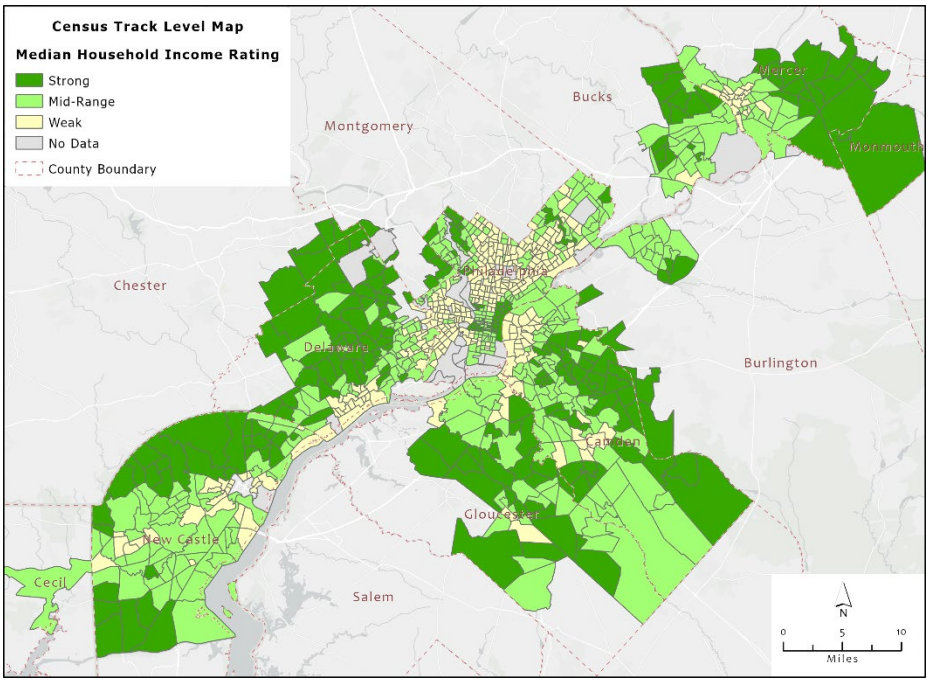

Figure D- 11: Tract Level Map, Median Household Income

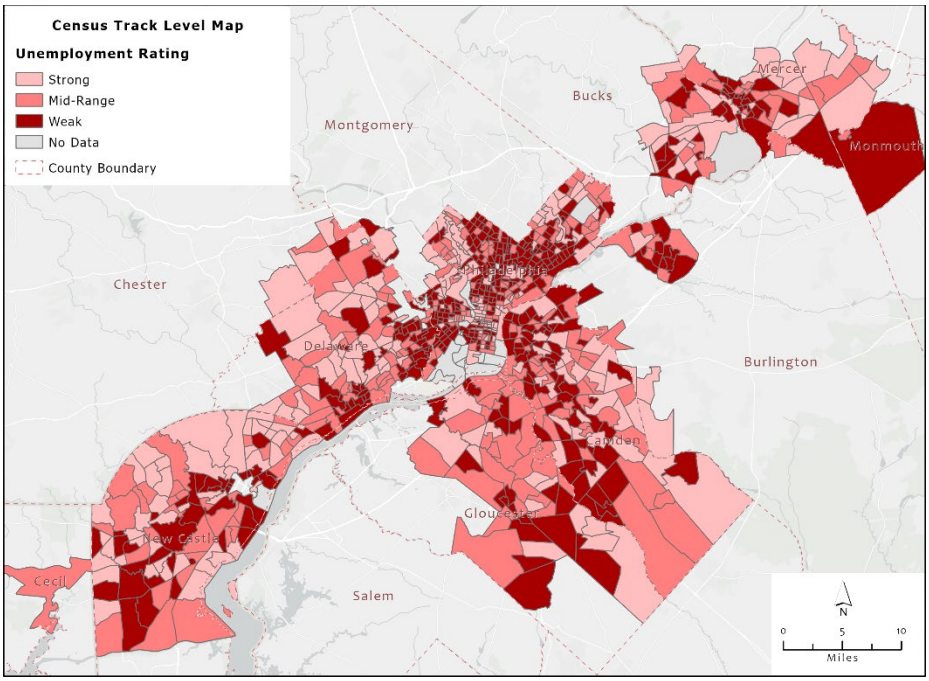

Figure D- 12: Tract level map, unemployment rate

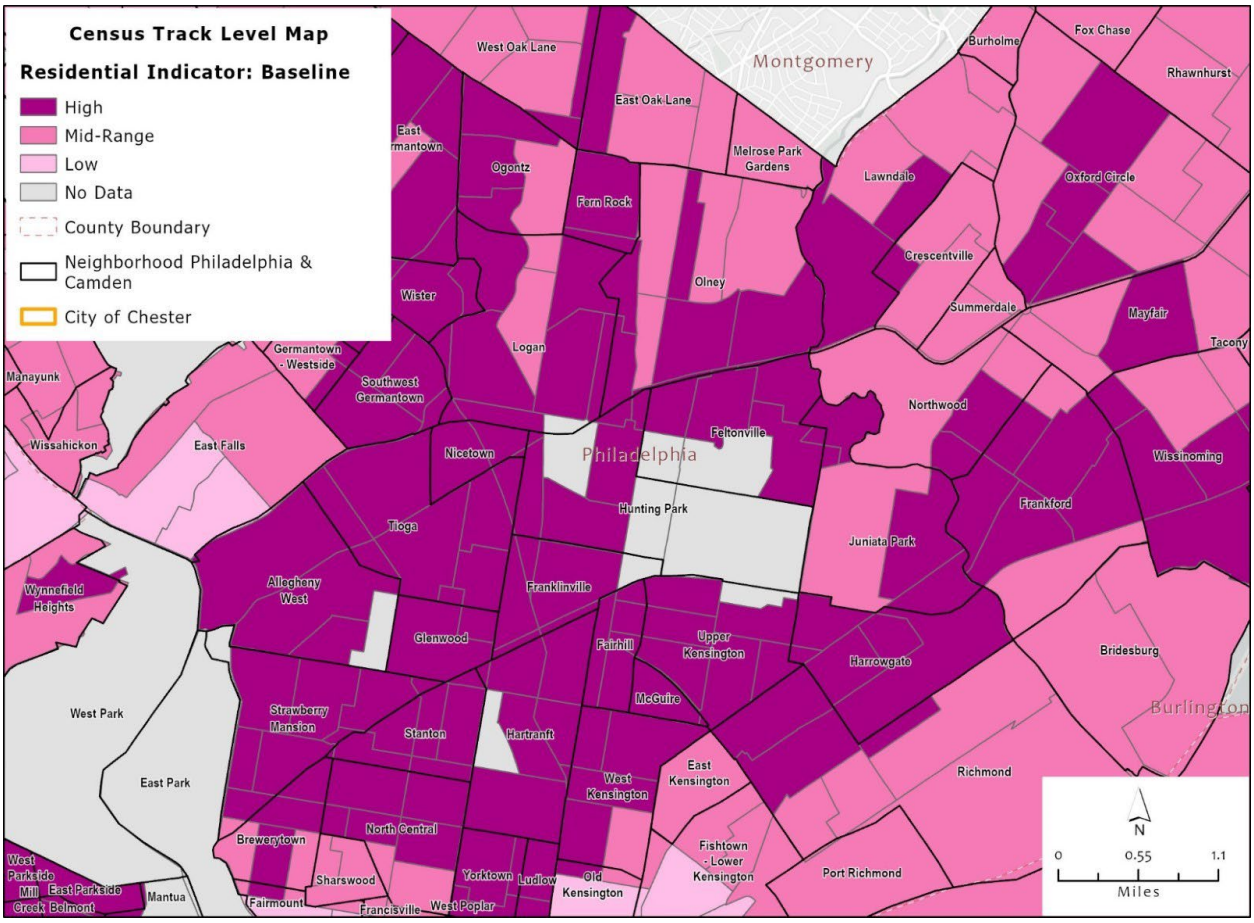

Figure D- 13: Overlay of residential indicator with neighborhoods – Philadelphia (north)

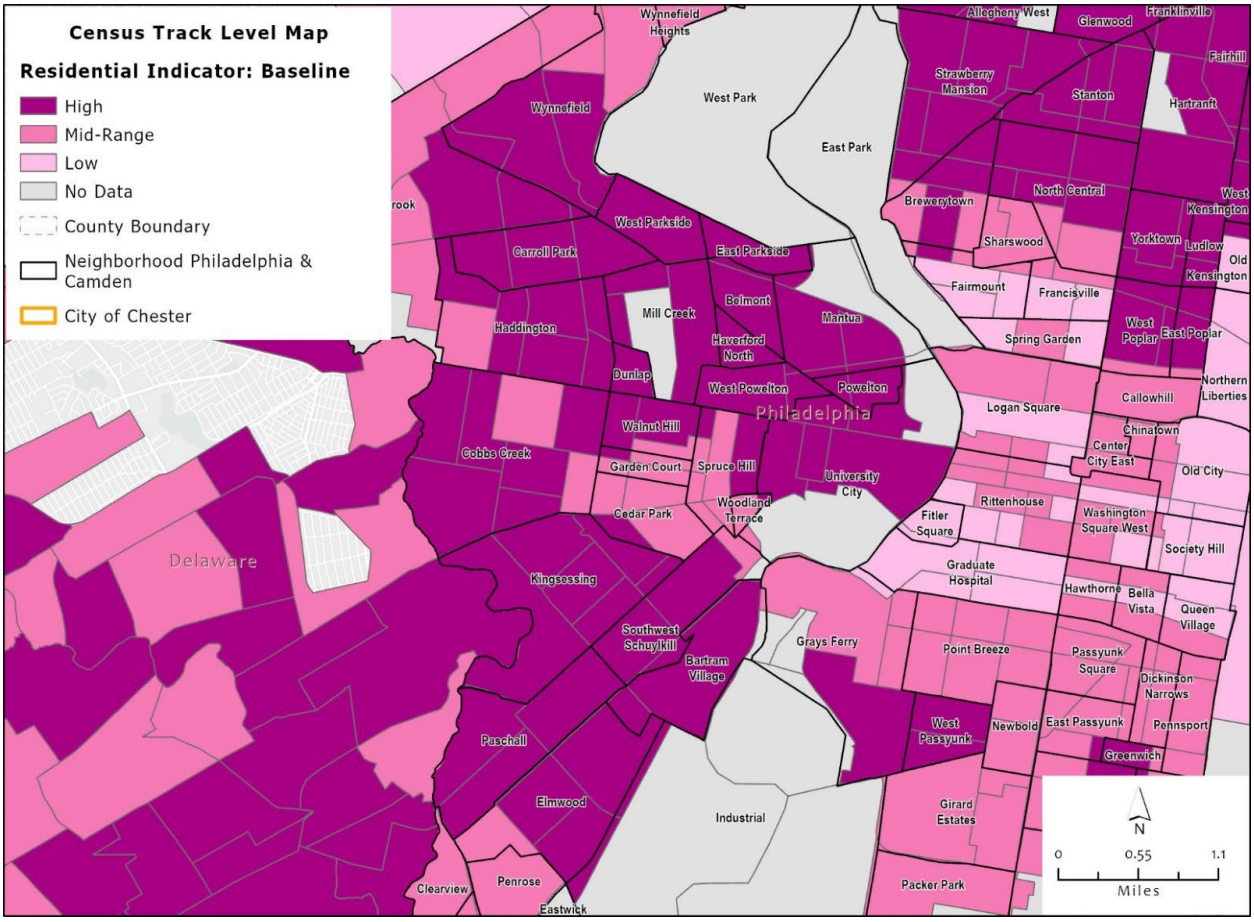

Figure D- 14: Overlay of residential indicator with neighborhoods – Philadelphia (west)

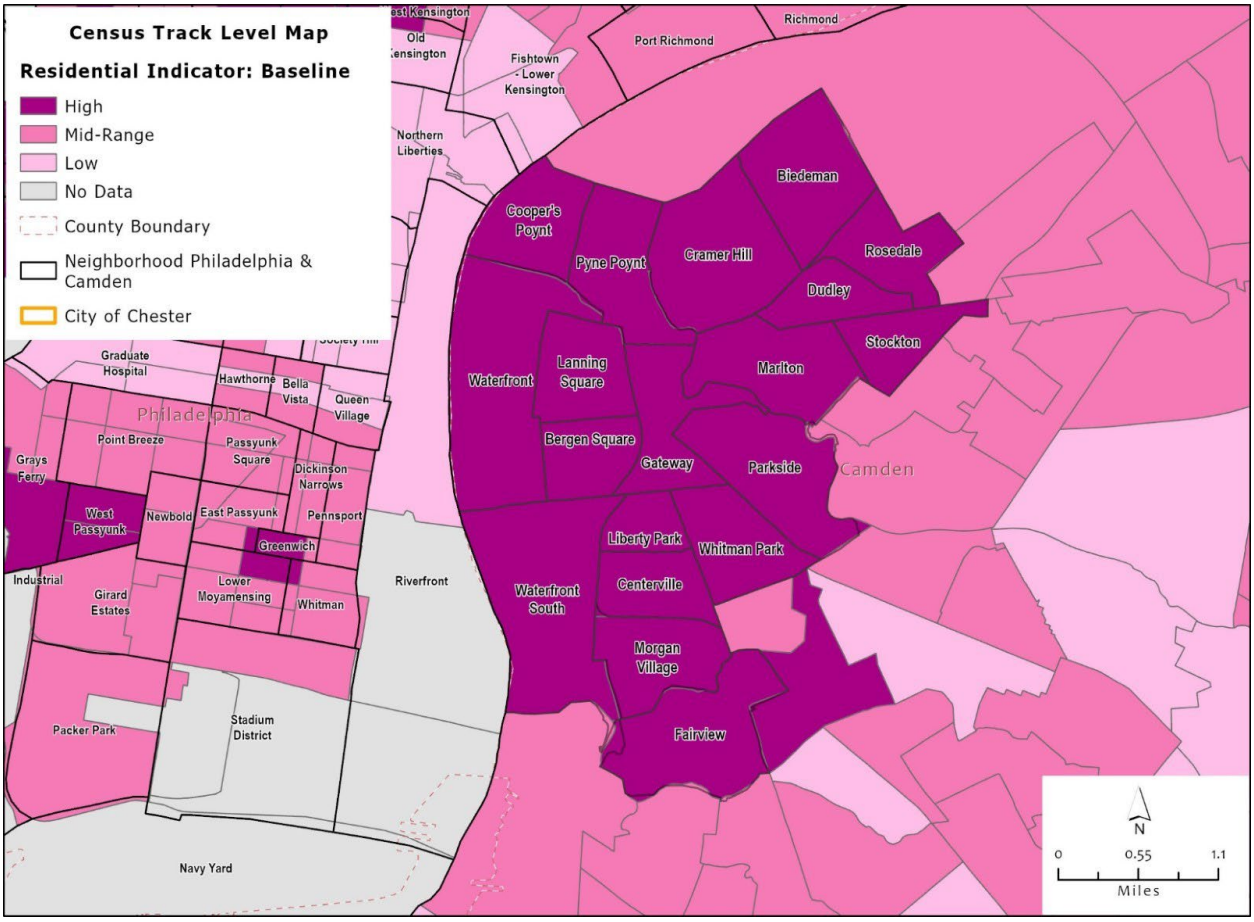

Figure D- 15: Overlay of residential indicator with neighborhoods - Camden

APPENDIX E – REPRESENTATIVE LOW FLOW PLOTS FOR EACH UTILITY

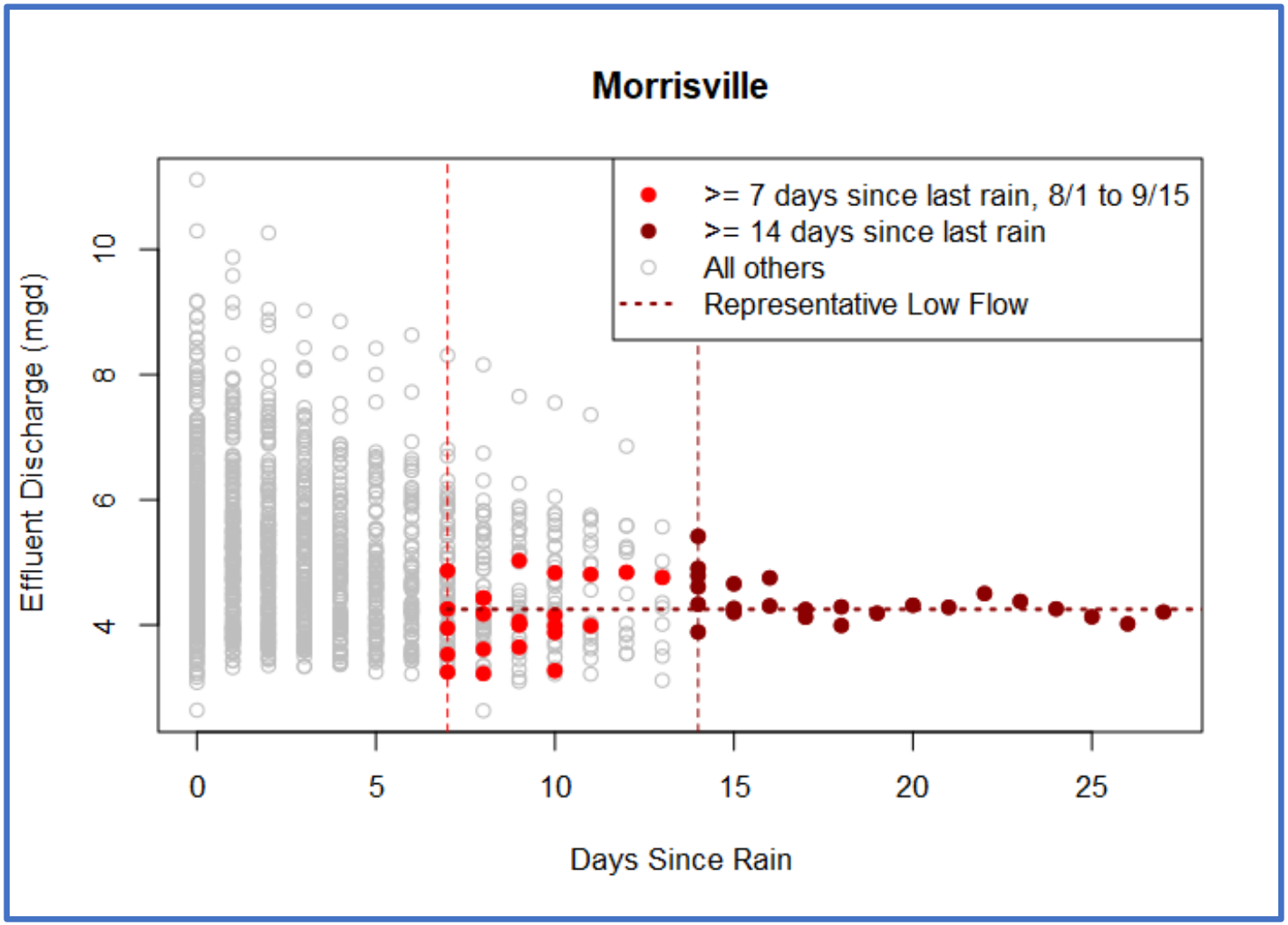

Figure E-1: Representative low flow - Morrisville

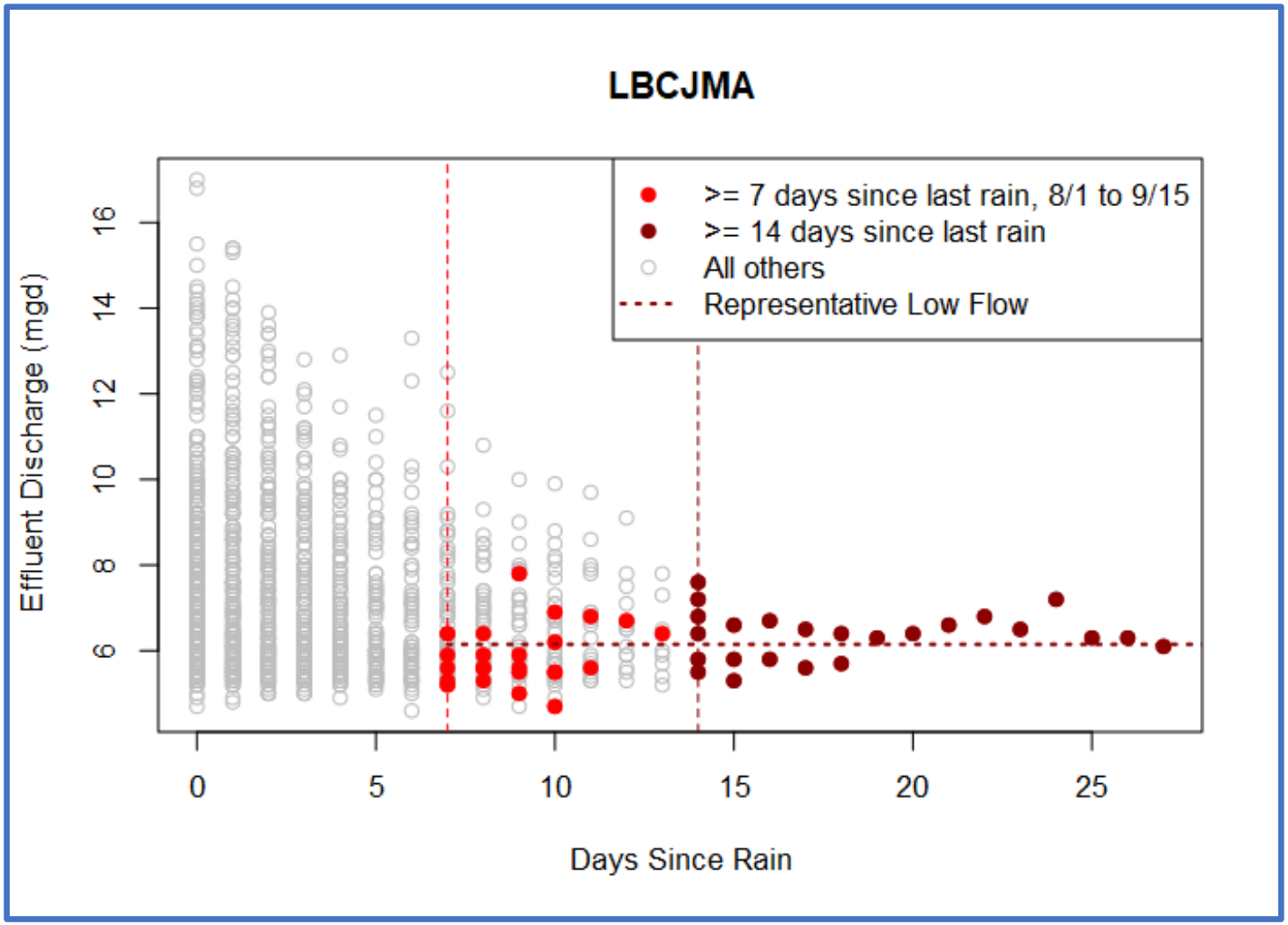

Figure E-2: ***Representative low flow*** **- LBCJMA**

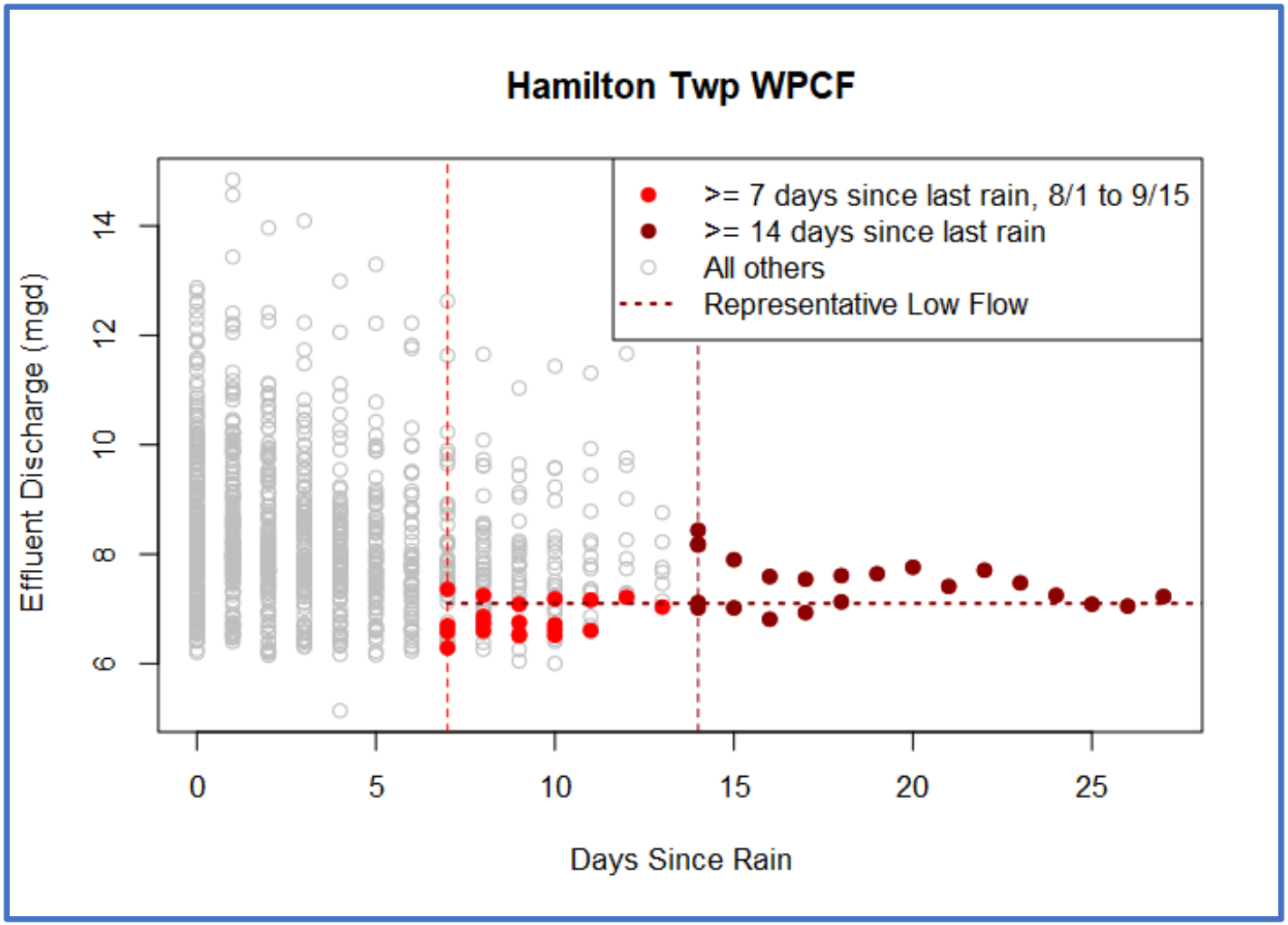

Figure E-3: *Representative low flow* – Hamilton TWP WPFC

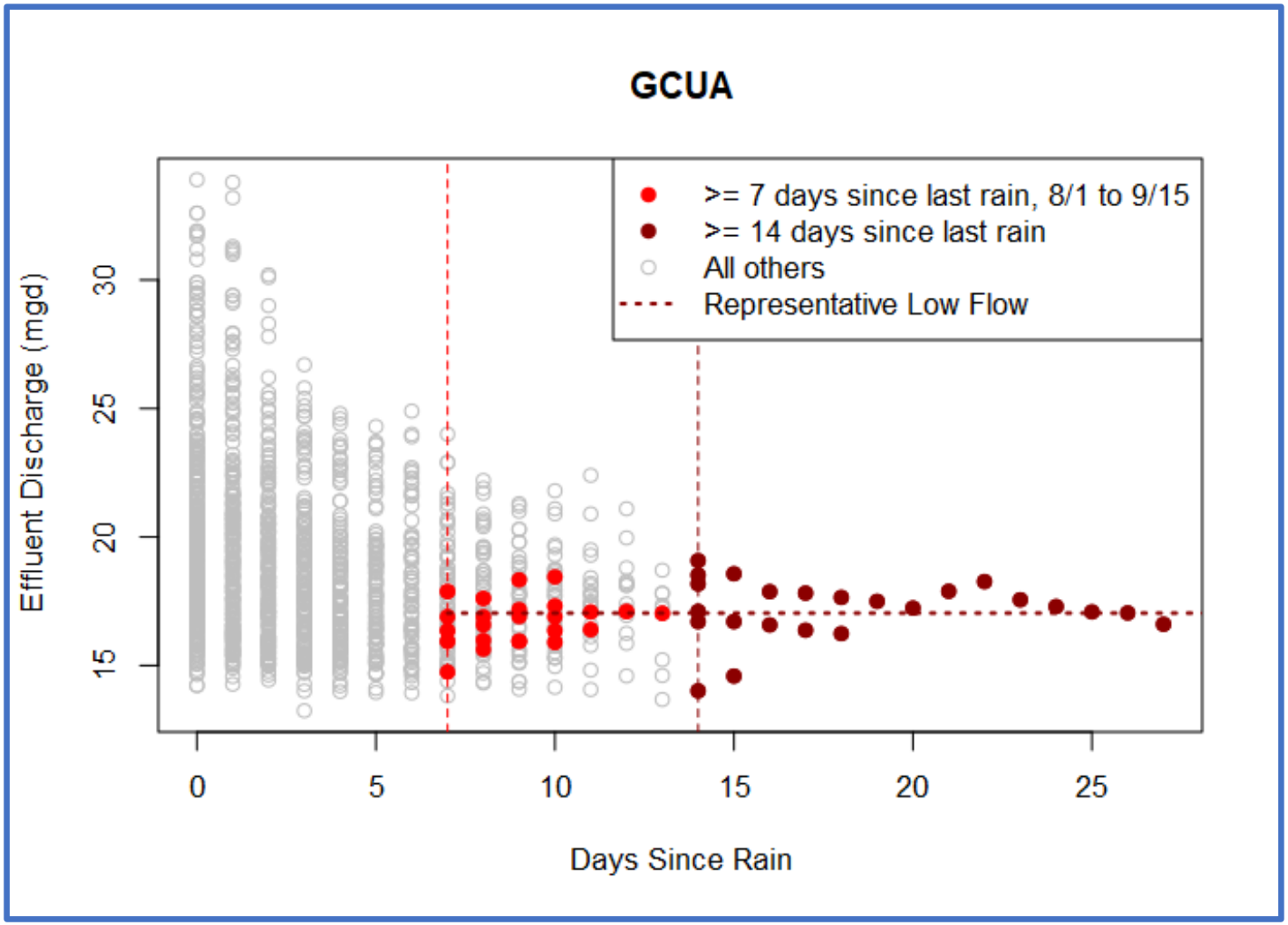

Figure E-4: ***Representative low flow*** **- GCUA**

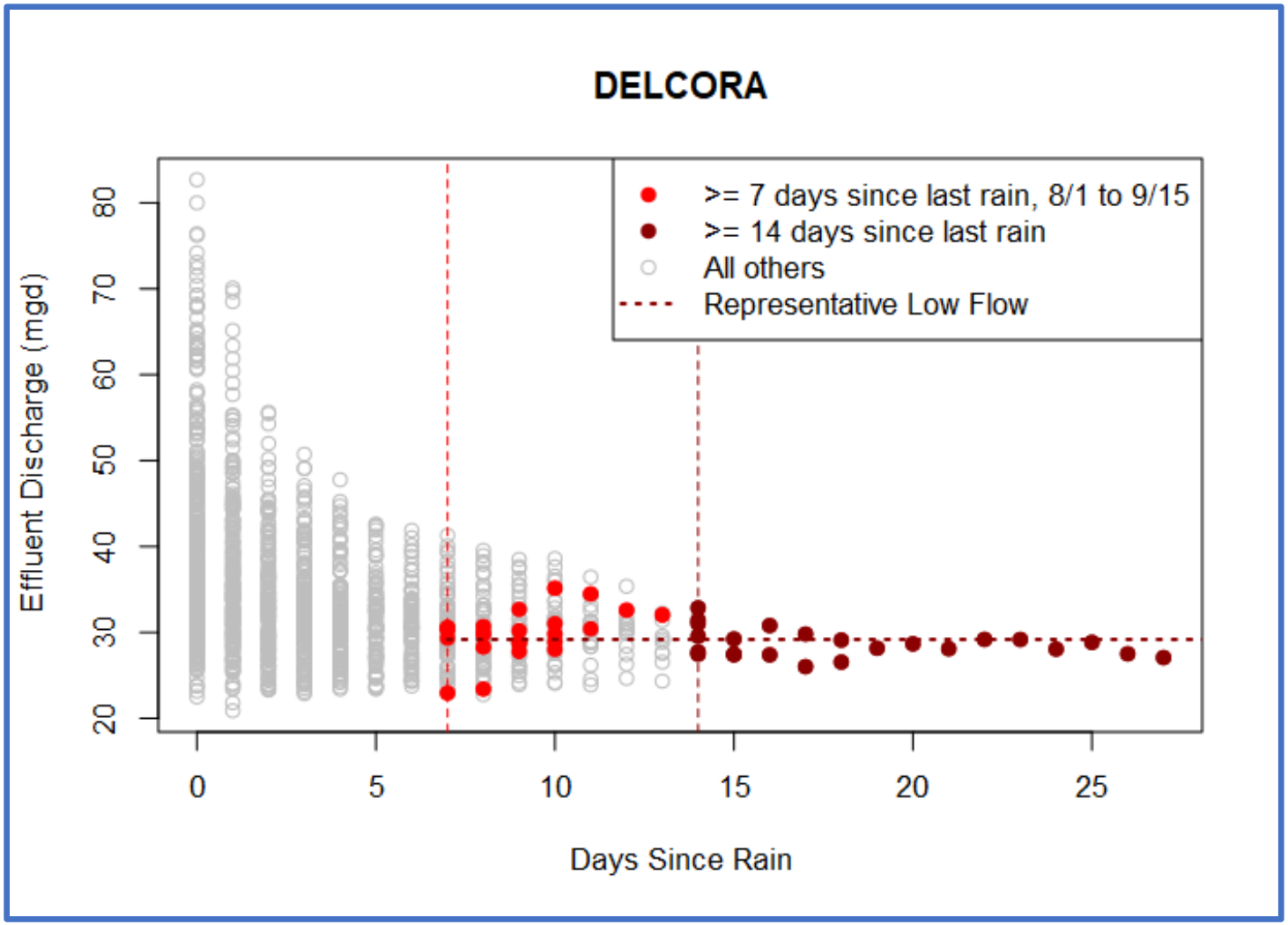

Figure E-5: ***Representative low flow*** **- DELCORA**

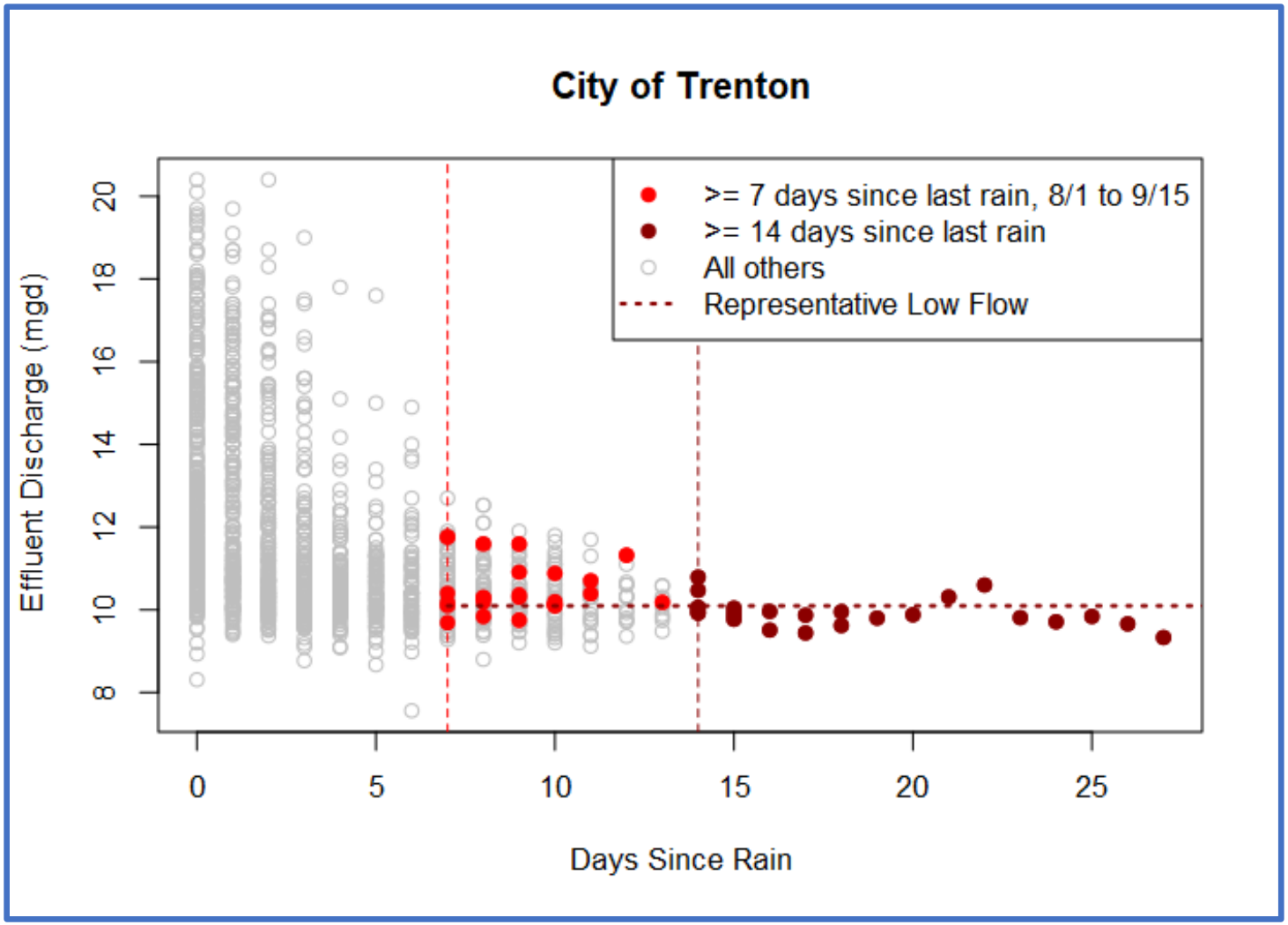

Figure E-6: *Representative low flow* – City of Trenton

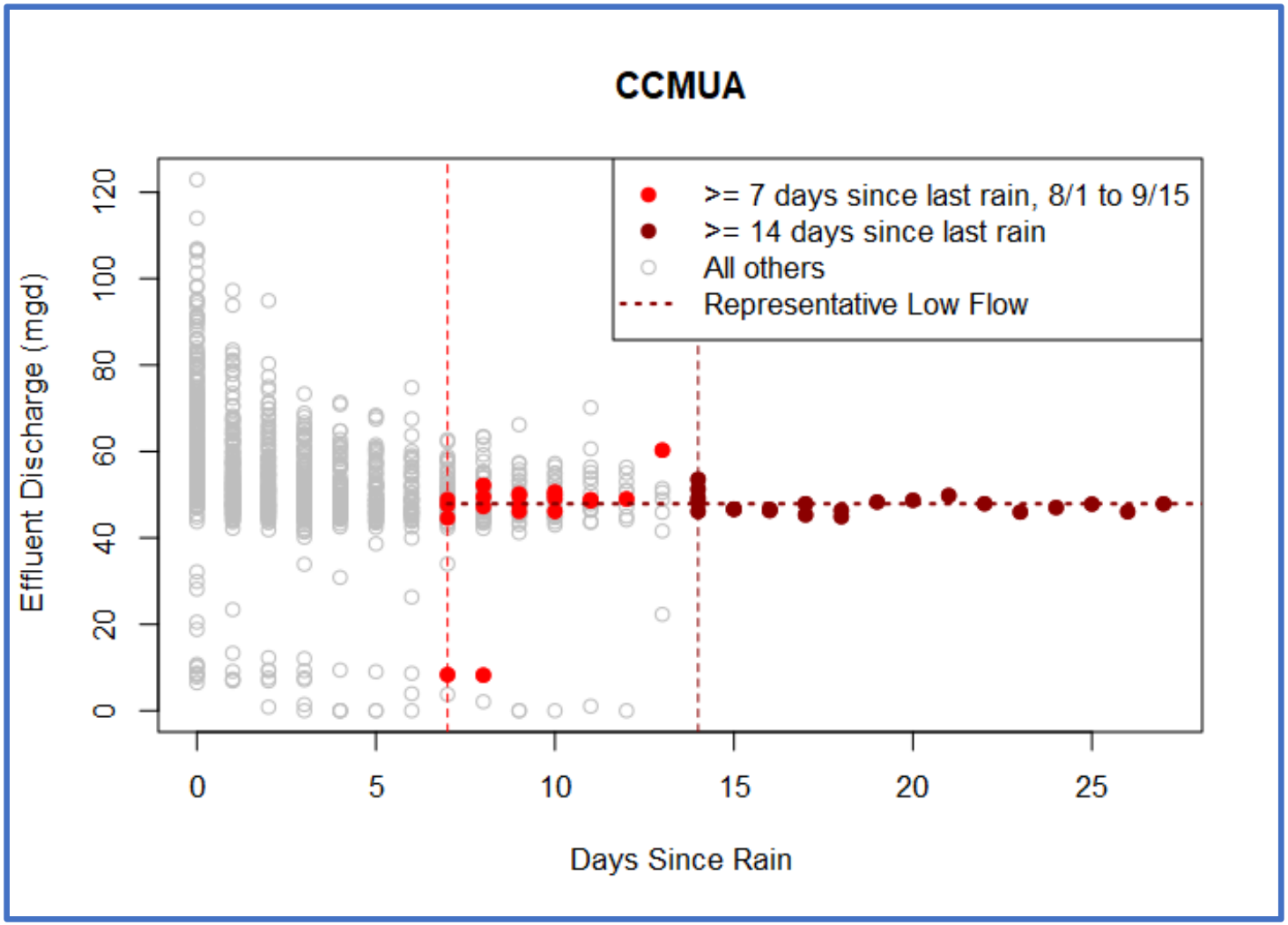

Figure E-7: ***Representative low flow*** **- CCMUA**

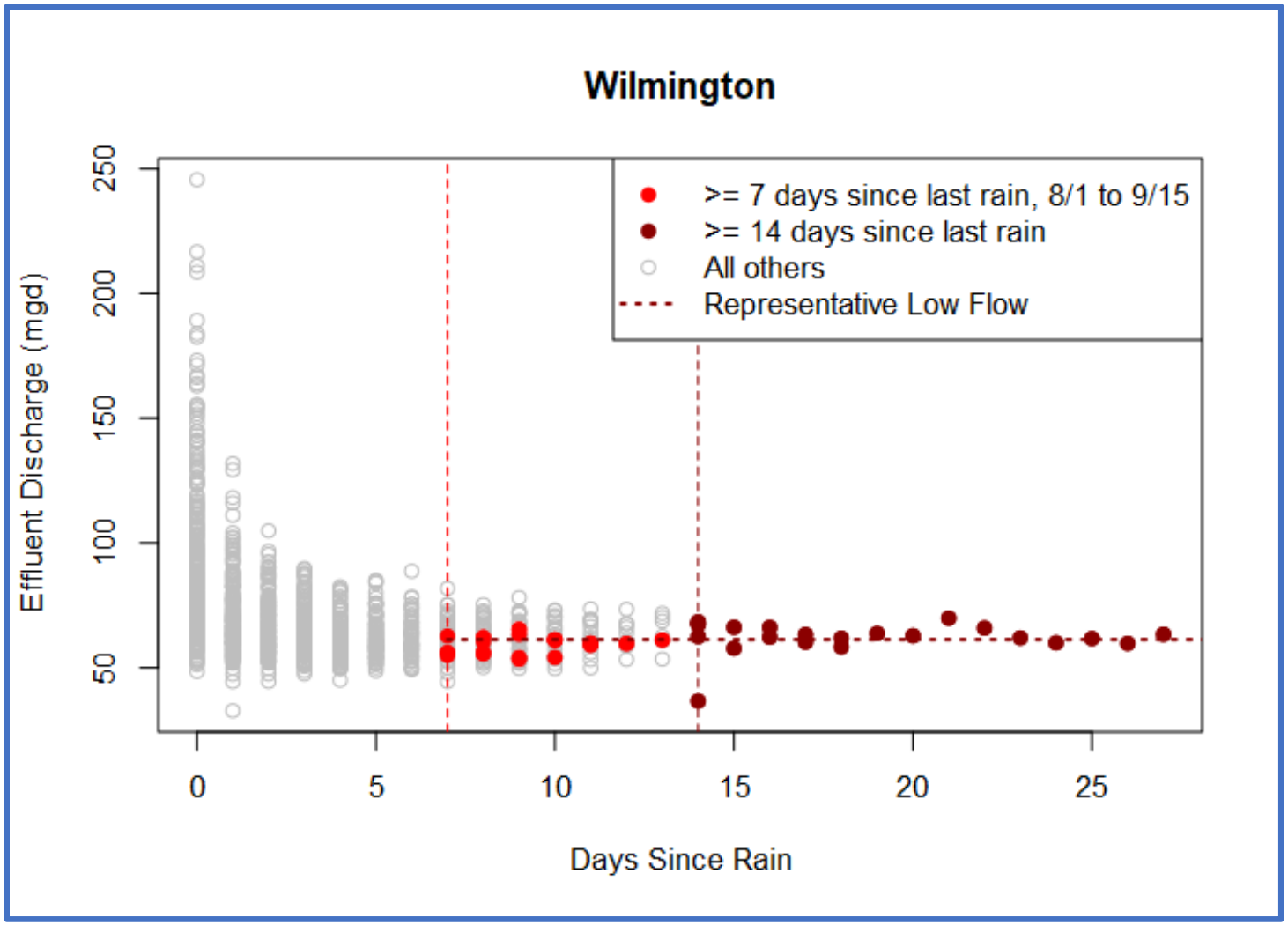

Figure E-8: *Representative low flow* - Wilmington

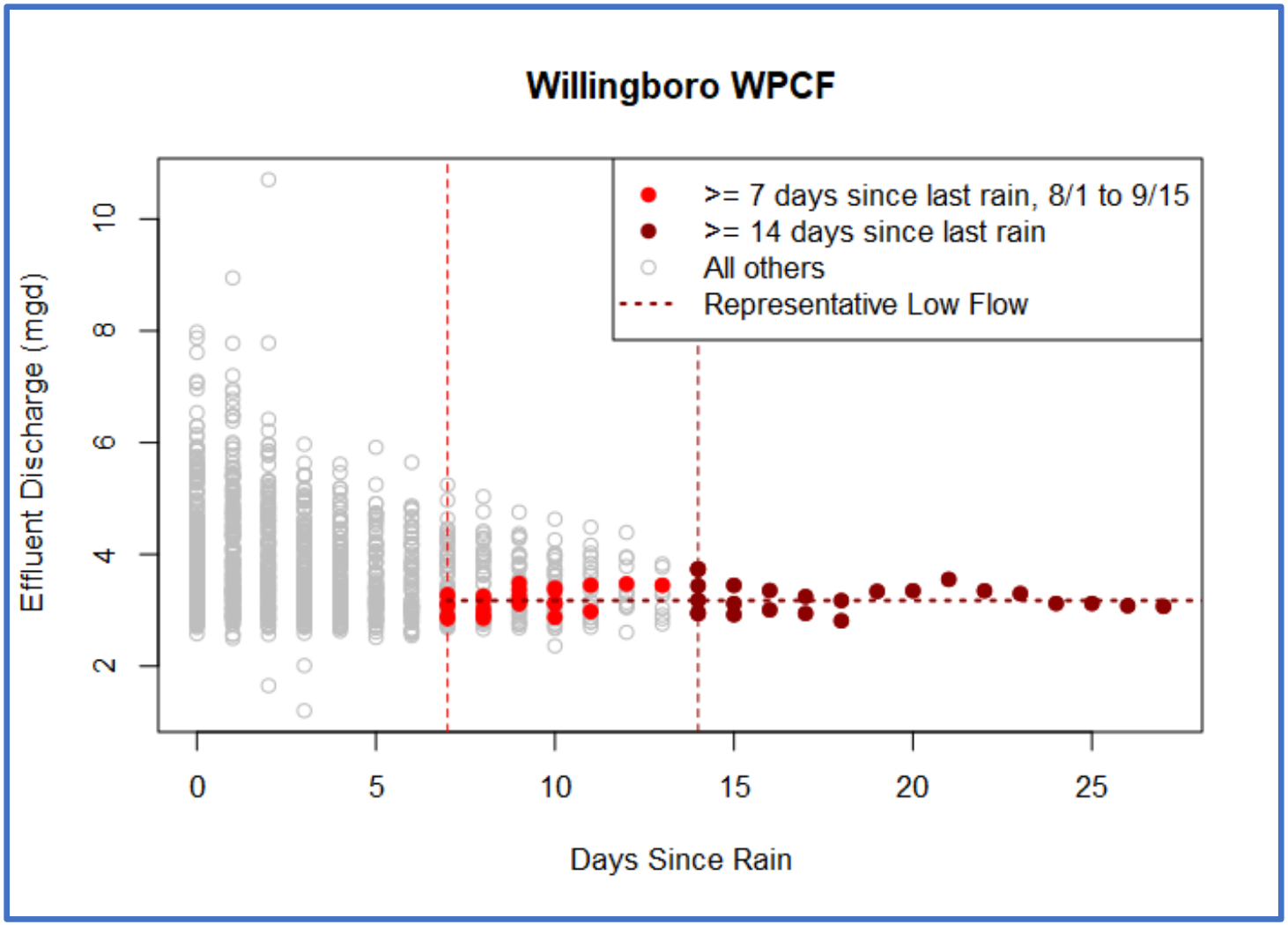

Figure E-9: *Representative low flow* – Willingboro WPCF

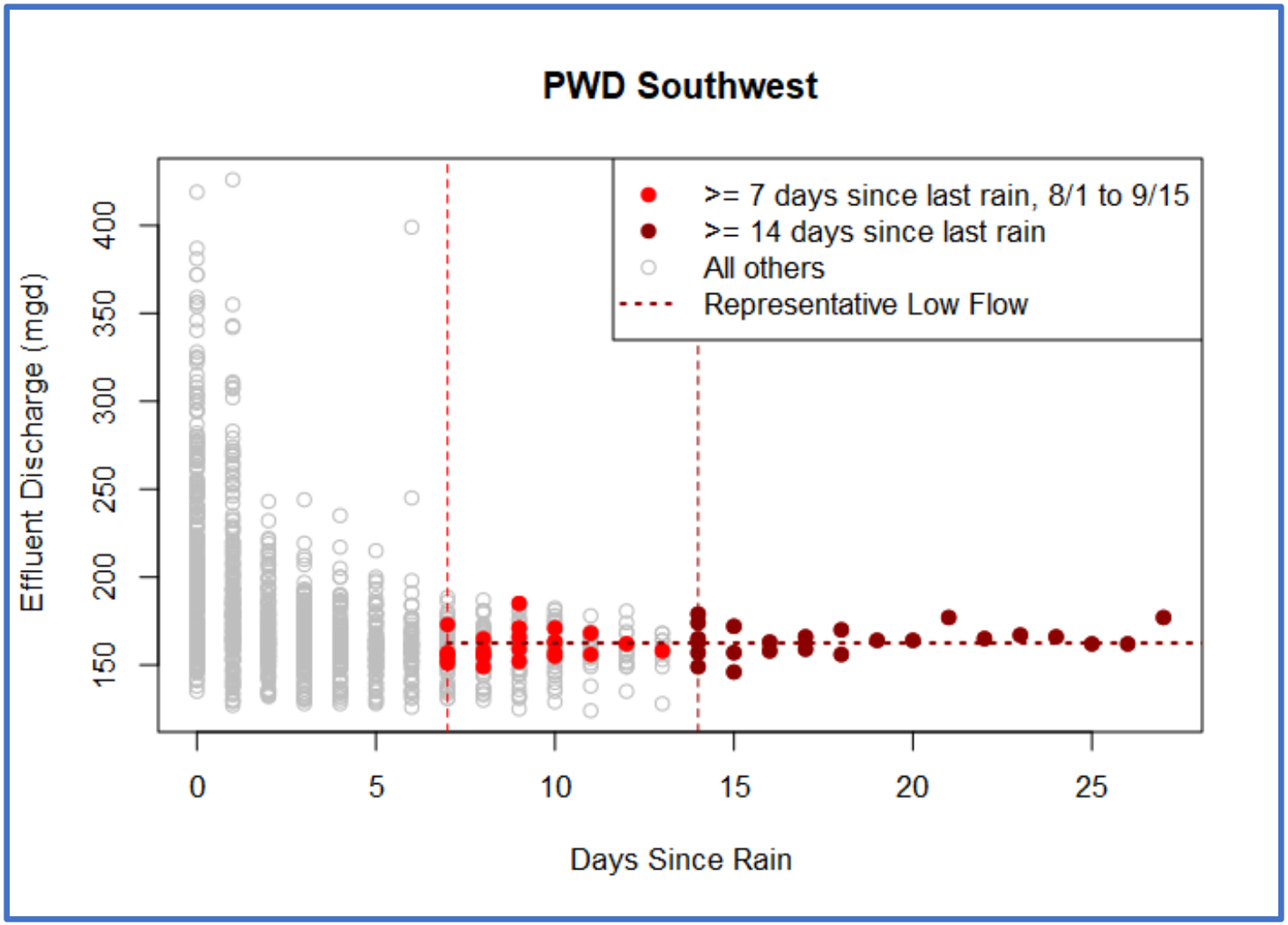

Figure E-10: ***Representative low flow*** **– PWD Southwest**

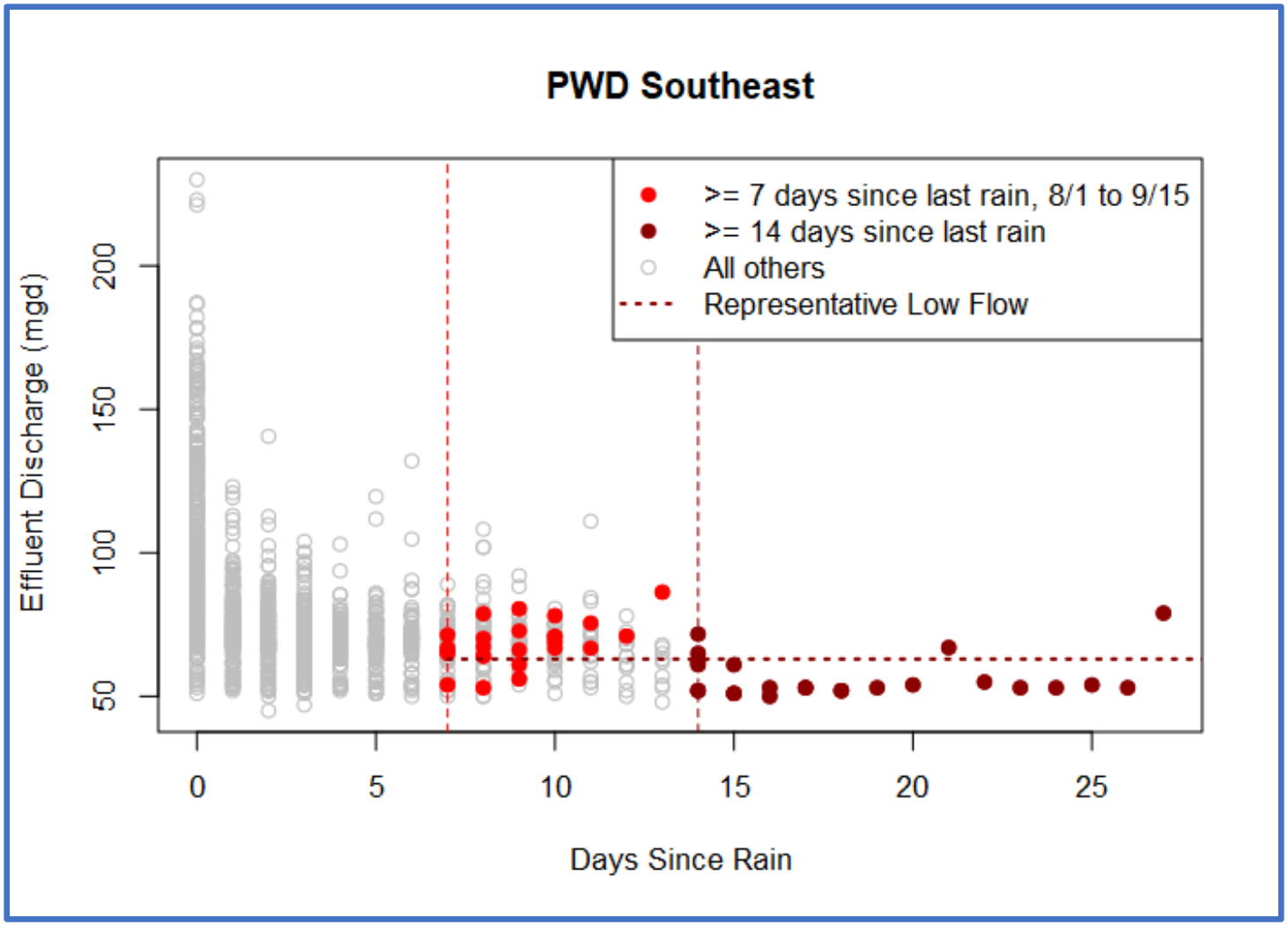

Figure E-11: *Representative low flow* – PWD Southeast

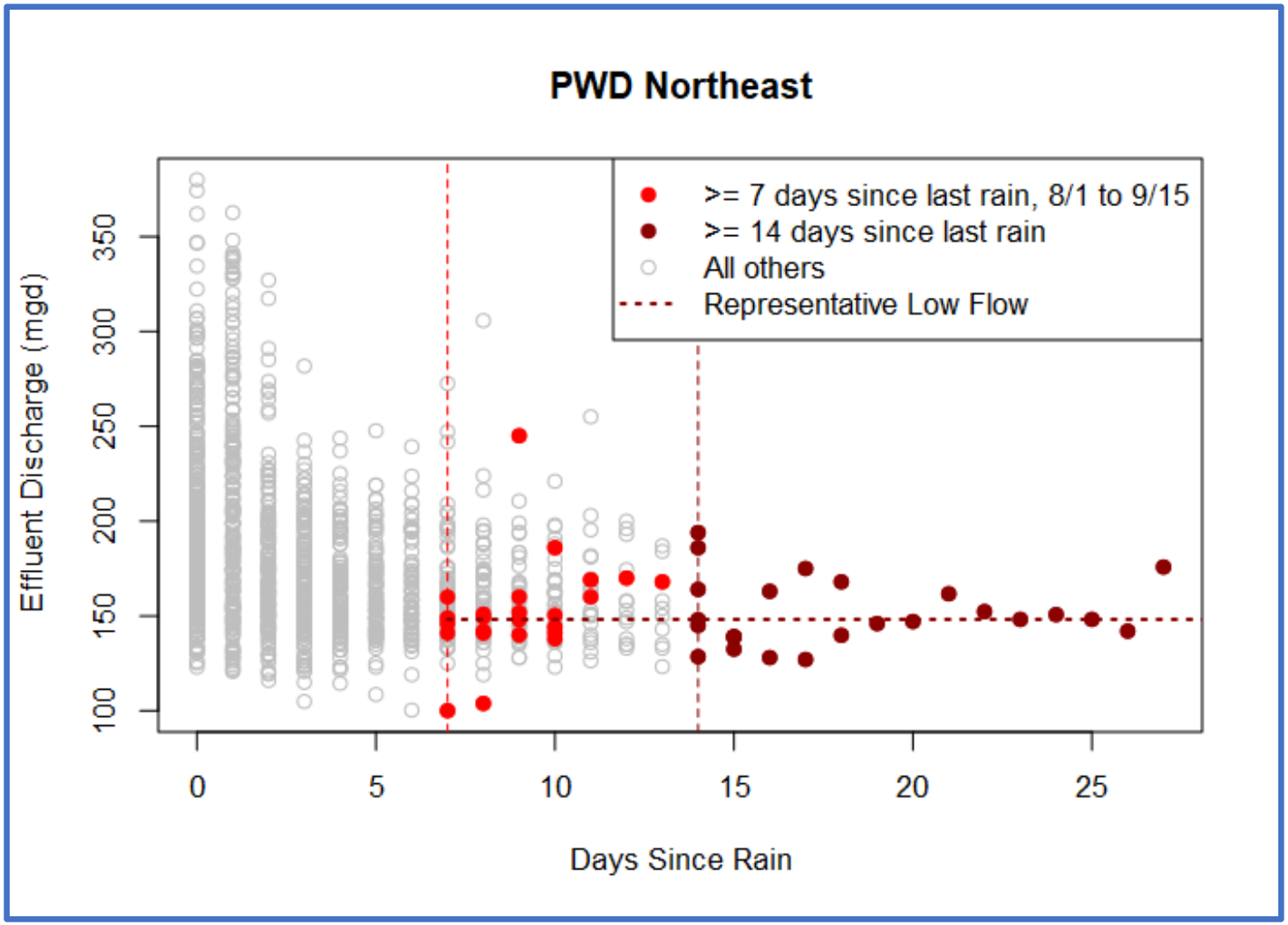

Figure E-12: ***Representative low flow*** **– PWD Northeast**

APPENDIX F – PARTAIL LIST OF COST AND AFFORDABILITY MITIGATION RESOURCES

Item	Description	More Information
Low Income Household Water Assistance Program (LIHWAP)	**LIHWAP** provides funds to assist low-income households with water and wastewater bills. LIHWAP grants are available to States, the District of Columbia, the Commonwealth of Puerto Rico, U.S. Territories, and Federally and state-recognized Indian Tribes and tribal organizations that received fiscal year 2021 Low Income Home Energy Assistance Program (LIHEAP) grants.	https://www.acf.hhs.gov/ocs/programs/lihwap
Bipartisan Infrastructure Law (BIL)	The **BIL** Includes $50 billion to the EPA to strengthen the nation's drinking water and wastewater systems. The majority of the water infrastructure dollars will flow through the State Revolving Funds. BIL includes targeted resources to disadvantaged communities.	https://www.epa.gov/system/files/documents/2021-12/governors-bil-letter-final-508.pdf
PENNVEST	**PENNVEST** serves the communities and citizens of Pennsylvania by funding sewer, storm water and drinking water projects. Funding consists primarily of low interest loans (with some grant funding available) to pay for costs associated with design, engineering, and construction of public or private owned drinking water or wastewater systems, non-point source pollution mitigation and storm water projects.	https://www.pennvest.pa.gov/Pages/default.aspx
New Jersey Water Bank (NJWB)	The New Jersey Water Bank (**NJWB**), which administers New Jersey's State Revolving Fund, is a partnership between the New Jersey Department of Environmental	https://www.nj.gov/dep/dwq/cwpl.htm

	Protection and the New Jersey Infrastructure Bank (NJIB) to provide low-cost financing for the design, construction, and implementation of projects that help to protect, maintain and improve water quality and projects to ensure safe drinking water. Projects eligible for financing include a wide variety of wastewater treatment works, stormwater management, drinking water systems, land acquisition, and landfill activities.	
Delaware Water Pollution Control Revolving Fund	The Delaware Water Pollution Control Revolving Fund provides low-interest loans and grants to municipalities, private organizations, nonprofit organizations and private individuals for projects that will improve water quality. Funds are made available to municipalities, private organizations, nonprofit organizations and private individuals in the form of low-interest loans, as well as grants to promote water quality improvement projects. Eligible projects include but are not limited to municipal wastewater treatment projects; nonpoint source pollution abatement projects; watershed protection, restoration, and estuary management projects.	https://dnrec.alpha.delaware.gov/environmental-finance/revolving-fund/
Water Innovation Finance and Innovation Act (WIFIA)	The Water Infrastructure Finance and Innovation Act of 2014 (**WIFIA**) established the WIFIA program, a federal credit program administered by EPA for eligible water and wastewater infrastructure projects. WIFIA and the WIFIA implementation rule outline the eligibility and other requirements for prospective borrowers. Eligible borrowers are local, state, tribal and federal government entities, partnerships and joint ventures, corporation and trusts, clean water and drinking water state revolving fund (SRF) programs	https://www.epa.gov/wifia/what-wifia
State infrastructure financing authority WIFIA (SWIFIA)	A loan program exclusively for State infrastructure financing authority borrowers, authorized by Congress in section 4201 of America's Water Infrastructure Act	https://www.epa.gov/wifia/what-swifia

	(AWIA) of 2018. Eligible borrowers are exclusively State infrastructure financing authorities.	
Environmental Impact Bond (EIB)	An Environmental Impact Bond (**EIB**) is an innovative financing tool that uses a Pay for Success approach to provide up-front capital from private investors for environmental projects, either to pilot a new approach whose performance is viewed as uncertain or to scale up a solution that has been tested in a pilot program. In its most basic form, investors pay the upfront costs for deploying these environmental solutions. Following deployment and program evaluation, the "payor"—whether it's the public agency or private institution that benefits from these solutions—repays investors an amount linked to the achievement of agreed-upon outcomes of the program. The bond structure is designed to meet the payor's needs—whether that's providing risk coverage in the case of underperformance, or a benefits share with investors and contractors to incentivize exceeding performance.	https://www.quantifiedventures.com/blog/what-is-an-environmental-impact-bond
Philadelphia Tiered Assistance Program (TAP)	The Tiered Assistance Program (TAP) provides customers with significant savings by offering a consistent bill based on their income. Customers do not have to be behind on and past due amounts are suspended and not enforced upon while enrolled in the program.	https://www.phila.gov/services/water-gas-utilities/pay-or-dispute-a-water-bill/water-bill-customer-assistance/