State of New Jersey
Department of Environmental Protection

2024 NEW JERSEY STATEWIDE WATER SUPPLY PLAN

APPENDIX D

2050 FORECAST WATER DEMANDS FOR PUBLIC COMMUNITY WATER SYSTEMS

Appendix D:

2050 Forecast Water Demands for Public Community Water Systems

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INTRODUCTION

One component of the 2024 New Jersey Statewide Water Supply Plan is the projection of water demands to the year 2050 for all public community water systems (PCWS) for which sufficient information is available. A spreadsheet model was developed for this purpose, incorporate results from additional spreadsheet models. The model is based upon and updates the methodology from a prior analysis (Van Abs et al., 2018) that provided PCWS demand projection to the year 2040.

Two demand starting points are used – the peak annual average year (from the DEP Deficit/Surplus Analysis) and the annual average demands from the years 2016 through 2020 (from the DEP New Jersey Water Tracking System). To facilitate planning, twelve scenarios are used.

- **Assumption of no change in residential per capita demands**
    1. 2050 Peak Demands: All PCWS retain their current water loss rate (using a reported value where available, or otherwise the median value from 2018-2019 for their respective geographic area (Bedrock and Coastal Plain geology).
    2. 2050 Peak Demands: All PCWS reach a water loss rate equivalent to the median value from 2018-2019 for their respective geographic area.
    3. 2050 Peak Demands: All PCWS reach a water loss rate equivalent to the 25th percentile value from 2018-2019 for their respective geographic area.
    4. 2050 Average Demands: All PCWS retain their current water loss rate (either a reported value or the median value from 2018-2019 for their respective geographic area.
    5. 2050 Average Annual Demands: All PCWS reach a water loss rate equivalent to the median value from 2018-2019 for their respective geographic area.
    6. 2050 Average Annual Demands: All PCWS reach a water loss rate equivalent to the 25th percentile value from 2018-2019 for their respective geographic area.
- **Assumption of a reduction in residential per capita demands by 10 percent by the year 2050**
    7. 2050 Peak Demands: All PCWS retain their current water loss rate (using a reported value where available, or otherwise the median value from 2018-2019 for their respective geographic area).
    8. 2050 Peak Demands: All PCWS reach a water loss rate equivalent to the median value from 2018-2019 for their respective geographic area.
    9. 2050 Peak Demands: All PCWS reach a water loss rate equivalent to the 25th percentile value from 2018-2019 for their respective geographic area.
    10. 2050 Average Annual Demands: All PCWS retain their current water loss rate (using a reported value, or otherwise the median value from 2018-2019 for their respective geographic area).
    11. 2050 Average Annual Demands: All PCWS reach a water loss rate equivalent to the median value from 2018-2019 for their respective geographic area.
    12. 2050 Average Annual Demands: All PCWS reach a water loss rate equivalent to the 25th percentile value from 2018-2019 for their respective geographic area.

The 10 percent reduction in per capita residential demands by the year 2050 is considered a very feasible level, given the ongoing trends for indoor residential demands and the improving technology for outdoor irrigation controllers. The model is constructed so that additional scenarios can be developed with different assumptions for per capita residential demands, using the existing Scenarios 5 through 8 as a base.

Scenarios 1 and 2 have the highest 2050 demands for most PCWS, though some with very low recent water loss rates may show an increase in demands even without a population increase. Scenario 12 has the lowest 2050 demands, as most PCWS would need to achieve a significant reduction in water losses to meet the 25th percentile level.

This appendix provides a detailed methodology and structure for the various spreadsheet programs used in the 2050 PCWS demand forecast scenarios. The tabulated PCWS 2050 Demands Model results are provided at the end of the appendix for the largest PCWS that comprise 80% of total average annual demands for the years 2016-2020.

PCWS 2050 DEMANDS MODEL

The spreadsheet model is developed for 583 PCWS. However, 49 lack peak and average annual demand information from DEP, leaving results for 534 PCWS. The spreadsheet includes six worksheets.

- 2020 Demands
- 2050 No Cons (no reduction in residential per capita demands from 2020 assumptions)
- 2050 Conservation (10% reduction in residential per capita demands from 2020 assumptions)
- Comparisons (of annual demands for all scenarios, relative to total PCWS limits)
- Static Comparisons (Static version of "Comparisons" for analysis)

The first three columns of each worksheet is the same, with basic PCWS information, drawn from DEP's Deficit/Surplus spreadsheet dated 8 June 2022.

A. PWSID Permit #
B. County
C. Name

The remaining columns change with the worksheet.

2020 DEMANDS WORKSHEET

This worksheet provides the foundation for the analysis, compiling available information for each PCWS using either system-specific information or, where direct information is not available, estimates from an analysis of PCWS with specific information. The columns and information sources are included below.

D. D/S Total Limits (mgd): This value is from Column "Total Limits (mgy)" in the DEP's Deficit/Surplus spreadsheet dated 8 June 2022, translated to mgd.
E. D/S Peak Annual Demand (mgd): This value is from Column "Peak Annual Demand (mgd)" in the DEP's Deficit/Surplus spreadsheet dated 8 June 2022.
F. D/S Peak Annual WL (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column R "D/S Peak Annual WL (mgd)".
G. D/S Peak Annual RES Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column S "D/S Peak Annual WL (mgd)".
H. D/S Peak Annual IND Demand (mgd): This value is from the RIC Analysis spreadsheet described below, in Compilations worksheet Column T "D/S Peak Annual WL (mgd)".
I. D/S Peak Annual COMM Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column U "D/S Peak Annual WL (mgd)".
J. D/S Peak Annual IND/COMM Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column V "D/S Peak Annual WL (mgd)". This value is "NA" if there are values in Columns H or I.
K. Check: This value is Column E minus the SUM of Columns F through J as a percentage of Column E (should equal zero).
L. D/S Peak Summer Demand (mgd): This value is Column E times Column X "Ratio Summer: Annual".

M. D/S Peak Non-Summer Demand (mgd): This value is Column E times Column Y "Ratio Non-Summer: Annual".

N. NJWaTr 2016-2020 Average Demand (mgd): This value is from the RIC Analysis spreadsheet described below, PCWS Demands Column H "NJWaTr 2016-2020 Average Demand (mgd)".

O. NJWaTr 2016-2020 Average WL (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column X "NJWaTr 2016-2020 Average WL (mgd)".

P. NJWaTr 2016-2020 Average RES Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column Y "NJWaTr 2016-2020 Average RES Demand (mgd)".

Q. NJWaTr 2016-2020 Average IND Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column Z "NJWaTr 2016-2020 Average IND Demand (mgd)".

R. NJWaTr 2016-2020 Average COMM Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column AA "NJWaTr 2016-2020 Average COMM Demand (mgd)".

S. NJWaTr 2016-2020 Average IND/COMM Demand (mgd): This value is from the RIC Analysis spreadsheet described below, Compilations worksheet Column AB "NJWaTr 2016-2020 Average IND/COMM Demand (mgd)". This value is "NA" if there are values in Columns Q or R.

T. Check: This value is Column N minus the SUM of Columns 0 through S as a percentage of Column N (should equal zero).

U. Average Summer Demand (mgd): This value is Column N times Column X "Ratio Summer: Annual".

V. Average Non-Summer Demand (mgd): This value is Column N times Column Y "Ratio Non-Summer: Annual".

W. (Blank)

X. Ratio Summer: Annual: For PCWS with available monthly demand data, this value is from Column U of the "NJWaTr_PWSID_Demands_2011-2020v3 Analysis" spreadsheet, "PCWS Sort" worksheet, Column U "Ratio Summer: Annual". All others use the relevant value for Bedrock or Coastal systems from Column AC "Median Ratio Summer: Annual".

Y. Ratio Non-Summer: Annual: For PCWS with available monthly demand data, this value is from Column U of the "NJWaTr_PWSID_Demands_2011-2020v3 Analysis" spreadsheet, "PCWS Sort" worksheet, Column V "Ratio Non-Summer: Annual". All others use the relevant value for Bedrock or Coastal systems from Column AD "Median Ratio Non-Summer: Annual".

Z. Ratio Peak Annual: Average Annual: This value is Column E divided by Column N.

2050 NO CONS WORKSHEET

This worksheet builds the first six (No Conservation) scenarios. Three are focused on peak annual demands, with current water losses, "Nominal" water losses (i.e., equivalent to the recent median water loss percentage) or "Optimal" water losses (i.e., equivalent to the recent 25th percentile water loss percentage). The other three scenarios are focused on average annual demands, with the same three water loss options. The columns and information sources are included below.

D. Coastal Plain or Bedrock: CP for PCWS is where the service area is predominantly in the Coastal Plain (Inner and Outer). BR for PCWS is where the service area is predominantly in the Bedrock area (Piedmont, Highlands, Valley & Ridge).

PEAK SECTOR DEMANDS ALL SCENARIOS

E. RES 2050 (mgd): Residential 2020 Demands from "2020 Demands" Column G, multiplied by the percent population change from "PCWS 2050 Pop" Column Z.

F. IND 2050 (mgd): Industrial 2020 Demands from "2020 Demand" Column H.

G. COMM 2050 (mgd): Commercial 2020 Demands from "2020 Demands" Column I, multiplied by the percent population change from "PCWS 2050 Pop" Column Z.

H. IND/COMM 2050 (mgd): Where the values in "2020 Demands" Column J equals "NA", then this column is also "NA". Otherwise, it is the value from "2020 Demands" Column J, multiplied by the percent population change from "PCWS 2050 Pop" Column Z.

CURRENT WATER LOSS SCENARIO (PEAK)

I. WL CURRENT (mgd): Column J minus the sum of Columns E through H, yielding the water losses in 2050 based on continuation of the current (2020) water loss rate.

J. ANNUAL (mgd): Sum of Columns E through H, divided by (1 – "2020 Demands" Column F / "2020 Demands" Column E).

K. SUMMER (mgd): Column J times "2020 Demands" Column X "Ratio Summer: Annual".

L. NON-SUMMER (mgd): Column J times "2020 Demands" Column Y "Ratio Summer: Annual".

MEDIAN 2020 WATER LOSS FOR ALL PCWS (PEAK)

M. WL MEDIAN (mgd): Column N minus the sum of Columns E through H, yielding the water losses in 2050 based on the median 2020 water loss rate.

N. ANNUAL (mgd): Sum of Columns E through H, divided by either 0.88 (representing a Nominal Water Loss of 12% for Coastal Plain PCWS) or 0.83 (representing a Nominal Water Loss of 17% for Bedrock PCWS).

O. SUMMER (mgd): Column N times "2020 Demands" Column X "Ratio Summer: Annual".

P. NON-SUMMER (mgd): Column N times "2020 Demands" Column Y "Ratio Summer: Annual".

OPTIMAL (25TH PERCENTILE) WL FOR ALL PCWS (PEAK)

Q. WL OPTIMAL (mgd): Column R minus the sum of Columns E through H, yielding the water losses in 2050 based on the 25th percentile 2020 water loss rate.

R. ANNUAL (mgd): Sum of Columns E through H, divided by either 0.919 (representing an Optimal Water Loss of 8.1% for Coastal Plain PCWS) or 0.87 (representing an Optimal Water Loss of 13% for Bedrock PCWS).

S. SUMMER (mgd): Column R times "2020 Demands" Column X "Ratio Summer: Annual".

T. NON-SUMMER (mgd): Column R times "2020 Demands" Column Y "Ratio Summer: Annual".

AVERAGE SECTOR DEMANDS ALL SCENARIOS (AVERAGE ANNUAL)

U. RES 2050 (mgd): Residential 2020 Demands from "2020 Demands" Column P, multiplied by the percent population change from "PCWS 2050 Pop" Column Z.

V. IND 2050 (mgd): Industrial 2020 Demands from "2020 Demand" Column Q.

W. COMM 2050 (mgd): Commercial 2020 Demands from "2020 Demands" Column R, multiplied by the percent population change from "PCWS 2050 Pop" Column Z.

X. IND/COMM 2050 (mgd): Where the values in "2020 Demands" Column S equals "NA", this column is also "NA". Otherwise, it is the value from "2020 Demands" Column S, multiplied by the percent population change from "PCWS 2050 Pop" Column Z.

CURRENT WATER LOSS SCENARIO (AVERAGE ANNUAL)

Y. WL CURRENT (mgd): Column Z minus the sum of Columns U through X, yielding the water losses in 2050 based on continuation of the current (2020) water loss rate.

Z. ANNUAL (mgd): Sum of Columns U through X, divided by (1 – "2020 Demands" Column O / "2020 Demands" Column N).

AA. SUMMER (mgd): Column Z times "2020 Demands" Column X "Ratio Summer: Annual".

AB. NON-SUMMER (mgd): Column Z times "2020 Demands" Column Y "Ratio Summer: Annual".

MEDIAN 2020 WATER LOSS FOR ALL PCWS (AVERAGE ANNUAL)

AC. WL MEDIAN (mgd): Column AD minus the sum of Columns U through X, yielding the water losses in 2050 based on the median 2020 water loss rate.

AD. ANNUAL (mgd): Sum of Columns U through X, divided by either 0.88 (representing a Nominal Water Loss of 12% for Coastal Plain PCWS) or 0.83 (representing a Nominal Water Loss of 17% for Bedrock PCWS).

AE. SUMMER (mgd): Column AD times "2020 Demands" Column X "Ratio Summer: Annual".

AF. NON-SUMMER (mgd): Column AD times "2020 Demands" Column Y "Ratio Summer: Annual".

OPTIMAL (25TH PERCENTILE) WL FOR ALL PCWS (AVERAGE ANNUAL)

AG. WL OPTIMAL (mgd): Column AH minus the sum of Columns U through X, yielding the water losses in 2050 based on the 25th percentile 2020 water loss rate.

AH. ANNUAL (mgd): Sum of Columns U through X, divided by either 0.919 (representing an Optimal Water Loss of 8.1% for Coastal Plain PCWS) or 0.87 (representing an Optimal Water Loss of 13% for Bedrock PCWS).

AI. SUMMER (mgd): Column AH times "2020 Demands" Column X "Ratio Summer: Annual".

AJ. NON-SUMMER (mgd): Column AH times "2020 Demands" Column Y "Ratio Summer: Annual".

2050 CONSERVATION WORKSHEET

This worksheet builds the last four scenarios, where residential per capita demands are assumed to be 10 percent lower by 2050. Two are focused on peak annual demands, with either "Nominal" water losses (i.e., equivalent to the recent median water loss percentage) or "Optimal" water losses (i.e., equivalent to the recent 25th percentile water loss percentage). The other two scenarios are focused on average annual demands, with the same two water loss options. The columns and information sources are the same as the "2050 No Cons" worksheet except that the values from the "2050 No Cons" worksheet are multiplied by 0.9 to represent a 10 percent reduction in residential per capita demand for the following columns:

PEAK SECTOR DEMANDS ALL SCENARIOS	AVERAGE SECTOR DEMANDS ALL SCENARIOS
E. RES 2050 (mgd)	U. RES 2050 (mgd)
G. COMM 2050 (mgd)	W. COMM 2050 (mgd)
H. IND/COMM 2050 (mgd)	X. IND/COMM 2050 (mgd)

Table D.1

COMPARISONS WORKSHEET

This worksheet compares the six "No Conservation" and "Conservation" scenarios. Rows highlighted in blue indicate that the PCWS is within the group of largest PCWS meeting 80% of total demands (using 2016-2020 averages); those also in bold are within the group of largest PCWS meeting 50% of total demands. The columns are included below.

A. PWSID Permit # (blue=Top 80%, bold=Top 50%)

B. County

C. Name

D. D/S Total Limits (mgd): from DEP Deficit/Surplus Analysis

E. POP CHANGE % 2020-2050: from PCWS 2050 Pop Worksheet, Column Z (see below)

PEAK ANNUAL, NO CONSERVATION

F. 2020 Peak (mgd): from 2020 Demands Worksheet, Column E

G. 2050 Peak, Current WL% (mgd): from 2050 No Cons Worksheet, Column J

H. 2050 Peak, Median WL% (mgd): from 2050 No Cons Worksheet, Column N

I. 2050 Peak, Optimal WL% (mgd): from 2050 No Cons Worksheet, Column R

PEAK ANNUAL, CONSERVATION

J. 2050 Peak, Current WL% (mgd): from 2050 Conservation Worksheet, Column J

K. 2050 Peak, Median WL% (mgd): from 2050 Conservation Worksheet, Column N

L. 2050 Peak, Optimal WL% (mgd): from 2050 Conservation Worksheet, Column R

AVERAGE ANNUAL, NO CONSERVATION

M. 2020 Annual Average (mgd): from 2020 Demands Worksheet, Column N

N. 2050 Average, Current WL% (mgd): from 2050 No Cons Worksheet, Column Z

O. 2050 Average, Median WL% (mgd): from 2050 No Cons Worksheet, Column AD

P. 2050 Average, Optimal WL% (mgd): from 2050 No Cons Worksheet, Column AH

AVERAGE ANNUAL, CONSERVATION

Q. 2050 Average, Current WL% (mgd): from 2050 Conservation Worksheet, Column Z

R. 2050 Average, Median WL% (mgd): from 2050 Conservation Worksheet, Column AD

S. 2050 Average, Optimal WL% (mgd): from 2050 Conservation Worksheet, Column AH

T. Blank

BALANCES

U. Remaining Capacity (mgd): This column compares the maximum value of columns F through S (i.e., all of the 2050 scenarios plus the 2020 peak and average values) to the Deficit/Surplus value in Column D. If Column D is “NA” then Column U is also “NA”. Some PCWS show “#DIV/0!” where demand data are lacking in the model.

V. Remaining Capacity %: This column expresses Column U as a percentage of Column D (again using “NA” or “#DIV/0!” where Column U is “NA” or “#DIV/0!”).

W. Top 90% of Avg Demands: Based on a separate analysis of annual average demands for the years 2016-2020 (Column M), 118 of the largest PCWS providing a total of 90% of total demands, and PCWS with Column M values of greater than 1.3 mgd are in that group. This column shows Y for PCWS within that group.

X. Top 80% of Avg Demands: Using the same approach for 80% of total demands, the breakpoint value is 2.525 mgd, with Y indicating that the PCWS is within that group (n=64).

Y. Top 50% of Avg Demands: Using the same approach for 50% of total demands, the breakpoint value is 14 mgd, with Y indicating that the PCWS is within that group (n=10).

Z. Top 90% With No Capacity: Where a PCWS within the top 90% group (Column W = “Y”) shows a value in Column V of less than zero (i.e., a deficit either exists or is forecast), then Column Z shows “CONCERN” to indicate a potential problem with meeting future demands. Otherwise, the column shows NA (or “#DIV/0!” where Column V is “#DIV/0!”). Of the 583 PCWS listed, 22 are flagged with “CONCERN”.

AA. NOTES: Provides explanation of issues regarding potential deficits (e.g., existing peak or average demands, peak future demands, average future demands, combination of future demands) or where the analysis has shown an unusual situation, such as where the annual average demands are greater than the peak demands from the Deficit/ Surplus analysis.

STATIC COMPARISONS WORKSHEET

This worksheet is a copy of the values from the Comparisons worksheet to allow for sorting, statistical analysis, etc., without the potential for disturbing the links and equations in the Comparisons worksheet.

PCWS 2050 POP WORKSHEET

This worksheet incorporates the information derived from the dasymetric analysis of PCWS populations for the year 2050, which is used in the 2050 demand scenarios (no conservation and conservation). The values in Columns A through W are static, copied from the population model described in the next section (Column X is blank). The remaining columns are as follows:

Y. POP CHANGE 2020-2050: Column W (POP 2050 TOTAL) minus Column M (POP 2020 TOTAL);

Z. POP CHANGE % 2020-2050: the result in Column Y as a percentage of Column M; and

AA. % 2050 POP in HD/MD: sums the 2050 projected populations in the medium and high-density residential land use classes and expresses it as a percentage of the total 2050 PCWS population (Column W).

PCWS 2020 AND 2050 POPULATION ESTIMATES

This worksheet is a static output from a GIS-based dasymetric evaluation of PCWS populations using 2020 Census populations at the census block level, a GIS coverage of the census blocks, the DEP 2015 Land Use/Land Cover GIS coverage, and the DEP PCWS service area GIS coverage. The full methodology for the dasymetric analysis is explained in Van Abs et al. (2018). In summary, dasymetric analysis is a process of identifying the most likely location of populations within a geographic area (in this case, PCWS service areas) for each census area, using geographic information on relative land use densities for residential housing.

The same method is used to project the location of 2050 municipal populations within PCWS service areas. Where municipal and PCWS boundaries are the same, the result is intuitive for the full population, but the expected development density associated with a population increase will not necessarily be the same as for the existing PCWS population. Given recent development trends in New Jersey, the model assumes that development will be at higher densities unless the municipality is predominantly low-density.

It is understood that all dasymetric models have uncertainties. In this case, the major uncertainties for 2020 populations are the potential for incorrect census data at the block level and the use of land use density categories that include a wide range of possible situations (especially for high density, which can range from 5 units per acres to far higher levels). However, dasymetric evaluations have been used previously in New Jersey and elsewhere and provide better results than any other large-scale methods.

The spreadsheet columns are included below.

A. PWSID #: from DEP Deficit/Surplus Analysis

B. County: From DEP Deficit/Surplus Analysis, this is the primary location of the PCWS, recognizing that some PCWS have multi-county service areas.

C. PCWS Name: from DEP Deficit/Surplus Analysis

D. POP 2020 HD CP: The estimated 2020 PCWS population within high density residential land use areas in any portion of the PCWS service area located within the Coastal Plain.

E. POP 2020 MD CP: The estimated 2020 PCWS population within medium density residential land use areas in any portion of the PCWS service area located within the Coastal Plain.

F. POP 2020 LD CP: The estimated 2020 PCWS population within low and rural density residential land use areas in any portion of the PCWS service area located within the Coastal Plain.

G. POP 2020 HD PM: The estimated 2020 PCWS population within high density residential land use areas in any portion of the PCWS service area located within the Piedmont Province.

H. POP 2020 MD PM: The estimated 2020 PCWS population within medium density residential land use areas in any portion of the PCWS service area located within the Piedmont Province.

I. POP 2020 LD PM: The estimated 2020 PCWS population within low and residential density residential land use areas in any portion of the PCWS service area located within the Piedmont Province.

J. POP 2020 HD HL: The estimated 2020 PCWS population within high density residential land use areas in any portion of the PCWS service area located within the Highlands and Valley & Ridge Provinces.

K. POP 2020 MD HL: The estimated 2020 PCWS population within medium density residential land use areas in any portion of the PCWS service area located within the Highlands and Valley & Ridge Provinces.

L. POP 2020 LD HL: The estimated 2020 PCWS population within low and rural density residential land use areas in any portion of the PCWS service area located within the Highlands and Valley & Ridge Provinces.

M. POP 2020 TOTAL: the totals of Columns D through L

N. POP 2050 HD CP: The estimated 2020 PCWS population within high density residential land use areas in any portion of the PCWS service area located within the Coastal Plain.

O. POP 2050 MD CP: The estimated 2020 PCWS population within medium density residential land use areas in any portion of the PCWS service area located within the Coastal Plain.

P. POP 2050 LD CP: The estimated 2020 PCWS population within low and rural density residential land use areas in any portion of the PCWS service area located within the Coastal Plain.

Q. POP 2050 HD PM: The estimated 2020 PCWS population within high density residential land use areas in any portion of the PCWS service area located within the Piedmont Province.

R. POP 2050 MD PM: The estimated 2020 PCWS population within medium density residential land use areas in any portion of the PCWS service area located within the Piedmont Province.

S. POP 2050 LD PM: The estimated 2020 PCWS population within low and residential density residential land use areas in any portion of the PCWS service area located within the Piedmont Province.

T. POP 2050 HD HL: The estimated 2020 PCWS population within high density residential land use areas in any portion of the PCWS service area located within the Highlands and Valley & Ridge Provinces.

U. POP 2050 MD HL: The estimated 2020 PCWS population within medium density residential land use areas in any portion of the PCWS service area located within the Highlands and Valley & Ridge Provinces.

V. POP 2050 LD HL: The estimated 2020 PCWS population within low and rural density residential land use areas in any portion of the PCWS service area located within the Highlands and Valley & Ridge Provinces.

W. POP 2050 TOTAL: the totals of Columns N through V

PCWS 2016-2020 ANNUAL AVERAGE DEMANDS

This analysis is discussed in detail in Appendix G “Seasonal PCWS Demand Analysis: Statewide and Coastal” of the 2024 NJSWSP. The analysis used monthly and annual water demand data for the years 2016 through 2020 (most recent available) to derive annual average demands and monthly average demands; the latter are used to assess the ratio of summer (June through September) to non-summer demands for each PCWS. Appendix K includes a detailed description of the spreadsheet.

PCWS RESIDENTIAL, INDUSTRIAL AND COMMERCIAL DEMANDS

This analysis is discussed in Appendix F "Estimating New Jersey Residential, Industrial and Commercial Demands by Public Community Water System" of the 2024 NJSWSP. The analysis estimates the percentage of water demands from residential, industrial and commercial (including public uses) customers using information reported to DEP under the Water Quality Accountability Act (the percentage of water sales that are residential), and information voluntarily provided by PCWS regarding the percentage of water sales that are residential, industrial and commercial (RIC). The analysis evaluates the statistical strength of relationships between those values and the percentage of the developed portions of PCWS service areas that are residential, industrial and commercial.

The spreadsheet "PCWS Residential, Industrial and Commercial Demands" provides eight worksheets providing the full analysis of the demand splits for each PCWS.

ALL PCWS RIC

This worksheet summarizes the results from the analyses elsewhere in the spreadsheet. The columns are included below.

A. PWSID Permit #: from DEP Deficit/Surplus Analysis
B. County: primary location of the PCWS, from DEP Deficit/Surplus Analysis
C. PCWS Name: from DEP Deficit/Surplus Analysis
D. D/S Total Limits (mgd): from DEP Deficit/Surplus Analysis
E. D/S Peak Annual Demand (mgd): from PCWS Demands worksheet, Column F
F. D/S Peak Annual WL (mgd): lookup value from Compilations worksheet, Column R
G. D/S Peak Annual RES Demand (mgd): lookup value from Compilations worksheet, Column S
H. D/S Peak Annual IND Demand (mgd): lookup value from Compilations worksheet, Column T
    - For most PCWS, this value is blank; only those PCWS that voluntarily supplied data on industrial demands have a value here.
I. D/S Peak Annual COMM Demand (mgd): lookup value from Compilations worksheet, Column U
    - For most PCWS, this value is blank; only those PCWS that voluntarily supplied data on commercial demands have a value here.
J. D/S Peak Annual IND/COMM Demand (mgd): lookup value from Compilations worksheet, Column V
    - Most PCWS have a value here, back-calculated using other known values. Only those PCWS that voluntarily supplied data on industrial and commercial demands show "NA" here.
K. NJWaTr 2016-2020 Average Demand (mgd): from PCWS Demands worksheet, Column J
L. NJWaTr 2016-2020 Average WL (mgd): lookup value from Compilations worksheet, Column X
M. NJWaTr 2016-2020 Average RES Demand (mgd): lookup value from Compilations worksheet, Column Y
N. NJWaTr 2016-2020 Average IND Demand (mgd): lookup value from Compilations worksheet, Column Z
    - For most PCWS, this value is blank; only those PCWS that voluntarily supplied data on industrial demands have a value here.
O. NJWaTr 2016-2020 Average COMM Demand (mgd): lookup value from Compilations worksheet, Column AA
    - For most PCWS, this value is blank; only those PCWS that voluntarily supplied data on commercial demands have a value here.
P. NJWaTr 2016-2020 Average IND/COMM Demand (mgd): lookup value from Compilations worksheet, Column AB
    - Most PCWS have a value here, back-calculated using other known values. Only those PCWS that voluntarily supplied data on industrial and commercial demands show "NA" here.

CALCULATIONS

This worksheet contains underlying calculations regarding the relationship between the percentage of water sales for residential, industrial and commercial (RIC) customers to the percentage of a PCWS service area that is in residential, industrial and commercial development (excluding all open space and water features). The results are used in other worksheets to develop RIC estimates for PCWS lacking water sales information for these customer classes.

A. PWSID: from DEP Deficit/Surplus Analysis

B. PCWS Name: from DEP Deficit/Surplus Analysis

C. WQAA RES Avg% 2019-2021: from DEP database on reported Residential water sales as a percent of total water sales (i.e., excluding water losses) for the years 2019 through 2021

o In some cases, obvious reporting errors were omitted, resulting in reliance on fewer than three years of data.

D. Blank

E. DEMAND RES %: Values shown here represent voluntary data from a PCWS.

F. DEMAND IND %: Values shown here represent voluntary data from a PCWS.

G. DEMAND COMM %: Values shown here represent voluntary data from a PCWS.

H. Blank

I. LU RES %: percentage of residential land use (all classifications) within the developed portion of a PCWS service area

J. LU IND %: percentage of industrial land use (all classifications) within the developed portion of a PCWS service area

K. LU COMM %: percentage of commercial land use (all classifications including public facilities) within the developed portion of a PCWS service area

L. Blank

M. DEMAND RES %: If a value is provided in Column E, that value is shown here, otherwise the value from Column C is used. The assumption is that the more detailed PCWS information should be used where available.

N. DEMAND IND %: If a value is provided in Column F, that value is shown here.

O. DEMAND COMM %: If a value is provided in Column G, that value is shown here.

P. Blank

Q. Ratio RES Demand/LU: Column M divided by Column I, showing the relationship between residential demands and land use

R. Ratio IND Demand/LU: Column N divided by Column J, showing the relationship between industrial demands and land use. Blank where Column N is blank.

S. Ratio COMM Demand/LU: Column O divided by Column K, showing the relationship between commercial demands and land use. Blank where Column O is blank.

T. Ratio IND/COMM Demand/LU: Where Columns R and S are blank, this value is back-calculated as the ratio of non-residential sales (100 minus Column C, the residential sales) divided by the combined percentages of industrial and commercial land uses (Columns J and K).

ANALYSIS RIC DATA

This worksheet uses information provided voluntarily by PCWS regarding their percentage sales to residential, industrial and commercial users, compares these values to what the same PCWS reported to DEP for percent residential sales, and assesses the relationship between the voluntary information on sales to the percentage of residential, industrial and commercial land uses within the developed portion of each PCWS service area. The analysis is reported in Appendix F. The worksheet columns are included below.

A. PWSID: from DEP Deficit/Surplus Analysis

B. PCWS Name: from DEP Deficit/Surplus Analysis

C. WQAA RES Avg% 2019-2021: from DEP database on reported Residential water sales as a percent of total water sales (i.e., excluding water losses) for the years 2019 through 2021

   - In some cases, obvious reporting errors were omitted, resulting in reliance on fewer than three years of data.

D. DEMAND RES %: The values shown here represent voluntary data from a PCWS.

E. DEMAND IND %: The values shown here represent voluntary data from a PCWS.

F. DEMAND COMM %: The values shown here represent voluntary data from a PCWS.

G. RES DIFF (WQAA-RIC): Column C (WQAA Residential demands) minus Column D (voluntary data)

   - In some cases, PCWS owners apparently reported residential demand percentages through the WQAA portal differently (e.g., as an average of all PCWS owned by the utility, rather than for each individual PCWS) than they did in the voluntary data. Because the voluntary data are more detailed, this analysis assumes that the voluntary data are more accurate.

H. LU RES %: percentage of residential land use (all classifications) within the developed portion of a PCWS service area

I. LU IND %: percentage of industrial land use (all classifications) within the developed portion of a PCWS service area

J. LU COMM %: percentage of commercial land use (all classifications including public facilities) within the developed portion of a PCWS service area

K. DEMAND RES %: equal to Column D

L. DEMAND IND %: equal to Column E unless zero, resulting in no value reported

M. DEMAND COMM %: equal to Column F unless zero, resulting in no value reported

N. Ratio RES Demand/LU: Column K divided by Column H, providing a ratio of percent residential sales to percent land use

O. Ratio IND Demand/LU: if Column L is greater than zero (blank) then Column L divided by Column I, providing a ratio of percent industrial sales to percent land use

P. Ratio COMM Demand/LU: if Column M is greater than zero (blank) then Column M divided by Column J, providing a ratio of percent commercial sales to percent land use

ANALYSIS R-ONLY DATA

This worksheet develops estimates of residential, industrial and commercial sales and ratios for sales to land uses, similar to the prior worksheet but using only the residential sales information provided through the WQAA data portal. The analysis is reported in Appendix F. The worksheet columns are included below.

A. PWSID: from DEP Deficit/Surplus Analysis

B. PCWS Name: from DEP Deficit/Surplus Analysis

C. WQAA RES Avg% 2019-2021: from DEP database on reported Residential water sales as a percent of total water sales (i.e., excluding water losses) for the years 2019 through 2021

   - In some cases, obvious reporting errors were omitted, resulting in reliance on fewer than three years of data.

D. LU RES %: percentage of residential land use (all classifications) within the developed portion of a PCWS service area

E. LU IND %: percentage of industrial land use (all classifications) within the developed portion of a PCWS service area

F. LU COMM %: percentage of commercial land use (all classifications including public facilities) within the developed portion of a PCWS service area

G. LU IND+ COMM %: Column E plus Column F, providing an aggregate industrial plus commercial land use percentage

H. IND/COMM SALES %: back-calculated as 100 minus Column C, in percent

I. Ratio RES Demand/LU: Column C divided by Column D, providing a ratio of percent residential sales to percent land use

J. Ratio IND/COMM Demand/LU: Column H divided by Column G, providing a ratio of percent industrial/commercial sales to percent industrial/commercial land use

COMPILATION

This worksheet estimates residential, industrial and commercial demands in mgd for peak and average demand years using information from the prior two worksheets ("Analysis RIC Data" and "Analysis R-only Data") for the combined set of 214 PCWS. It estimates the amount of water that does not result in water sales to RIC customers using the results of the Water Loss analysis from Appendix E.

The columns are included below.

A. PWSID: from DEP Deficit/Surplus Analysis

B. PCWS Name: from DEP Deficit/Surplus Analysis

C. WQAA RES Avg% 2019-2021: from DEP database on reported Residential water sales as a percent of total water sales (i.e., excluding water losses) for the years 2019 through 2021

o In some cases, obvious reporting errors were omitted, resulting in reliance on fewer than three years of data.

D. DEMAND RES %: The pasted value is the WQAA reported value, except where voluntary data from a PCWS exists

E. DEMAND IND %: values shown here represent voluntary data from a PCWS

F. DEMAND COMM %: values shown here represent voluntary data from a PCWS

G. DEMAND IND/COMM %: Where no voluntary data from a PCWS exists, the value is 100-Column D, representing the non-residential component of water sales.

H. RES DIFF (WQAA-RIC): The pasted value from Column G of "Analysis RIC Data" worksheet

I. LU RES %: The pasted value from Column D of "Analysis R-only Data" worksheet

J. LU IND %: The pasted value from Column E of "Analysis R-only Data" worksheet

K. LU COMM %: The pasted value from Column F of "Analysis R-only Data" worksheet

L. LU IND+ COMM %: The pasted value from Column G of "Analysis R-only Data" worksheet

M. Ratio RES Demand/LU: The pasted value from Column I of "Analysis R-only Data" worksheet, except where a value exists for the PCWS in Column H of "Analysis RIC Data".

N. Ratio IND Demand/LU: The pasted value from Column O of "Analysis R-only Data" worksheet

O. Ratio COMM Demand/LU: The pasted value from Column J of "Analysis R-only Data" worksheet, except where a value exists for the PCWS in Column P of "Analysis R-only Data" worksheet

P. WL %: lookup value from "WL Analysis" worksheet, Column C.

Q. D/S Peak Annual Demand (mgd): lookup value from "PCWS Demands" worksheet, Column E

R. D/S Peak Annual WL (mgd): Column Q times Column P, in mgd

S. D/S Peak Annual RES Demand (mgd): Column Q minus Column R (providing the peak total demands not involved in water loss) times Column D, in mgd

T. D/S Peak Annual IND Demand (mgd): if there is a value in Column E, Column Q minus Column R (providing the peak total demands not involved in water loss) times Column E, in mgd

U. D/S Peak Annual COMM Demand (mgd): if there is a value in Column F, Column Q minus Column R (providing the peak total demands not involved in water loss) times Column F, in mgd

V. D/S Peak Annual IND/COMM Demand (mgd): if there is no value in Column U, Column Q minus Column R (providing the peak total demands not involved in water loss) times Column G, in mgd

W. NJWaTr 2016-2020 Average Demand (mgd): lookup value from "PCWS Demands" worksheet, Column J

X. NJWaTr 2016-2020 Average WL (mgd): Column W times Column P, in mgd

Y. NJWaTr 2016-2020 Average RES Demand (mgd): Column W minus Column X (providing the average total demands not involved in water loss), times Column D, in mgd

Z. NJWaTr 2016-2020 Average IND Demand (mgd): if there is a value in Column E, Column W minus Column X (providing the average total demands not involved in water loss) times Column E, in mgd

AA. NJWaTr 2016-2020 Average COMM Demand (mgd): if there is a value in Column F, Column W minus Column X (providing the average total demands not involved in water loss) times Column F, in mgd

AB. NJWaTr 2016-2020 Average IND/COMM Demand (mgd): if there is no value in Column AA, Column W minus Column X (providing the average total demands not involved in water loss) times Column G, in mgd

PCWS DEMANDS

This worksheet calculates estimated 2020 residential demands for all 583 PCWS in the model using the 2020 dasymetric population estimates by residential land use density from the "PCWS 2020 and 2050 Population Estimates" described above and the per capita residential demands from Van Abs et al. (2018).

A. PWSID Permit #: from DEP Deficit/Surplus Analysis

B. County: primary location of the PCWS, from DEP Deficit/Surplus Analysis

C. PCWS Name: from DEP Deficit/Surplus Analysis

D. D/S Total Limits (mgd): from DEP Deficit/Surplus Analysis

E. D/S Peak Annual Demand (mgd): from PCWS Demands worksheet, Column F

F. Peak Annual Demand Used (mgd): The value from Column E unless "NA", at which point the value is Column I times 1.49, which is the median ratio of peak to annual average demands for those PCWS with sufficient information.

G. NJWaTr 2016-2020 Average Demand (mgd): from DEP, as discussed in Appendix G "Seasonal PCWS Demand Analysis: Statewide and Coastal", as listed in the "PCWS 2016-2020 Annual Average Demands" spreadsheet

H. Average Demand by Pop Served (mgd): If Column G is "NA" (no available average demand) then this value is from Column AC.

I. Average Annual Demand Used (mgd): the value from Column G of H, whichever is not "NA"

J. POP 2020 HD CP: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column D

K. POP 2020 MD CP: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column E

L. POP 2020 LD CP: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column F

M. POP 2020 HD PM: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column G

N. POP 2020 MD PM: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column H

O. POP 2020 LD PM: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column I

P. POP 2020 HD HL: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column J

Q. POP 2020 MD HL: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column K

R. POP 2020 LD HL: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column L

S. POP 2020 TOTAL: from "PCWS 2020 and 2050 Population Estimates" spreadsheet, Column M

T. HD CP (mgd): Column AF Row 2 from the residential per capita demand table (see below) times Column J, expressed as mgd

U. MD CP (mgd): Column AF Row 3 from the residential per capita demand table (see below) times Column K, expressed as mgd

V. LD CP (mgd): Column AF Row 4 from the residential per capita demand table (see below) times Column L, expressed as mgd

W. HD PM (mgd): Column AG Row 2 from the residential per capita demand table (see below) times Column M, expressed as mgd

X. MD PM (mgd): Column AG Row 3 from the residential per capita demand table (see below) times Column N, expressed as mgd

Y. LD PM (mgd): Column AG Row 4 from the residential per capita demand table (see below) times Column O, expressed as mgd

Z. HD HL (mgd): Column AH Row 2 from the residential per capita demand table (see below) times Column P, expressed as mgd

AA. MD HL (mgd): Column AH Row 3 from the residential per capita demand table (see below) times Column Q, expressed as mgd

AB. LD HL (mgd): Column AH Row 4 from the residential per capita demand table (see below) times Column R, expressed as mgd

AC. TOTAL (mgd): sum of Columns T through AB

The final portion of this worksheet is a table from Van Abs et al. (2018) providing the per capita water demands (annual, summer and non-summer) by geophysical region (Coastal Plain, Piedmont, Highlands and Valley & Ridge).

	AE	AF	AG	AH
Row	**Residential Density/Region**	**Coastal Plain (CP)**	**Piedmont (PM)**	**Highlands and Ridge & Valley (HL)**
2	**High Density (HD) Annual**	47.92	58.46	42.04
3	**Medium Density (MD) Annual**	59.04	61.2	53.52
4	**Low Density (LD) Annual**	93.27	73.95	61.09
5	**High Density (HD) Summer**	53.49	62.61	42.47
6	**Medium Density (MD) Summer**	75.88	76.62	59.42
7	**Low Density (LD) Summer**	141.05	108.92	81.75
8	**High Density (HD) Non-Summer**	45.13	56.27	41.82
9	**Medium Density (MD) Non-Summer**	50.59	53.17	50.62
10	**Low Density (LD) Non-Summer**	69.36	56.61	50.84

Table D.2

PCWS LULC

This worksheet is from the DEP 2015 Land Use/Land Cover GIS coverage, as used in the dasymetric population analysis discussed above in "PCWS 2020 and 2050 Population Estimates".

A. PWSID Permit #: from DEP Deficit/Surplus Analysis
B. PCWS Name: from DEP Deficit/Surplus Analysis
C. RES% Served: the residential percentage of the developed portion of a PCWS service area (i.e., not including open space, wetlands and other non-developed areas)
D. IND% Served: the industrial percentage of the developed portion of a PCWS service area
E. COM% Served: the commercial percentage of the developed portion of a PCWS service area
F. IND/COMM% Served: the combined industrial and commercial percentage of the developed portion of a PCWS service area

WL ANALYSIS

The values in this spreadsheet are from the analysis described below.

A. PWSID Permit #: from DEP Deficit/Surplus Analysis
B. PCWS Name: from DEP Deficit/Surplus Analysis
C. Average 2018-2019 % WL or UFW
D. Source: DEP or Delaware River Basin Commission (DRBC)
E. Overlap with DEP UFW: If water loss information is available from both sources, the value is "Y". The DRBC results were used in this case.
F. Coastal (C) or Bedrock (BR): location of the PCWS service area primarily in the Inner or Outer Coastal Plain (C) or the Piedmont, Highlands or Valley & Ridge regions (BR)
G. Utility Size (L>300 mgm, M>30 mgm, S>5<=30 mgm): based on 2016-2020 annual average water demands as reported by DEP
H. Total Limits (mgm) (From Col I, D/S Analysis 6/2022): PCWS total limits for supplying water based on the DEP Deficit/Surplus Analysis

PCWS WATER LOSS ANALYSIS

This analysis is discussed in detail in Appendix E "New Jersey Assessment of Water Losses for Public Community Water Systems" of the 2024 NJSWSP. The analysis is based on the spreadsheet "Combined UFW NRW Analysis Final". There are three worksheets within the spreadsheet.

WL_UFWCOMBINE W DUPES

This worksheet contains information on water losses reported to both the DEP and Delaware River Basin Commission (DRBC); there are 319 values representing 234 PCWS, as 77 PCWS have submitted information to DEP for either Unaccounted For Water or Water Loss (using the AWWA methodology), and also reported Water Loss values to DRBC. The worksheet calculates the differences between the two reported values in those cases; the differences are split roughly half and half as to which is higher, and the median difference is a negative 1.2 percent. The columns are included below.

A. PWSID Permit #: from DEP Deficit/Surplus Analysis
B. PCWS Name: from DEP Deficit/Surplus Analysis
C. Average 2018-2019 % WL or UFW
D. Source: DEP or DRBC
E. Coastal (C) or Bedrock (BR): location of the PCWS service area primarily in the Inner or Outer Coastal Plain (C) or the Piedmont, Highlands or Valley & Ridge regions (BR)
F. Utility Size (L>300 mgm, M>30 mgm, S>5<=30 mgm): based on 2016-2020 annual average water demands as reported by DEP
G. Total Limits (mgm) (From Col I, D/S Analysis 6/2022): PCWS total limits for supplying water based on the DEP Deficit/Surplus Analysis
H. Overlap with DEP UFW: "Y" if data from the PCWS is available from both agencies
I. UFW-WL: for PCWS with "Y" in Column H, the DEP results minus the DRBC results

WL_UFWANALYSIS BY SIZE

This worksheet uses the DRBC data for PCWS that supplied results to both DEP and DRBC. For all other PCWS, it uses the available data from either DEP or DRBC. PCWS are sorted/grouped by Total Limits:

The analysis calculates the median and 25th percentile water losses as a percentage by Utility Size categories. Those medians are then tabulated as follows:

PCWS Size	Bedrock n=	Coastal n=	Total
Large	13	16	**29**
Medium	42	90	**132**
Small	35	38	**73**
Total	**90**	**144**	**234**

Table D.3

PCWS Size	Median Bedrock %NRW/UFW	Median Coastal %NRW/UFW	Ratio Bedrock to Coastal	25th Percentile Bedrock %NRW/UFW	25th Percentile Coastal %NRW/UFW	Ratio Bedrock to Coastal
Large	20.1	11.8	1.7	12.6	7.3	1.7
Medium	16.5	11.2	1.5	12.7	7.8	1.6
Small	17.1	13.7	1.3	13.0	9.2	1.4

Table D.4

The worksheet columns are included below.

A. PWSID Permit #: from DEP Deficit/Surplus Analysis
B. PCWS Name: from DEP Deficit/Surplus Analysis
C. Average 2018-2019 % WL or UFW
D. Source: indicates which data source was used (DEP or DRBC)
E. Overlap with DEP UFW: "Y" if data from the PCWS was available from both agencies, and so the DRBC data was used
F. Coastal (C) or Bedrock (BR): location of the PCWS service area primarily in the Inner or Outer Coastal Plain (C) or the Piedmont, Highlands or Valley & Ridge regions (BR)
G. Utility Size (L>300 mgm, M>30 mgm, S>5<=30 mgm): based on 2016-2020 annual average water demands as reported by DEP
H. Total Limits (mgm) (From Col I, D/S Analysis 6/2022): PCWS total limits for supplying water based on the DEP Deficit/Surplus Analysis
I. Median Loss %: for each Utility Size category
J. 25th Percentile Loss %: for each Utility Size category

WL_UFWANALYSIS BY REGION

This worksheet assesses water losses for all PCWS in each region, Coastal Plain (C) or Bedrock (BR), regardless of PCWS size. Because the statistical analysis (Appendix E) indicates that the Water Loss percentages are not statistically different between PCWS size classifications for each region, but are statistically different between regions, the values from this worksheet are used in the PCWS Demands Analysis.

The worksheet columns are included below.

A. PWSID Permit #: from DEP Deficit/Surplus Analysis
B. PCWS Name: from DEP Deficit/Surplus Analysis
C. Average 2018-2019 % WL or UFW
D. Source: indicates which data source was used (DEP or DRBC)
E. Overlap with DEP UFW: "Y" if data from the PCWS was available from both agencies, and so the DRBC data was used
F. Coastal (C) or Bedrock (BR): location of the PCWS service area primarily in the Inner or Outer Coastal Plain (C) or the Piedmont, Highlands or Valley & Ridge regions (BR)
G. Utility Size (L>300 mgm, M>30 mgm, S>5<=30 mgm): based on 2016-2020 annual average water demands as reported by DEP
H. Total Limits (mgm) (From Col I, D/S Analysis 6/2022): PCWS total limits for supplying water based on the DEP Deficit/Surplus Analysis
I. Median Loss %: for all PCWS by region (C) or (BR)
J. 25th Percentile Loss %: for all PCWS by region (C) or (BR)