# The Pennsylvania Water and Wastewater Gap Study

pennsylvania

DEPARTMENT OF ENVIRONMENTAL PROTECTION

## EXECUTIVE SUMMARY

Defining what should be done to improve Pennsylvania's water and wastewater systems is a challenge. Most of the systems are small, were built at different times with different materials, face different local geographic and climatic conditions, and have been maintained and managed with varying degrees of care. Some were built well and meticulously cared for, but many are in bad condition.

The Pennsylvania Department of Environmental Protection (DEP) has been concerned about the sustainability of water and wastewater systems for some time and has targeted programs to assist systems with these problems. However, better information was needed to help decision-makers direct large-scale solutions. The *Pennsylvania Water and Wastewater Gap Study* is an attempt to provide some of that information.

In 2002, the U. S. Environmental Protection Agency (EPA) issued the national report, *Clean Water and Drinking Water Infrastructure Gap Analysis*. This study was a landmark because it was the first to introduce the concept of "gap" to the water and wastewater industry. In this context, "gap" is the *difference* between the total amounts of money water or wastewater systems can be expected to generate in total income over a period of time, typically 10-20 years, and the total amount of resources they will need. The dollars "needed" in this calculation include funds for operation and maintenance and debt service in addition to capital improvement needs. This study estimated the gap at $534 billion for all the wastewater and drinking water systems in the U. S. The study explained that 3 percent annual increases in user charges would reduce the gap from $534 billion to $76 billion. This study illustrated that the problem can be addressed in large part with reasonable increases in what consumers pay. The data used for the study was not, however, sufficiently robust to allow conclusions on an individual state basis.

In 2008, Governor Rendell created the Governor's Sustainable Water Infrastructure Task Force to look at the issue of the commonwealth's aging drinking water and wastewater infrastructure. The purpose of the Task Force was to provide an analysis of the issues related to the cost-effective and sustained investment in our water and wastewater infrastructure, including potential funding sources and financing options. The Task Force also addressed the following issues:

1. The current and projected costs and financial resources for the construction, upgrade, repair, operation and maintenance of the commonwealth's water and wastewater infrastructure.
2. The current and projected gap between water and wastewater service and infrastructure financing needs and available resources. The Task Force found the total gap for Pennsylvania was $28.3 billion for wastewater and $15.5 billion for drinking water. This gap could be significantly reduced to $1.7 billion and $5.1 billion, respectively, by simply requiring user rates to be figured to either fully cover the cost of operation or up to 1.5 percent of the median household income; whichever is less.
3. The potential sustainable funding from federal, state, and local sources.
4. The actual costs of providing water and wastewater services.
5. Projected cost savings that could be realized by the implementation of non-structural alternatives ("green" infrastructure).
6. Any recommendations for needed legislative or regulatory change to promote sustainable water and wastewater services.

The Task Force final report, *Creating a Sustainable Solution for Pennsylvania,* was published in November 2008.

DEP learned a great deal about doing gap studies completing this initial analysis and applied that knowledge in a much more efficient effort in 2015. The major improvement in approach came as a result of using existing statewide sources of data and combining them in a logical method to generate updated gap figures. Any method of calculating gap will involve a series of assumptions and therefore some degree of error. However, DEP is convinced that the new approach is at least as valid as the original Gap Study approach, and is much less resource intensive. Another thing that DEP learned is that it is not feasible to calculate a true 20-year gap. This is because capital needs are not normally planned for more than 5-10 years into the future. The 2015 update therefore calculates the 10-year gap for drinking water and wastewater infrastructure. The reader may choose to double those numbers to compare to the 20-year gap calculated in the original Gap Study, but should do so knowing that out-year numbers are less reliable.

At current user rates, the updated (2015) total drinking water and wastewater gap over the next 10 years in Pennsylvania is $18.6 billion, $10.2 billion for drinking water and $8.4 billion for wastewater. That total is reduced to $4.2 billion if rates are increased to 1.5 percent of median household income. Use of 1.5 percent as an affordability standard (each, for water and wastewater, for a total of 3.0 percent) is based on experience in several national financial assistance programs over the past 50 years, and is considered a reliable indicator of what the affordable ceiling should be for the customers of a water or wastewater system. Based on current funding assistance levels, the state will only have $0.9 billion in subsidy dollars to address the $18.4 billion gap, which suggests that user rates need to exceed 1.5 percent and/or funding needs to be increased.

An understanding of gap can be an important sustainability tool for individual systems. A Gap Study at a water or wastewater system is a cursory asset management plan. It provides key information to the system that, if put to use, can move them on a path to improved sustainability.

## ACROYNMS

| | |
|---|---|
| CWNS: | EPA Clean Watersheds Needs Survey |
| DCED: | Pennsylvania Department of Community and Economic Development |
| DEP: | Pennsylvania Department of Environmental Protection |
| DWINS: | EPA Drinking Water Infrastructure Needs Survey & Assessment |
| EPA: | U.S. Environmental Protection Agency |
| MHI: | Median Household Income as calculated by the U. S. Census Bureau |
| O&M: | A combined cost of both operations and maintenance in a water or wastewater system |
| PENNVEST: | The Pennsylvania Infrastructure Investment Authority |

## DEFINITIONS

| | |
|---|---|
| Asset Management: | A process for maintaining a desired level of service at the lowest life-cycle cost. It incorporates a detailed asset inventory, condition assessment, risk of asset failure, the consequences of those failures, an estimated cost of asset renewals and a prioritization and schedule of those renewals |
| Full-Cost Pricing: | A pricing structure for drinking water and wastewater service that fully recovers the cost of providing that service in an economically efficient, environmentally sound and acceptable manner |
| Gap: | The *difference* between the total amounts of money water or wastewater systems can be expected to generate in total income over a period of time, typically 10 or 20 years, and the total amount of resources they will need. The dollars "needed" in this calculation include funds for O&M and debt service in addition to capital improvement needs. Gap can be calculated at actual current user rates as well as at higher rates. Gap data from individual systems can be analyzed on a state or national level to guide policy-level decision-making. |
| Infrastructure: | The basic tools, equipment and facilities used by a water or wastewater system to provide services to its customers. |
| Needs Survey: | Reference to the EPA Clean Watersheds Needs Survey or EPA Drinking Water Infrastructure Needs Survey & Assessment |

## PROBLEM STATEMENT

### Nature of the Problem

Many of Pennsylvania's water and wastewater systems need a significant amount of repair and rehabilitation. Problems caused by failing assets are expected to become more common and more serious. Some of the failures could be locally catastrophic but most will be subtle, like increasingly leaky water and wastewater pipes. All of these anticipated failures will cost money, directly and indirectly, that can be minimized through more cost-effectively planned investments in infrastructure improvements.

Some water and wastewater systems are effectively managed like a business. However, in too many cases, system owners are more focused on keeping customer user rates low, and system managers are content to simply operate what they have. Both operators and owners assume that government funding will always be available when major parts of the system need to be repaired or replaced. However, governmental funding agencies in Pennsylvania do not have enough money to fund all the work needed. In addition, few systems are making regular significant improvements, despite the fact that most of them could assess higher user charge rates to pay for the work.

State policies could address the issue but decision-makers cannot implement policies without hard data. The Pennsylvania Water and Wastewater Gap Study ("Gap Study") is designed to provide some of that information.

### Current Methods of Assessing Need

EPA requires states to collect information on water and wastewater system capital needs. This information is provided to Congress every four years. The most recent "Needs Survey" data for Pennsylvania estimates 20-year capital needs of $14.2 billion for water (2011 DWINS) and $6.9 billion for wastewater (2012 CWNS) for a total of $21.1 billion. These surveys do not collect information on the total cost to operate and maintain water or wastewater systems or the local revenues available to pay for those costs.

EPA produced a national study in 2002 called the *Clean Water and Drinking Water Infrastructure Gap Analysis*. This study was a landmark because it was the first to introduce the concept of "gap" to the water and wastewater industry. In this context, "gap" is the *difference* between the total amounts of money water or wastewater systems can be expected to generate in total income over a period of time, typically 10-20 years, and the total amount of resources they will need. The dollars "needed" in this calculation include funds for O&M and debt service in addition to capital improvement needs. In other words, the basic formula for calculating gap, is:

Gap = [Revenue] – [Current O&M and Debt Service] – [Payments for Capital Improvements]

The 2002 EPA study estimated the gap at $534 billion for all the wastewater and drinking water systems in the U. S. The study explained that 3 percent annual increases in user charges would reduce the gap from $534 billion to $76 billion. The study illustrated that the problem can be addressed in large part with reasonable increases in what consumers pay. The data used for the study was not,

however, sufficiently robust to allow conclusions on an individual state basis. As such there was no way for individual states to tell how well they fare relative to the national average.

In 2008, Governor Rendell created the Governor's Sustainable Water Infrastructure Task Force to look at the issue of the commonwealth's aging drinking water and wastewater infrastructure. The purpose of the Task Force was to analyze the issues related to the cost-effective and sustained investment in our water and wastewater infrastructure, including potential funding sources and financing options. The Task Force used the framework created from the EPA national study to define the gap for the commonwealth's water and wastewater system infrastructure. They found the total 20-year gap for Pennsylvania was $28.3 billion for wastewater and $15.5 billion for drinking water. This gap could be significantly reduced to $1.7 billion and $5.1 billion, respectively, by simply requiring user rates to either fully cover the cost of operation or charge up to 1.5 percent of the median household income; whichever is less. Appendix A is a summary of the methodology the Task Force used to complete the original Pennsylvania Gap Study.

As a result of the lessons learned from the Gap Study, DEP developed a methodology to update the results of the gap analysis using other available data that is less resource intensive to collect. This methodology combines financial data submitted by water and wastewater systems to DCED and the capital improvement data collected as part of the EPA Needs Surveys (referred to in the report as the DCED/NS approach).

**Resource Needs**

The original Gap Study required at least two days per system to collect and process the needed system-specific data. A total of 199 out of the total of 3259 systems successfully completed the study. Approximately 21 other systems were also interviewed but the data were not sufficiently complete for use in the study. That means at least 440 (220 x 2) days were used in the study to collect data on about 6 percent of the systems in the state. Time was also invested by EPA and its contractor.

Alternative methods to estimate the gap figures were developed since completion of the original Gap Study. These methods, described in Appendices B and C, take advantage of existing available data rather than the on-site survey approach taken by the original Gap Study. These methods provide a reasonable approach to updating figures for gap without the time and staff resource necessary for on-site surveys.

For drinking water, the study was constrained because of limited data (explained below and in Appendix B). The effort relied entirely on state staff and college interns, with a total investment of about 50 days in total staff time. For wastewater, the DCED/NS Approach relied entirely on state staff and college interns, with a total investment of about 100 days in total staff time. This effort generated gap data on 439 wastewater systems which represents 20 percent of the 2200 publicly-owned wastewater systems in the state.

**Current Funding Programs**

For the purpose of this study, it is assumed that funding levels will remain stable over the coming 10 years. A listing of the available funding options for Pennsylvania water and wastewater systems is in Appendix D. The largest water and wastewater funding program in Pennsylvania is managed by

PENNVEST with technical support from DEP. Though funding amounts vary from year to year, current estimates reflect PENNVEST funding of $300 million per year in low-interest loans and $60 million per year in grants. Other programs provide a total of $61 million per year. Most of the funding in the state ($342 million, or 81 percent) is provided in the form of loans. The balance of $79 million is grants.

The value of a government subsidized loan to the recipient is a function of how much lower the interest rate is than what would be available on the open market. For example, when the market interest rate is 3.6 percent and a subsidized loan is provided at 2.0 percent the recipient is saving 1.6 percent. In this example the recipient saves 13.9 percent of the cost of the project, which is the same as a 13.9 percent grant.[1]

The value of subsidy dollars to the state is impacted by when it becomes available. Capital construction estimates reflect what it would cost to build the project today. Those costs will increase with inflation. This study addresses that by comparing current construction costs to the present worth of future funding appropriations.

PENNVEST is expected to provide $3.6 billion over the coming 10 years in grants and loans, or $360 million per year. With consideration of terms and present worth, the cash value of that amount is $0.8 billion. Total available subsidy value increases to $0.9 billion when the other funding sources listed in Appendix D are added to the PENNVEST amount.

This study assumes an unrestricted source of private capital that can be borrowed by water and wastewater systems at market rates within affordability constraints.

## UPDATED GAP RESULTS

Since the completion of the original Gap Study, alternative methods to update the gap figures were developed that make use of needs survey and other state data that was unknown or unavailable at the time the Gap Study was developed. These alternative methods, described in Appendices B and C were developed to take advantage of existing available data rather than the on-site survey approach taken by the original Gap Study as described in Appendix A. These methods provide a reasonable approach to updating figures for gap, without the intensive resources needed to complete the on-site surveys done for the Gap Study. Table 1 summarizes the capital needs and gaps as calculated using the different methodologies.

Appendix B is the methodology developed to estimate updated gap numbers for drinking water systems (Macro Approach) and Appendix C is for wastewater systems (DCED/NS Approach). A different approach had to be used for drinking water than was used for wastewater because the DWINS information as provided by EPA does not provide system-specific capital needs. If EPA provides this more detailed financial information to Pennsylvania, the more detailed approach described in Appendix C for wastewater systems could be applied to drinking water systems.

[1] The calculation of savings uses a formula which calculates the annual payment that the system would pay at the market rate, and then makes the same calculation at the subsidized rate. The difference between the two (the annual savings) is multiplied by 20 years, which is the duration of a typical PENNVEST loan. The 20 year savings total is divided by what the total payments would have been at market rate, which provides a percentage savings.

**TABLE 1. Capital Needs and Gap**
$ Billion (From Different Methodologies)

| | Drinking Water | | | | Wastewater | | | |
|---|---|---|---|---|---|---|---|---|
| | Capital Needs | Gap ("As-Is" Rates) | Gap (Rates at 1.0 percent MHI) | Gap (Rates at 1.5 percent MHI) | Capital Needs | Gap ("As-Is" Rates) | Gap (Rates at 1.0 percent MHI) | Gap (Rates at 1.5 percent MHI) |
| Gap Study (20 years) | 11.5 | 15.5 | 8.0 | 5.1 | 25 | 28.3 | 18.0 | 1.7 |
| 2011 DWINS (20 years) | 14.2 | NA | NA | NA | - | NA | NA | NA |
| 2012 CWNS (20 years) | - | NA | NA | NA | 6.9 | NA | NA | NA |
| 2015 Updates (10 years) | | 10.2 | 8.8 | - | | 8.4 | 7.5 | 4.2 |

The available data suggests that drinking water needs will be entirely met on a statewide average basis if rates are allowed, where needed, to rise to 1.5 percent of median household income. As discussed in Appendix B, the nature of the available data limits confidence in the 2015 drinking water "Macro approach," particularly given a much different conclusion from the original Gap Study. No drinking water system is "average" in all respects; in fact, some will have challenging extremes (like low median household income and huge capital needs) which result in a large gap. Those gaps do not go away just because there is another system out there with high median household income and low capital needs. The available data did not however allow more discrete qualification. The effect is to understate the drinking water gap at the 1.0 and 1.5 percent of MHI user charge rates.

Ten wastewater systems had gap calculations from both the original Gap Study and the DCED/NS Approach. The sample size was too small to draw any conclusions about the two approaches from that data.

## LESSONS LEARNED

1. There are different ways to calculate gap. Table 2 is a summary of the advantages and disadvantages of these methodologies.

**TABLE 2. Methodology Summary**

| Methodology | Advantages | Disadvantages |
|---|---|---|
| Original Gap Study -- Capital and financial data collected on-site | 1. Inventory approach promotes accuracy and encourages local asset management | 1. Substantial staff work in addition to doing required EPA Needs Survey<br>2. Requires state to identify replacement and new assets as well as estimate their cost<br>3. Poor statewide statistical precision due to small sample size |
| *DCED/NS Approach* -- Needs Survey capital data for individual systems, with DCED financial data for those systems *(Done for wastewater)* (**The best approach if data is available**) | 1. Low cost and fast to produce and update<br>2. Accurate and precise on a system and state level because it includes data from so many systems | 1. Merging Needs Survey data set with DCED and U.S. Census Bureau can be difficult |
| *Macro Approach* -- Statewide total Needs Survey capital data, with DCED financial data totaled for the state from individual systems | 1. Low cost and fast to produce and update | 1. Macro approach introduces unknown error because the distribution of MHI may track differently than system expenses. |

2. Data collected in a Gap Study should be limited to what is needed for the gap calculation, supplemented by other information needed for sustainability or other clearly-defined purposes. Some of the data collected in the original Gap Study was never used. An example is the mechanism used to collect debt service information. The questionnaire required a listing of each source of debt (generally loans or bonds). The structure of the debt had to be described, as well as the debt service payments required to retire that debt. A problem was encountered when the debt structure used by the system did not fit the programmed formats in the questionnaire. During the data collection phase DEP realized that the only information that was really needed was the total debt service payment for each of the coming 20 years; the structure of the debt instrument did not matter.

3. Accurate data analysis is crucial. The Gap Study calculations done in July 2008 were done quickly and errors were made.

4. Special consideration should be made to ensure inclusion of privately-owned system data. Large investor-owned systems need to be given adequate time to isolate the data for the individual community systems in the sample.

5. Statistical precision should be understood and acceptable:

   - The 2002 EPA Gap Study did not offer any measure of statistical precision.

   - The original Gap Study estimated precision of +/- 49 percent for drinking water suggests a range of the 20-year gap from $4.1 Billion to $12.1 Billion. The precision for wastewater was +/- 22 percent, suggesting a range of $18.3 Billion to $25.4 Billion.

   - The DEP 2015 wastewater calculations calculated an $8.4 Billion "as-is" 10-year gap with a 95 percent confidence interval of +/- $2.3 Billion. The range at 1.0 percent of MHI was $7.5 Billion +/- $1.9 Billion, and at 1.5 percent of MHI, $4.2 Billion +/- $1.3 Billion. The drinking water methodology did not include a method to calculate statistical precision due to the non-availability of system-specific needs data.

## CONCLUSIONS

### Water and Wastewater System Finances

There are two system financial conclusions from the Gap Study:

1. The gap between current system revenues and what will be needed over the next 10 years is significant. The total drops by 77 percent if user rates are raised to 1.5 percent of median household income.

2. The gap which remains after rates are raised to 1.5 percent of median household income is a concern. The total ($4.2 billion, which is entirely for wastewater systems) is significantly more than the available subsidy dollars ($0.9 billion).

### Incorporation into Existing Programs

States know which systems are addressing their drinking water and wastewater treatment obligations. However, states that lack data on gap cannot be expected to know how much of the unsatisfied local financial obligation can affordably be met with local sources.

There is no absolute limit to how high rates can be. It is frequently stated that safe potable drinking water and waterways free of wastewater pollution are priceless. The reality is that states have traditionally found user charge rates of more than 1.5 percent of MHI (each, for water and wastewater) to be high, especially in lower-income communities. If the premise that costs above some acceptable level (like 1.5 percent of MHI) cannot be locally financed is accepted, then it follows that there will need to be some combination of:

- Targeting of public funding to infrastructure needs that are locally unaffordable
- Cost-saving efficiencies
- Increased public financial assistance

## Targeting of Public Financial Assistance

The total subsidy available in Pennsylvania over the next 10-year period is $0.9 billion.[2] This suggests that there will not be enough subsidy money available to satisfy the locally-unaffordable needs, even if the subsidy is distributed strictly with affordability in mind. In Pennsylvania, PENNVEST varies the interest rates of its loans depending on the affordability of the project, but affordability is not the only determinant for identifying which projects are funded and at what terms. This means that less than the $0.9 billion will be available to address the state gap.

## Cost-saving Efficiencies

Asset Management is a process which drinking water and wastewater systems can use to make optimum decisions on asset repair and replacement. The use of Asset Management can save money by timing the replacement of assets so that useful life is maximized and expensive catastrophic failures are minimized. DEP Compliance Assistance Programs are developing tools to promote improvements in the Asset Management process. Within resource limits, DEP will also continue to provide training in Asset Management.

Pennsylvania has also supported energy analyses and system consolidation. It has also considered changes that would prevent the use of water and wastewater system revenues for anything other than system expenses. Pennsylvania has also promoted administrative streamlining at drinking water and wastewater systems.

## Funding

It is unclear what the future will bring relative to funding. It appears unlikely that funding will increase markedly from either state or federal sources, and it could decline. This study has assumed a continuation of the existing situation.

Pennsylvania plans to monitor the success of its programs as resources allow. For example, it would be useful to track the number of systems that apply Asset Management. Changes in system and statewide gap can also serve as indicators of infrastructure health and the overall effectiveness of state programs.

[2] The calculation of that amount required a review of all known funding sources as well as recognition of the differences in funding terms (grant vs. loan). The cash value of funding from programs which provided low-interest loans was calculated to a grant-equivalent. A summary is provided in Appendix D. The figures are different from what was previously developed by the Gap Study because funding programs have changed, errors were corrected and the funding totals were calculated in present-worth to match the present-worth capital cost.

## APPENDIX A
## PENNSYLVANIA GAP STUDY

### Questions to be Answered

One of DEP's primary goals is to target available technical, managerial and financial assistance programs to support sustainable drinking water and wastewater system infrastructure. In 2006, EPA asked DEP if Pennsylvania would like to participate in a state-level Gap Study. DEP agreed to do the study with EPA assistance. The effort was important to Pennsylvania because existing state programs were finding indicators of infrastructure shortfalls, but there was no state-level data to support them. Recognizing the value in a state-level Gap Study, EPA provided Gap Study logic and contractor support, with the intention of incorporating gap concepts into the 2012 CWNS[3]. The beginnings of this study morphed into Governor Rendell's Infrastructure Task Force Study in 2008. The purpose of the Task Force was to finalize a report that provided an analysis of the issues related to the cost-effective and sustained investment in our water and wastewater infrastructure, including potential funding sources and financing options. The Task Force was also assigned the task of: (1) calculating the current and projected costs and financial resources for the construction, upgrade, repair, operation and maintenance of the commonwealth's water and wastewater infrastructure, and (2) the current and projected gap between water and wastewater service and infrastructure financing needs and available resources. The study begun in 2006 with EPA met this purpose.

### Design

*Sampling*

The original Pennsylvania study is based on data collected at drinking water and wastewater systems.

Considerable effort was placed in the selection of the sample. The objective was to derive conclusions on the water and the wastewater systems in each of the six Pennsylvania major river basins (Upper/Middle Susquehanna, Lower Susquehanna, Delaware, Ohio, Potomac, and Great Lakes). The study focused on these basins to maintain statistical accuracy while minimizing workload. The samples were drawn from drinking water and wastewater systems in the EPA Needs Survey databases. The statistical analysis made use of information about the relative needs that the systems were known to have.

Developing a sampling protocol was challenging. Focusing on large systems maximized statistical precision. Studying a large system that has 5 percent of the entire needs in the state added far more statistical reliability than a system that has 0.005 percent of the needs. However, DEP was concerned that needs in small systems were under-represented in the EPA databases. A compromise was made to include a mix of small, medium and large systems in the study. The sample was intended to result in a +/- 30 percent error with a 95 percent confidence level, applied at the basin level. Table 3 is a summary of the sample distribution by system size.

[3] EPA subsequently eliminated the use of a gap approach in the 2012 CWNS due to a shortfall in financial resources.

**TABLE 3. Gap Study Sample Distribution**

**Drinking Water**

| System Population | Total Number of Systems | Percent Sampled | Sample Size |
|---|---|---|---|
| | | | |
| < 3,301 | 1,647 | 1.0 | 16 |
| 3,301-10,000 | 162 | 40.1 | 65 |
| 10,001-50,000 | 104 | 40.4 | 42 |
| > 50,000 | 31 | 61.3 | 19 |
| **Total** | **1,944** | | **141** |

**Wastewater**

| System Flow (MGD) | Total Number of Systems | Percent Sampled | Sample Size |
|---|---|---|---|
| | | | |
| <0.1 | 1,242 | 3.2 | 40 |
| 0.1 - 1 | 380 | 1.1 | 43 |
| 1 – 5 | 200 | 19.0 | 38 |
| >5 | 76 | 40.8 | 31 |
| **Total** | **1,898** | | **152** |

DEP was unable to complete data collection from all the systems in the intended sampling. As a result, the intended level of statistical precision was not achieved. Approximately half of the samples were collected. EPA calculated the statistical reliability at +/- 49 percent for drinking water and +/- 22 percent for wastewater with a confidence level of 95 percent.

*Database and Content of Questionnaire*

The data collected at each system was placed in a computerized questionnaire. The data included information on the general nature of the drinking water or wastewater system, revenues, expenditures, debt service and other information. It provided a basis for estimating capital needs by creating an inventory of existing assets. Each asset was assigned a measure of adequacy and those that would need renewal within 20 years were identified. Additional questions were designed to identify new assets that would need to be added in the system in the next 20 years. Separate questionnaires were developed for drinking water and wastewater systems because the treatment technologies are different. The questionnaires were loaded on laptop computers.

Previous EPA needs surveys were not used as a source of capital needs data for the Gap Study. With few exceptions, these needs surveys only accept needs that are documented by the systems in formal reports. Because most systems in Pennsylvania do not have plans that extend more than 5 to 10 years into the future and some systems have no plans at all, these needs surveys tend to underestimate the 20-year needs.

The data were analyzed to identify assets that would need to be constructed within the coming 20 years and those assets were priced by EPA using national average unit costs, primarily using *RS Means Internet Cost Works*. The data were compiled by the EPA contractor. Errors identified in the compilation were resolved by DEP staff. Information on a system was not used if it was missing components that were needed to calculate gap.

**Data Collection**

DEP sent letters to system owners to inform them of the project and solicit their assistance. The study required an on-site visit by a state employee to the drinking water or wastewater system. Site visits began in late 2007.

The data were collected by 13 state employees. These employees were either DEP permanent staff or part-time employees of DEP's Drinking Water and Wastewater Outreach Assistance Program. These part-time employees also work full-time in some capacity at a water or wastewater system. Each data collector was trained by a single project coordinator in an effort to maintain consistency. These data collectors spent about two days on average to collect and process the data for each system.

The difficulty in collecting the data varied greatly from system to system. Some system managers had all the necessary information available to them. It was not unusual for the system manager to refer the data collector to someone else for financial information. Some data collectors sent the system manager a copy of the questionnaire in advance, a process which likely made the interview more efficient. One large system offered technical and budget information, but despite a number of requests refused to provide revenue information.

The system managers consistently demonstrated a professional concern for the work they do. All were asked to offer advice on what the state should do to support the industry. The most common reply was "provide grants," or "reduce the complexity of the PENNVEST process." Others wanted to have better-trained board members or board members that would reliably attend meetings and support rate increases. Some wanted training on asset management principles or a requirement that systems apply asset management. Some wanted better recognition of the service they provide to the public. One offered to help other systems apply asset management principles at their system.

**Results**

*Total Capital Needs*

The data showed that there is an enormous amount of construction that needs to be done in the next 20 years. It also showed that user charge rates in many systems are low. It showed that much of the need could be addressed by the systems without government subsidy if rates were increased to up to 1.5 percent of local median household income (MHI). It is important to note that the data showed that some systems were able to meet their needs with rates less than 1.5 percent of MHI. Rate increases to 1.5 percent of MHI were not assumed for those systems.

An evaluation of the Gap Study data available in June 2008 was included in the *Governor's Sustainable Infrastructure Task Force Report, Creating a Sustainable Solution for Pennsylvania,* Nov. 1, 2008. Data continued to be collected after the Task Force completed its work until June, 2009. At

that time information was complete for 199 systems (75 drinking water and 124 wastewater systems). The limited data continued to prevent statistically reliable distinctions between basins.

The total estimated capital improvement needs at drinking water systems is $7.5 billion. The total estimated total capital improvement needs at wastewater systems is $23.4 billion. These figures differ from the EPA Needs Surveys for the following reasons:

1. Data for several larger drinking water private systems was either missing or not complete for the Gap Study.
2. The EPA documentation requirements for wastewater systems result in many needs not being included because most systems in Pennsylvania do not have specific plans for more than 5 years.

*Water and Wastewater Infrastructure Gap*

The formula used to calculate the gap in the Pennsylvania Gap Study was:

**[20-Year Gap] = [O&M Expense x 20 years] + [Total Debt] + [Capital Need] – [Annual Revenue x 20 years]**

A system is therefore said to have a gap if it will need more money than it expects to have. The gap amount is normally presented in text as a positive number.

Annual revenue is a function of the number of households and the annual user cost per household. It was calculated first at existing user charge rates, or "as-is" rates. The gap calculation assumes that O&M costs will increase at a rate of 2 percent per year more than inflation. This is because many older assets will not be replaced in the near future and will therefore require increased repairs.

Current research indicates that rates should be considered readily affordable if they are 1.5 percent or less of local MHI. For example, a community with an MHI of $50,000 would be expected to affordably pay up to $750 per household per year or $62.50/month in user charges. Gap was also calculated to show what it would be if each system raised its user charge rates to 0.5, 1.0, 1.5, 2 and 2.5 percent of Median Household Income (MHI). A common outcome was to have a large gap at "as-is" rates, a smaller gap at 1.0 percent and little or no gap at 1.5 or 2 percent.

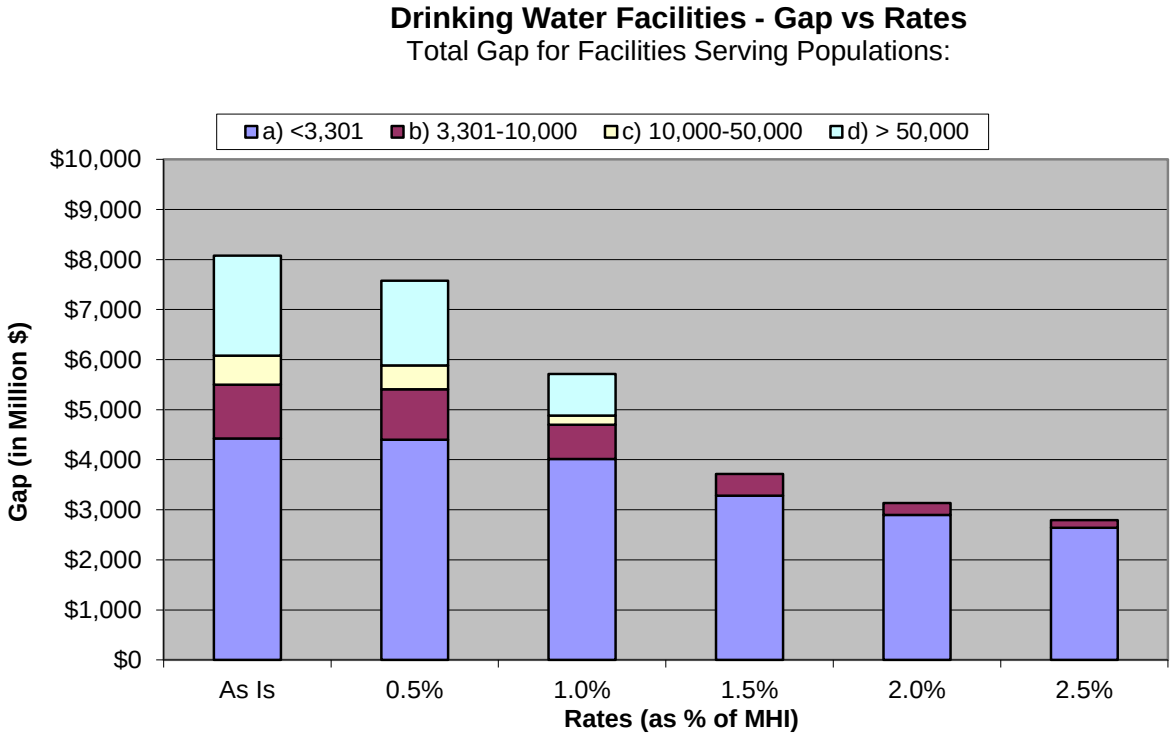
It is difficult to estimate what MHI should be assumed for a drinking water or wastewater system if its service area boundaries do not match the jurisdictional boundaries used by the U.S. Census Bureau. The Gap Study overcame this problem by using a database on the PENNVEST website which maintained a list of system MHI's that were pro-rated to reflect the population in the jurisdictions served by the system.

Commercial and industrial revenue was not included because it was difficult to isolate in most systems and there is no known way to calculate increases that would correspond to the percent of household MHI for these users. It was assumed that this revenue reflected only a small portion of total revenue in most systems, especially those with large gaps. In hindsight, this assumption should have been further tested.

The statewide gap is the total gap for all of the systems in the state. Graph 1 shows the total statewide gap for drinking water. The first column in this graph, "as-is" user charge rates, shows that drinking water systems need a total of $8 Billion more than what is provided at current user charge rates to satisfy 20 year needs. The second column shows that the statewide gap is reduced to $7.6 Billion if user rates are increased to 0.5 percent of local MHI. Similarly, at 1.5 percent of MHI, the gap is $3.7 Billion.

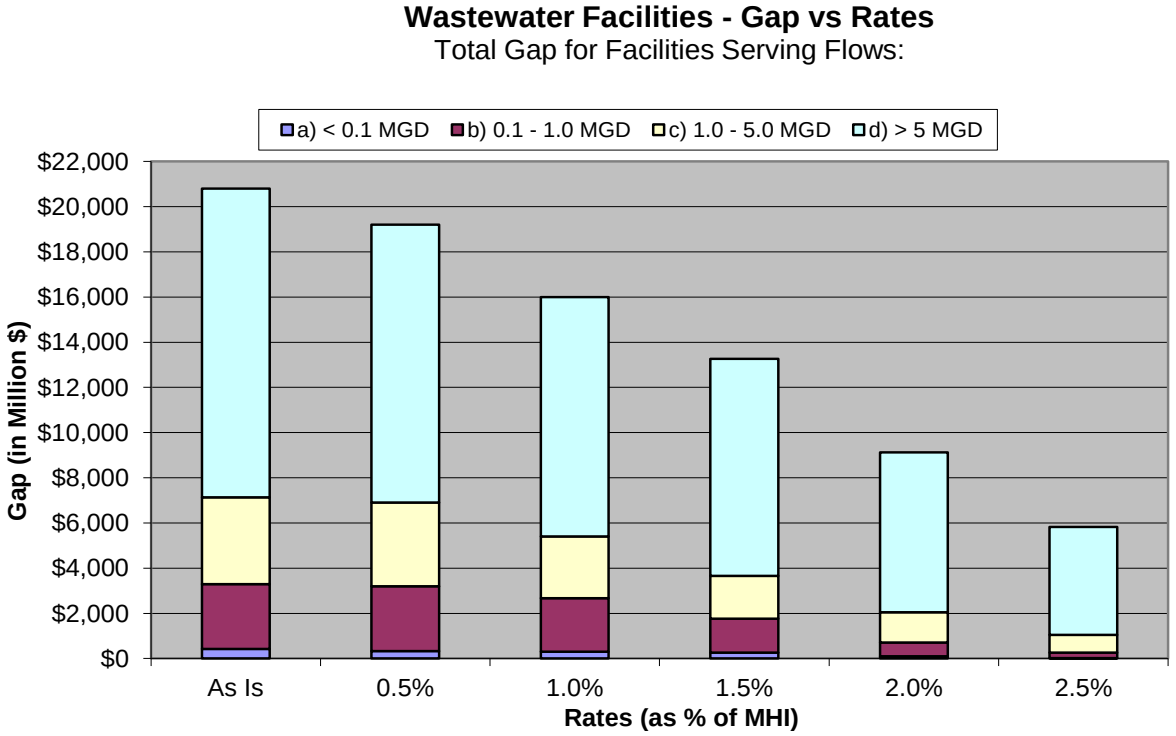
Graph 1 shows that addressing the gap is most difficult for small systems. This is a function of both high cost and low MHI in those systems. The data suggests many small drinking water systems will not be able to meet their needs without subsidy.

**GRAPH 1**



Graph 2 shows the statewide gap totals for wastewater. The first column, "as-is" user charge rates, shows that wastewater systems need a total of $20.8 Billion more to satisfy 20-year needs than is provided at current user charge rates. The second column shows that the statewide gap is reduced to $19.2 Billion if rates are increased to 0.5 percent of MHI. Similarly, at 1.5 percent of MHI, the gap is reduced to $13.3 Billion. The wastewater gap is different than drinking water in that the largest gap dollars are in the larger systems.

**GRAPH 2**



## APPENDIX B
## DRINKING WATER GAP METHODOLOGY
## Macro Approach 2015 Update

The 2008 study attempted to address all community water systems (CWS) in the state, both publicly and privately owned. It was difficult to obtain good system-specific data on individual private investor-owned water systems because the companies that own those systems do not reliably separate their revenues and expenses on an individual system basis. DEP also came to the conclusion that the large private systems are generally willing to raise rates as needed to pay for needed upgrades. Therefore, the main problems DEP wants to address are at publicly-owned systems. As a result, for the purpose of calculating a statewide gap, the decision was made to focus the 2015 update on only publicly-owned drinking water systems.

Another major challenge that had to be overcome is the lack of system-specific capital needs data. DWINS provides a total statewide capital need, not individual system needs. EPA was asked, but was unable to provide the capital needs for the sample of drinking water systems that were surveyed for DWINS in 2011. If that had been provided, DEP would have calculated individual drinking water system gap amounts and extrapolated that amount into a statewide total. Lacking that information DEP was constrained to doing a single statewide gap calculation.

The general formula used is:

**Total Gap = (Revenue) – (Current O&M & Debt Service) – (Capital Needs)**

### "As-Is" Gap

The "As-Is" gap is the gap calculated using current drinking water system user charge rates.

"As-Is" Revenue is estimated by adding up individual drinking water system revenues from the DCED website spreadsheet. That total is $1.37 billion, representing the revenue from the 6.7 million people served reflected in the audits that were provided to DCED. The population served by all public water systems in Pennsylvania, including those that are both publicly and privately owned is 10.6 million. That proportion (10.6/6.7, or 1.58), when multiplied by the DCED revenue, provides an estimate of the revenue from all public water systems in the state ($1.37 billion x 1.58 = $2.16 billion).

Current O&M & Debt Service is estimated similarly. The total from the DCED website is $1.3 billion, representing the O&M & Debt Service from the 6.7 million people served reflected in the audits that were provided to DCED. The population served by all public water systems in Pennsylvania, including those that are both publicly and privately owned is 10.6 million. That proportion (10.6/6.7, or 1.58), when multiplied by the DCED O&M & Debt Service, provides an estimate of the O&M & Debt Service from all public water systems in the state ($1.31 billion x 1.58 = $2.07 billion).

Capital Needs data is provided by the DWINS. The total of $14.2 billion represents the EPA estimate of what will be needed over 20 years. That number is adjusted to an annual number by multiplying it by an average annual equivalent factor (20 years @ 4.63 percent) of 0.078; $14.2 billion x 0.078 = $1.11 billion). The result is:

**Annual Gap $_{\text{as-is}}$ = $2.16 billion - $2.07 billion - $1.11 billion = -$1.02 billion**

The negative number means that there is a need for an additional $1.02 billion, statewide on an annual basis, than is provided through current revenues. On a 10-year basis there is a gap of $10.2 billion (10 x $1.02).

**Gap at One Percent MHI**

Gap was then calculated on the basis of what it would be if revenues were increased to reflect 1.0 percent of MHI.

The revenue portion of that calculation is estimated by multiplying the number of households times the statewide MHI times 1.0 percent. The number of households is estimated by dividing the population served by all public water systems in Pennsylvania by the average population per household.

Households is therefore = [10.6 million persons / (2.48 persons / household)] = 4.27 million households

Revenue is therefore 4.27 million households x 1.0 percent x $53,952 = $2.31 billion.

The Current Revenue & Debt Service and Capital Needs calculations are the same as was used in the As-Is calculation above. The statewide annual gap at user rates at 1.0 percent of MHI is therefore:

**Annual Gap$_{\text{1.0 percent MHI}}$ =$2.31 billion - $2.08 billion - $1.10 billion=-$0.88 billion**

The negative number means that there is a need for an additional $0.88 billion, statewide on an annual basis, than is provided through the revenues from user charges at 1 percent of MHI. On a 10-year basis there is a gap of $8.8 billion (10 x $0.88). The fact that the gap at 1.0 percent of MHI is smaller than what it was at current rates suggests that current rates are less than 1 percent of MHI. This is consistent with what was found in the original Gap Study.

**Gap at 1.5 Percent MHI**

Gap was then calculated on the basis of what it would be if revenues were increased to reflect 1.5 percent of MHI.

The calculations are the same as what was used at 1.0 percent of MHI except for the use of 1.5 percent as follows:

Revenue is 4.27 million Households x 1.5 percent X $53,952 = $3.46 billion.

**Annual Gap$_{\text{1.5 percent MHI}}$ =$3.46 billion - $2.07 billion - $1.11 billion =+0.28 billion**

The positive number means that, on an average basis, needs are satisfied with revenues which are less than 1.5 percent of MHI.

The largest single source of error in the above may be in the use of the statewide average MHI. The 2008 Gap Study showed that, proportionally, the largest gaps were in the smallest systems, which could be assumed to have lower MHIs. The inverse would suggest that larger and wealthier communities would be able to satisfy their infrastructure needs at a relatively lower MHI. The overall effect may be to understate the total gap.

Information Sources for this analysis include:

- Public Community Water System Population = 7.4 million (source: PADWIS)
- Residents per Household = 2.48 (source: U.S. Census Bureau)
- Statewide MHI = $53,952 (source: U.S. Census Bureau)
- DCED System Population = 6.7 million (source: DCED)
- Statewide Total Capital Need = $14.22 billion (source: 2011 EPA DWINSA)
- Total Community Water System Population = 10.6 million (source: PADWIS)
- Average Annual Equivalent Factor = 0.0777 at 20 years and 4.625 percent discount Rate

**APPENDIX C:**
**WASTEWATER GAP METHODOLOGY**
**(DCED/NS Approach; 2015 Update)**

Because needs survey data was used to identify capital needs for wastewater systems, this methodology is for a 10-year gap instead of 20-year gap. The reason is that EPA requires specific documentation of project planning in order for a need to be accepted. Most wastewater systems in Pennsylvania develop plans of future capital construction for five to ten years into the future. The formula deals with that shortcoming by assuming that the 2012 CWNS capital improvement needs reflect a 10-year time span rather than 20 years. The formula is also made somewhat more sophisticated by recognizing that the money needed by drinking water and wastewater systems for capital construction is not paid for immediately at the time of construction. Capital projects are typically financed with 20-year loan repayment terms. In such a case the fact that it is a 10-year analysis means that the average project will be constructed in year 5. Since the average construction takes place in year 5, and this is a 10-year study, 5 years of a 20-year loan will be repaid during the 10 year planning period. This means that (on average) 25 percent (5/20) of the loans will be amortized within the 10-year period. The formula is therefore:

**[10-Year gap] = [Annual O&M Expense x 10 years] + [Existing Annual Debt x 10 years] + [0.25 x Capital Need] - [Annual Revenue x 10 years]**

## Authorities

### *Data Sources*

The DCED website provides data from annual audits of wastewater systems owned by Municipal Authorities for a number of fiscal years. This study used the most recent data from 2010-2013 audits, if available. The study used the following data from the DCED website:

- Type of Facility (Wastewater only, or both Drinking Water and Wastewater)
- User Rate Billings (Total Operating Revenue minus State Operating Grants minus Other Operating Revenue)
- Debt Service Payments
- Expenditures (Operational plus Non-Operational)
- Revenue (Operational plus Non-Operational)

The study also used total wastewater capital needs from the EPA 2012 CWNS. In addition, DEP collected data from the specific authority website, if available, and the U. S. Census Bureau for:

- Population served
- Median Household Income (HMI) for the service area

### *Calculated Values*

Using the data collected, the following values are calculated:

1. Capital Improvement Needs – These infrastructure improvements are in present value.

2. Escalation of O&M Costs: As in the original Gap Study, the analysis assumed that O&M costs escalate two percent per year. For a 10-year calculation, the present value of O&M is therefore calculated using an escalation factor of 11.17 (1.02+1.04+…1.22 = 11.17).

3. General gap formula:

   **10-year gap = (11.17 * Expenditures) + (10 * Debt Service Payments) + (0.25 * Total Wastewater Needs) - (10 * Revenue).**

   The gap is calculated at current "as-is" user charge rates, as well as with revenues that would be received if rates were set at 1.0 percent and 1.5 percent of MHI. Only gap shortfalls are counted. For example, if the gap calculation at 1.0 percent of MHI results in more revenue than is needed to satisfy expenses, gap is assumed to be zero for that system at those rates.

4. Split costs for Authorities that own both drinking water and wastewater (DCED code 114): The DCED data for such systems commingles drinking water and wastewater revenue and expense data. The assumption is that one-half of debt service payments are for wastewater. The gap formula is therefore revised by dividing the debt service payments by two.

5. EDU estimate: It is assumed that the number of equivalent dwelling units (EDUs) is equal to the population divided by 2.5 persons.

Table 4 is an example of these calculations as they apply to an Authority.

**TABLE 4. Example Gap Figures for an Authority**

| Audit Year | 2013 |
|---|---|
| | |
| User Rate Billings | $100,544,066 |
| Debt Service Payments (Annual Total) | $24,854,857 |
| Expenditures (Op and Non-Op) | $100,656,799 |
| Revenue (Op and Non-Op) | $100,544,066 |
| Population | 850,000 |
| Median Household Income (2010-adjusted dollars) | $28,588 |
| Total Capital Needs (from 2012 EPA CWNS Categories I-V) | $543,582,446 |
| 10-Year Gap ("As-Is" User Charge Rates) | $503,339,966 |
| Number of Households | 400,000 |
| Current User Rate / Year | $251.36 |
| User Rate / MHI (in percent) | 0.88 percent |
| 10-Year Gap (rates of 1.0 percent MHI ) | $365,260,626 |
| 10-Year Gap (rates of 1.5 percent MHI) | ($206,499,374)* |

* The negative gap figure suggests that the system is able to meet its obligations at rates less than 1.5 percent of MHI. The system gap of $206,499,374 would therefore not be used in the calculation of state-wide gap.

**Municipalities**

***Data Sources***

The information used to calculate gap for municipalities, townships, boroughs and cities is similar to Authorities. However, the DCED website provides slightly different information as follows:

- DCED provides information on population served.
- The data for the system is used only if the data includes Sewer Revenue and Sewer Expenses.
- DCED provides total debt service for the community, a portion of which can be assumed to involve the wastewater system. The study assumed that the percentage of wastewater debt service is equal to Sewer Revenue divided by Total Revenue. See Sewer Revenue Percentage in the formula below.

***Calculated Values***

The following values are calculated using the data collected:

1. General Gap formula:

**10-year gap = (11.17 * Expenditures) + (10 * Debt Service Payments * Sewer Revenue Percentage / 100) + (0.25 * Total System Need from CWNS-2012) - (10 * Revenue).**

2. EDU estimate: It is assumed that the number of equivalent dwelling units (EDUs) is equal to the population divided by 2.5 persons.

Table 5 is an example of these calculations as they apply to a municipality.

**TABLE 5. Example Gap Figures for a Municipality**

| Audit Year | 2013 |
|---|---|
| | |
| Total Revenues (Op and Non-Op) | $148,248,204 |
| Sewer Revenue | $15,032,509 |
| Sewer Expenditures | $10,312,684 |
| Debt Service | $4,780,743 |
| Census Population | 106,632 |
| Median Household Income (2010-adjusted dollars) | $36,454 |
| Total Capital Needs (from 2012 EPA CWNS Categories I-V) | $141,004,839 |
| Sewer Revenue Percent (Sewer / Total) | 10.14 Percent |
| Number of Households | 42,653 |
| 10-Year Gap ("As-Is" User Charge Rates) | $4,966,519 |
| Current User Rate / Household / Year | $352.44 |
| User Rate / MHI (in percent) | 0.97 Percent |
| 10-Year Gap (rates of 1.0 percent MHI ) | ($195,637)* |
| 10-Year Gap (rates of 1.5 percent MHI) | ($77,939,260) |

* The negative Gap figure suggests that the system is able to meet its obligations at rates less than 1.0 percent of MHI. The figure of $195,637 would therefore not be used in the calculation of state-wide gap (same applies for the 1.5 percent of MHI gap figure).

**Statewide Gap Calculation**

The above examples display the calculation of the 10-year gap of individual entities at "as-is" rates and at revenues that would be received if the system increased its rates to 1.0 percent and 1.5 percent of MHI. Note that the 20-year gap is assumed to be twice the amount reflected below for the 10-year gap.

Data are available to calculate the gap for 439 of the 2200 active wastewater entities in Pennsylvania. Statewide gap is scaled up from the size distribution of the sample.

The average gap varies significantly depending on the population size of the community. For that reason the data are broken down into communities of three size categories (<10,000, 10,000-100,000 and >100,000). The number of systems in each size category is known for the sample. It is assumed that the 1761 unaccounted-for communities are distributed among the three size categories in the same proportion as the 439 in the sample. See the tables below.

**TABLE 6. Distribution of Systems in Sample by Community Population**

| **Size Category (population served)** | **Number of Systems in Sample** | **Percent** |
|---|---|---|
| | | |
| Large (>100,000) | 7 | 1.6 |
| Medium (10,000 – 100,000) | 86 | 19.6 |
| Small (<10,000) | 346 | 78.8 |
| **Total** | **439** | **100** |

**TABLE 7. Assumed Population Distribution of Unaccounted-for Systems**
(using percentages from Table 6)

| **Size Category (population served)** | **Assumed Number of Unaccounted-for Systems by Population** | **Percent** |
|---|---|---|
| | | |
| Large (>100,000) | 28 | 1.6 |
| Medium (10,000 – 100,000) | 345 | 19.6 |
| Small (<10,000) | 1388 | 78.8 |
| **Total** | **1761** | **100** |

**TABLE 8. Assumed Population Distribution Statewide**
**(totals of Tables 6 and 7)**

| **Size Category (population served)** | Number of Systems in Sample | Assumed Number of Unaccounted-for Systems by Population | Assumed Total Number of Systems Statewide by Size Category |
|---|---|---|---|
| Large (>100,000) | 7 | 28 | 35 |
| Medium (10,000 – 100,000) | 86 | 345 | 431 |
| Small (<10,000) | 346 | 1388 | 1734 |
| **Total** | **439** | **1761** | **2200** |

**TABLE 9. Total 10-Year Gap at "As-Is" User Rates, by System Size Category**

| Size Category (population served) | Assumed Total Number of Systems Statewide by Size Category | Average Gap from Sample ($) | Calculated Statewide Gap by Size Category ($) |
|---|---|---|---|
| | | | |
| Large (>100,000) | 35 | $22,335,461 | $ 828,150,165 |
| Medium (10,000 – 100,000) | 431 | $ 6,627,160 | $2,856,305,786 |
| Small (<10,000) | 1734 | $ 2,719,791 | $4,716,117,112 |
| **Total** | **2200** | | **$8,400,573,063** |

The gap for each system in the sample is recalculated assuming rates of 1.0 percent of MHI. Positive balances are eliminated, and averages calculated as follows:

**TABLE 10. Total Gap at Rates Adjusted to 1.0 Percent of MHI, by System Size Category**

| Size Category (population served) | Assumed Total Number of Systems Statewide by Size Category | Average Gap ($) | Calculated Statewide Gap by Size Category ($) |
|---|---|---|---|
| | | | |
| Large (>100,000) | 35 | 0 | 0 |
| Medium (10,000 – 100,000) | 431 | $6,258,851 | $2,697,564,600 |
| Small (<10,000) | 1734 | $2,741,949 | $4,754,540,227 |
| **Total** | **2200** | | **$7,452,104,827** |

The same is done again with rates at 1.5 percent of MHI.

**TABLE 11. Total Gap at Rates Adjusted to 1.5 Percent of MHI, by System Size Category**

| Size Category | Assumed Total Number of Systems Statewide by Size Category | Average Gap ($) | Calculated Statewide Gap by Size Category ($) |
|---|---|---|---|
| | | | |
| Large (>100,000) | 35 | 0 | 0 |
| Medium (10,000 – 100,000) | 431 | $1,929,940 | $ 831,804,053 |
| Small (<10,000) | 1734 | $1,564,458 | $3,369,948,089 |
| **Total** | **2200** | | **$4,201,752,141** |

The above tables show that the gap of large systems decreases from $0.8 billion at current rates to zero if rates are allowed to rise to about 1.0 percent of MHI. The gap of medium systems is similarly reduced from $2.9 billion at current rates to $2.7 billion at 1.0 percent of MHI and further reduced to $0.8 billion at 1.5 percent. The gap of small systems is reduced from $4.7 billion at current rates to $3.4 billion at 1.5 percent.

Overall, statewide 10-year gap is reduced from $8.4 billion at current rates to $7.5 billion at 1.0 percent, and $4.2 billion at 1.5 percent.

**Statistical Significance**

Statistical variation was calculated for each size category using the following formula:

$$\text{(Size Category Average Gap)} \pm [(\text{t value}) \times (\text{standard deviation})] / \sqrt{n}$$

The 95 percent confidence interval for the $8.4 billion gap is +/- $2.3 Billion. This means we can say with a confidence of 95 percent that the statewide 10-year gap at current rates is between $6.1 billion (8.4-2.3) and $10.7 billion (8.4 + 2.3).

**APPENDIX D: Projected State and Federal Water & Wastewater Subsidies 2015-2025**[1]

| Program Name | Annual Funding | Loan vs Grant | Annual Cash Value | 10-Year Cash Value | 10-Year Present Worth |
|---|---|---|---|---|---|
| U.S. Department of Agriculture Loan | $42,388,000 | Loan | $2,361,012 | $23,610,116 | $17,802,027 |
| U.S. Department of Agriculture Grant | $11,557,000 | Grant | $11,557,000 | $115,570,000 | $87,139,780 |
| PENNVEST Loan | $300,000,000 | Loan | $41,820,000 | $418,200,000 | $315,322,800 |
| PENNVEST Grant | $60,000,000 | Grant | $60,000,000 | $600,000,000 | $452,400,000 |
| Community Development Block Grant (CDBG)/HUD | $6,000,000 | Grant | $6,000,000 | $60,000,000 | $45,420,000 |
| Appalachian Region Commission (ARC) | $1,500,000 | Grant | $1,500,000 | $15,000,000 | $11,310,000 |
| **Total** | **$421,445,000** | | **$123,238,012** | **$1,232,380,116** | **$929,214,607** |

[1] As of August 4, 2015

For more information, visit www.dep.pa.gov, keyword: InfrastructureFinance

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