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Sustainability Brief: Water Infrastructure

New Jersey depends on water resources for the health of its people, the strength of its economy, and the vitality of its ecosystems. The dependability of our public[1] water infrastructure (water supply, wastewater and stormwater) is a fundamental element of sustainable communities and critical to sustainable development. Many other resources and types of infrastructure are important to New Jersey – water is irreplaceable.[2]

1 Background

New Jersey has roughly 600 Public Community Water Supply (PCWS) systems, defined as water systems with at least 15 or more service connections used by year-round residents or regularly serving at least 25 year-round residents. Private, on-site wells supply the roughly one-seventh of residents not served by PWCS systems. New Jersey relies on aquifers for approximately 40% and surface waters for approximately 60% of potable water supply. PCWS systems (whether owned privately, by investors or by government) serve small to very large areas of developed lands, ensuring reliable provision of potable and production water to customers within their service areas; most serve fewer than 3,000 connections (roughly 10,000 people). New Jersey has among the highest share of customers served by investor-owned water utilities in the nation, though most individual systems are government entities or very small systems for specific developments. However, State drinking water safety and environmental regulations for PCWS systems apply regardless of ownership.

New Jersey has roughly 260 public sewerage systems, which likewise serve small to very large areas of developed lands, ensuring reliable management of public and industrial wastewater from customers within their service areas. The two largest sewer systems in the state – Passaic Valley Sewerage Commissioners (PVSC) and Middlesex County Utility Authority (MCUA) – are in northern New Jersey. Nearly all systems are government-owned (e.g., municipalities, municipal utility authorities, county MUAs, regional agencies), but there are some small private systems for specific developments. Again, State environmental regulations wastewater systems apply regardless of the form of ownership. Where public sewerage systems do not exist, development relies on septic systems. While many areas have both public water supply and sewerage, some areas will have public water and septic systems, or private wells and public sewers.

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[1] In this case "public" refers to the clientele, not the system ownership.

[2] Much of the information provided in this report is drawn from the Water Resources Baseline Assessment Report prepared for the Together North Jersey project, funded in part by the U.S. Department of Housing and Urban Development.

Public stormwater systems individually tend to serve very small areas, discharging stormwater to local streams either untreated or with minimal treatment, rather than being collected into large systems for treatment. However, in aggregate these systems manage stormwater from nearly all urbanized areas. The major exceptions are the Combined Sewer Systems, which function as both sewer systems and stormwater systems. These systems provide stormwater treatment at the sewage treatment plant up to the pipeline or plant capacity, but overflow to local waters with minimal or no treatment when the collection system or treatment plant reach capacity. The Passaic Valley Sewerage Commissioners service area (including municipalities that feed to the system) includes most of northern New Jersey's combined sewers. Facilities of eastern Union County and the Camden area comprise most of the other large areas of combined sewers. The presence of combined sewers is a very expensive future issue, and also complicates assessments of available capacity.

2 Sustainability Issues

2.1 The Costs of Unsustainable Water Utilities

Where water infrastructure systems are not managed in a sustainable fashion, society will incur costs and economic inefficiencies including: insufficient water for users due to insufficient water availability or delivery systems; loss of water values caused by pollution stemming in part from poor sewage or stormwater management; economic disruption caused by infrastructure failure and inadequate infrastructure robustness and resiliency in the face of extreme weather events; and social disruption caused by inequities in utility service, loss of service for extended periods, and loss of employment due to service disruption. Many of these issues were recently highlighted by Superstorm Sandy.

A major problem New Jersey faces is that our water infrastructure suffers from extensive and costly deferred maintenance, as emphasized by the NJ Clean Water Council and the Water Supply Advisory Council (2010). Too much emphasis has been placed on minimizing current rates, creating a major risk of system failures in the future; emergency maintenance costs will rising rapidly as systems literally crumble. Water infrastructure inevitably wears out. The aging process can only be offset by well-planned, ongoing maintenance. Otherwise, we face rising failures combined with rising costs, placing our economic competitiveness at risk (not to mention our quality of life and environmental quality). While comprehensive figures are not yet available, it is clear that the necessary costs will be in the tens of billions of dollars over the next several decades.

2.2 New Jersey Water Utility Demands

Water demands in New Jersey (excluding power generation, which generally occurs in estuarine areas) is roughly 550 billion gallons per year, or 1.5 billion gallons per day, of which over 80% is for potable water. PCWS systems provide water to residences, businesses, commerce, industry and public facilities. Demands are usually higher in the summer due to outdoor uses, a pattern that is most prominent in suburban areas with large lawns and pools, and least prominent in cities. Average per capita use in New Jersey is roughly 130 gallons per person per day, which includes all types of uses. Residential uses alone are significantly lower.

Sewage is generated from three broad sources: customers, I&I (inflow and infiltration), and stormwater influx to combined systems. Residential annual flows tend to be fairly constant, at roughly 85-90% of water demands. Poor maintenance leads to increased I&I. Stormwater influx to combined sewers corresponds to precipitation events. Industrial sewage flows are highly dependent on the manufacturing process involved, and over the last several decades have significantly declined statewide as water-dependent manufacturing has either ceased or become more water efficient.

The extension of sewer service to new areas is controlled by NJDEP through the adoption of wastewater management plans with sewer service areas, pursuant to the Water Quality Management Planning rules. NJDEP is currently in the process of reviewing and approving revised sewer service area mapping for all of New Jersey (see www.nj.gov/dep/wqmp). Many of the largest public sewerage systems already serve the maximum area possible for their systems, making sewer service area mapping less of a management issue for them.

2.3 Assessment of Availability Water Utility Capacity

Two generally accepted measures of Net Available Capacity for PCWS and public sewerage systems are:

a) ***Public Water Supply System Net Available Capacity***: A useful measure of system available capacity is the Net Surplus/Deficit Analysis of a water supply system, defined as the firm capacity (i.e., the ability to meet demands during periods of foreseeable system limitations) including contracted supplies, minus the highest monthly demand during recent years. NJDEP routinely maintains and reports the Deficit/Surplus Analysis for all PCWS systems.

b) ***Sewerage System Net Capacity***: One measure of system capacity is the available capacity, calculated as system design or planning flow minus peak flows. The type of the system guides the selection of the most appropriate peak flows. Systems with CSOs would focus more on peak daily flows, as these trigger the greatest water quality problems due to discharges of highly contaminated effluent. For most other facilities, the monthly or MAX3MO flows may be the best indication of system stress, depending on the extent to which the system can equalize (smooth out) peak flows. Likewise, environmental impacts are likely to be most critical during the growing season, when warm temperatures and lower average flows heighten ecosystem stress. For facilities receiving sewage that derives from aquifers, summer flows may be most critical for surficial aquifers (as a measure of ecosystem stress) while annual or multi-year flows may be most critical for confined aquifers (as an indication of the potential for potential saltwater infiltration). New Jersey uses two different systems statewide – one compares projections of future demands against total system capacity using annual average flows, and the other tracks the Maximum Three-month Average Flow (MAX3MO) against total system capacity. However, in general the MAX3MO is most appropriate for use.

In addition, all types of public water utilities should consider ***Water System Reliability.*** National standards exist for delivered drinking water quality and for sewage effluent discharges. State standards exist for stormwater system construction and detention basin maintenance for new systems (but not older systems). However, there are no national standards for system reliability regarding consistency of delivery (for water supply), pipeline breaks that prevent collection and delivery to the treatment plant (for sewerage), or stormwater system reliability. Part of reliability involves ensuring that critical infrastructure is protected from extreme weather events and other causes of catastrophic failure. Resiliency is another aspect, where systems are capable of coming back up to acceptable operating parameters when damage does occur.

New Jersey has not implemented a rigorous system of sustainable utility management; the concept is being explored but many utilities do not apply national state-of-the-art approach, and few if any that do have fully implemented their programs.

2.4 Water Utility Challenges in New Jersey

The largest challenges for PCWS systems will be ensuring that they maintain the capacity and capability to provide high quality potable water on an uninterrupted basis, in response to both existing needs and future demands. High peak summer demands stress system capacity, while deferred maintenance increases the risks of system failure. At the same time, an increasing awareness of ecological flow needs will limit the ability of utilities to increase demands on shallow aquifers, and better science regarding confined aquifers may increase constraints on those systems as well. Many aquifers along the coast and within inland watersheds are fully utilized or overstressed, and new allocations from those aquifers will be rare and difficult. Water supply planning will be necessary to reduce or eliminate deficits in several key areas. Finally, some facilities are at risk from natural disasters, which must be addressed.

As has been true since the 1980's, significant attention must be paid to the Passaic and Hackensack River reservoir systems, as they are highly interdependent, interconnected and stressed during severe droughts. Other areas such as central New Jersey and the Delaware River area have sufficient surface water supplies. The pending NJ Statewide Water Supply Plan from NJDEP should provide additional information on these and all other systems.

Public sewer capacity is limited in many of the state's urban areas, due to treatment plant size, CSO problems or both. However, in some cases water availability constraints may be more important in coming years (see "Sustainability and Water Availability" briefing paper). The proper designation of new sewer service areas is important to: avoid dense development within environmentally sensitive areas; establish a priority for use of limited sewerage capacity; and encourage efficient use of land for development, avoiding situations where the density of development on sewers is less cost-effective.

No authoritative figures are available regarding the total costs of deferred maintenance, but anecdotal and individual system evidence indicates that they will be high. Regardless of the total costs, the costs of not taking action include emergency repairs at much higher cost, plus service disruptions, undermining of streets and buildings, etc., as has been seen many times in recent years, including major water main breaks in Hoboken and Edison during a two-week period in early 2013. To the deferred maintenance costs must also be added the upcoming costs of system improvements to meet public health requirements and address increasing demands, and further needs to improve system resilience in the face of increased flood frequency and height, coastal storm surges, power losses, etc. Deferred maintenance costs will harm the ability of water supply utilities to address other emerging needs.

Wealth distribution is significantly skewed toward the more modern suburban and exurban areas, with the cities and inner ring suburbs and some rural areas have significantly lower average household incomes and accumulated wealth. As such, the developed areas with the greatest legacies of infrastructure disinvestment and environmental damage also tend to have the fewest financial resources to address those problems. These disparities in environmental quality, infrastructure integrity and fiscal capacity raise major problems of equity.

Without adequate water utility systems, the economy of New Jersey cannot thrive. Water supply, wastewater and stormwater systems must be in place, with sufficient capacity, managed in a manner that ensures quality services at the lowest lifecycle costs, or all other efforts will ultimately fail. The absence of a negative (systems that aren't badly failing yet) doesn't maximize the potential benefits of having good water utility systems.

3 Sustainability Responses

New Jersey has robust systems in place to ensure that water supply and wastewater treatment facilities meet standards for drinking water and effluent quality, respectively. Construction standards for new collection and distribution systems are implemented through various NJDEP regulations for treatment works approvals, and through the Residential Site Improvement Standards that municipalities must require. The greatest ongoing shortfall for water infrastructure is the maintenance of the "unseen" infrastructure – pipelines below ground. The NJ Clean Water Council and Water Supply Advisory Council have called for coordinated and cooperative action by the NJDEP, NJ Department of Community Affairs and Board of Public Utilities (BPU) to ensure proper asset management. NJDEP is now requiring the initial steps of asset management for all municipal combined sewer systems, and is incorporating asset management principles into funding requirements related to restoration of Hurricane Sandy damages. BPU recently authorized investor-owned utilities to implement limited improvements of water supply pipelines outside of the normal rate-setting process (Distribution System Improvement Charge, or DSIC). NJDEP and NJDCA are exploring methods for improving actions by government-owned water supply and sewer systems. However, little has changed to improve storm-water system maintenance.

4 Implications

These sustainability objectives have several major implications and underlying assumptions:

- Human health and welfare requires access to water supplies, which for urban areas requires effective and affordable water supply infrastructure.
- An implied hierarchy of human uses exists, with demands for human health, sanitation and consumption having a higher priority than recreational and outdoor uses.
- Water demands for human health and welfare should be efficient to reduce competition with other uses and ecological needs.
- Net capacity for PCWS systems may be increased through reduced leakage of the pipeline system (supply side conservation), reduced overall or peak consumer demand (demand side conservation), or development of addition supply within constraints of water availability.
- Net capacity for public sewerage systems may be increased through reduced Infiltration & Inflow into the pipeline system, reduced consumer sewage creation (e.g., reduced indoor water use), diversion of stormwater from combined sewer systems (e.g., system separation, green technology, stormwater reuse), or development of additional treatment plant or flow equalization capacity.
- Stormwater utility systems will require significant modification to meet modern standards for stormwater management regarding rate and volume of flow, discharge quality and recharge.
- Asset maintenance is a critical aspect of water infrastructure sustainability.

5 Defining & Tracking Sustainability

Based on the information provided above, sustainability objectives are proposed for consideration:

- Water Supply Infrastructure - Public water supply infrastructure has and will have sufficient capacity and reliability to meet customer needs with minimal service disruptions at sufficient quantity and quality (including peak demands and drought needs) at the lowest possible lifecycle cost, using water supplies that do not exceed sustainable levels of water availability.
- Human Health and Welfare – Water supplies are available in sufficient quantity and quality to support efficient uses that sustain human health, sanitation and consumption from residences and businesses, and for recreational and outdoor uses, within the limits of water availability.
- Water Quality Infrastructure
    - Public wastewater infrastructure has and will have sufficient capacity and reliability to collect and treat sewage of sufficient quantity and quality to meet customer needs with minimal service disruptions at the lowest possible lifecycle cost, while protecting public health and the environment.
    - Public stormwater infrastructure protects public health and safety and the waters of the State from flooding, contamination, recharge loss and surface water damages during normal operating conditions, with minimal service disruptions at the lowest possible lifecycle cost, while protecting public health and the environment.

Table 1 provides preliminary targets and indicators for water infrastructure. Municipal action will be feasible with regard to all aspects of utility management, with some limited by the extent to which they have direct or indirect control (i.e., through appointments) of the utilities. Boards of Health will have access to data on disease outbreaks from drinking water and on recreational water quality and beach closings (where relevant).

6 Conclusions

Water infrastructure must be maintained and, where necessary, upgraded to protect the economic viability and environmental integrity of our society. Most regulatory efforts have focused on objectives such as drinking water quality (health) and wastewater effluent quality (environment), and therefore on the treatment plants that achieve these objectives. Little attention has been paid to the underground infrastructure by many water utilities; this is especially true for stormwater systems. Instead, rates have in many or most cases been artificially kept low for the short-term benefit of utility customers, while deferred maintenance results in increasing potential and actuality of breakdowns and costly emergency repairs. Moving water utility management to routine systems of asset management will reduce lifecycle costs of the utilities, but will require political will to allow rates to be set at sustainable levels.

Table 1: Preliminary Sustainability Indicators and Targets for Water Resources

Category	Definition	Preliminary Indicators	Preliminary Targets	Scale of Analysis	Availability and Period of Data
Water Supply Infrastructure: Public Community Water Supply Systems	*Public water supply infrastructure has and will have sufficient capacity and reliability to meet customer needs with minimal service disruptions at sufficient quantity and quality (including peak demands and drought needs) at the lowest possible lifecycle cost, using water supplies that do not exceed sustainable levels of water availability.*	•Customer density •Delivered drinking water quality •Firm Capacity + Contracted Supplies •Peak monthly demands •Pipeline breaks •Residential water use •Water rates per thousand gallons •Asset mgt reports and system budgets	•Accounts per linear mile and per square mile served •Drinking Water Quality violations (reliability) •Net Available Capacity as Current and Projected Net Surplus/Deficit Analysis by PCWS system (capacity) •Pipeline network annual breaks per pipeline mile and trend by system (reliability) •% Households exceeding 75 gpcd (demand efficiency) •Affordability as average system household cost relative to 1% of area median household income, by system (equity) •Comprehensive asset mgt plan implementation	•PCWS systems •All public water supply systems •PCWS systems •PCWS systems •PCWS systems •PCWS systems •PCWS systems	•No State database. Ad hoc by PCWS system •Data from 1970's, routinely updated •Updated routinely •No State database. Ad hoc by PCWS system • No State database. PCWS systems record for billing purposes •Census Bureau data on household income •Ad hoc by PCWS system
Human Health and Welfare	*Water supplies are available in sufficient quantity and quality to support efficient uses that sustain human health, sanitation and consumption from residences and businesses, and for recreational and outdoor uses, within the limits of water availability.*	•Enteric disease incidence per year from drinking water supplies •Disconnected residential customers •# Homeless persons •Bacterial concentrations in recreational waters	•# Enteric disease incidence (public health) •% of households with active access to potable water supply (access) •Recreational uses – see Water Quality	•Statewide •Any scale, municipal to statewide •See Water Quality	•Occurrence data NJ Department of Health tracking system •No State database. Use PCWS service areas and development data •See Water Quality

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Water Quality Infrastructure	*•Public wastewater infrastructure has and will have sufficient capacity and reliability to collect and treat sewage of sufficient quantity and quality to meet customer needs with minimal service disruptions at the lowest possible lifecycle cost, while protecting public health and the environment.*	**Wastewater**: •Customer density	•Accounts per linear mile and per square mile served	•Public sewer system	•No State database. Ad hoc by sewer system
		•Monthly, MAX3MO and annual average sewage flows	•Current and Projected Net Available Capacity (capacity, MAX3MO method)	•Wastewater treatment facility	•Quarterly data
		•CSO volumes and discharge days	•CSO discharges as % annual flow	•Public sewer system	•Not routinely monitored; estimates
		•Effluent quality	•Effluent quality violations (reliability)	• Wastewater treatment facility	•Monthly or more frequent data
		•Sewerage rates per thousand gallons	•Affordability as average system household cost relative to 1.5% of area median household income, by system (equity)	•Public sewer system	• Census Bureau data on household income
	•Public stormwater infrastructure protects public health and safety and the waters of the State from flooding, contamination, recharge loss and surface water damages during normal operating conditions, with minimal service disruptions at the lowest possible lifecycle cost, while protecting public	•Infrastructure reliability	•Annual line breaks per mile •Comprehensive asset mgt plan implementation	• Public sewer system • Public sewer system	•Ad hoc by system •Ad hoc by system
		Stormwater: •Development occurring prior to and after adoption of the original Residential Improvement Standards and the 2004 NJDEP Stormwater Rules, NJAC 7:8 (capacity and recharge potential)	•% of development with rate, velocity and treatment controls meeting current requirements	•Any scale, but mostly municipal or subwatershed	•1986, 1995, 2002, 2007 Land Use/Land Cover based on aerial photo interpretation •Satellite remote sensory data for land cover;
		•Beach closings (reliability)	•Trend of beach closings caused by stormwater discharges	•Ocean beaches, back bay beaches, fresh water beaches	•Summer data by beach for ocean and back bay; some health dept data
		•Recharge loss •Stream daily flows	•Stream baseflow as a percentage of annual flows	•Gaged drainage area, watershed or	• Varies by gaging station, many have

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	health and the environment.			subwatershed	decades of data

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