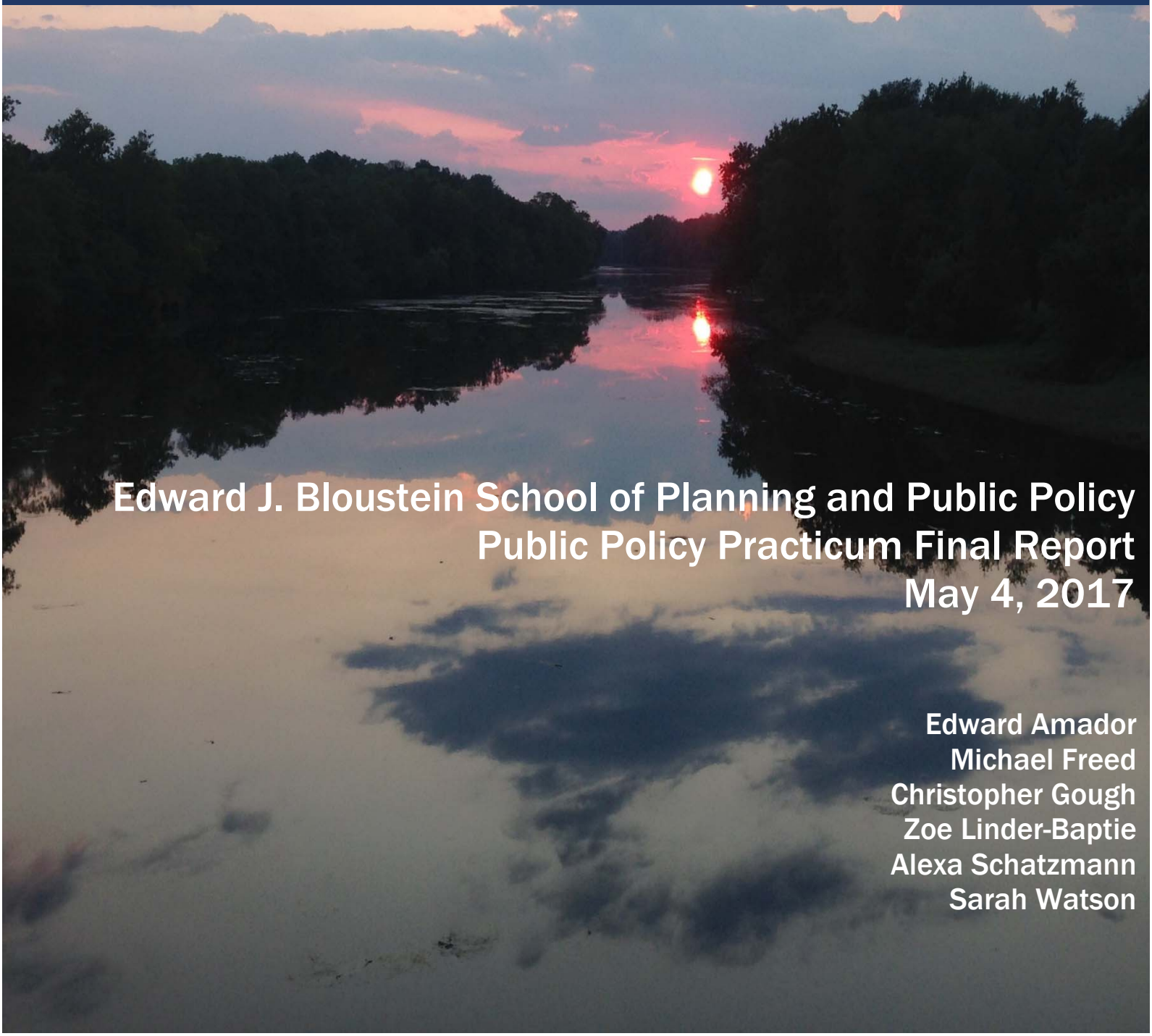
Every Drop Counts

Locally Driven Policies to Help Improve Water Quality in the Raritan River Basin

A Report for the Sustainable Raritan River Initiative



Edward J. Bloustein School of Planning and Public Policy

Public Policy Practicum Final Report

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Executive Summary

This report was commissioned by the Sustainable Raritan River Initiative to identify locally driven policies that can be implemented at the municipal level to improve water quality in the Raritan River Basin. The Sustainable Raritan River Initiative is a joint program of the Edward J. Bloustein School of Planning and Public Policy and the School of Environmental and Biological Science at Rutgers, the State University of New Jersey. The Initiative "works with various stakeholders around the Raritan River Basin to balance social, economic and environmental objectives towards the common goal of restoring the Raritan River, its tributaries and its estuary for current and future generations," according to its mission statement. The purpose of this document is to build on the work that has already been done to restore and protect the Raritan River Basin, particularly through assessing policy options for improving water quality.

We conducted nearly two dozen interviews in a two-month period with various Raritan River basin stakeholders and water quality experts in New Jersey and elsewhere. Our interview subjects identified many challenges and had numerous proposed solutions. We also explored how water quality improvements were attained in other watersheds with similarities to the Raritan Basin, including the Charles River in Massachusetts, the James River in Virginia, and the Anacostia River in Maryland/Washington, D.C. Included in the report are five case studies, two of which are on New Jersey communities and the other three are the river basins listed above.

Our Recommendations

We developed two sets of recommendations based on the overall feasibility of implementation. High feasibility recommendations were determined based on the overall likelihood that such a policy could be implemented. These policy options have been -- or are under current consideration as of May 2017 -- in New Jersey or elsewhere, and have the potential for a higher level of impact on overall water quality if applied at a large scale.

High feasibility recommendations:

- **County and municipal level incentives to developers**

Local governments should create incentive programs to speed up permitting or make minor code waivers in exchange for developers using green infrastructure for stormwater management.

- **Septic pump-out requirements tied to permits**

Local governments should establish a permit program for septic systems with a pump-out certificate as the primary requirement. This would improve overall maintenance of septic systems and reduce groundwater pollution.

- **Local ordinances expanding riparian buffer requirements beyond state minimum standards**

Local governments should use a local ordinance to expand riparian buffers beyond state minimums helping to protect waterways while simplifying building rules.

- **Local ordinances that are more stringent than state minimum standards**

State stormwater regulations establish minimum standards communities must follow, but they are allowed to adopt ordinances that exceed these minimum requirements. Such ordinances should establish much tighter triggers for when stormwater regulations must apply or require builders or property owners to manage all stormwater on site for new development.

- **Local ordinances requiring green infrastructure use as part of stormwater management**

Green infrastructure methods are encouraged for stormwater management, but not required. As a result, they often are not used because developers and builders prefer to use methods they know and can create quickly. Local ordinances requiring green infrastructure methods should expand their use, which reduces stormwater runoff volume and pollution.

We also included several longer-term recommendations because they help address some of the overarching themes we found during our interviews. These longer-term recommendations help address large scale behavior change among those charged with implementing water quality regulations, or are programs that are not feasible given current state priorities, but may become more feasible in the future.

Longer term recommendations:

- Require green infrastructure and stormwater management education (and continuing education) for professional engineers, developers and those appointed to planning boards
- Implement stormwater utility fees based on stormwater generated on property
- Conduct a study to closely examine individual municipal ordinances and rank effectiveness based on peer-reviewed research.

Overarching Policy Challenges

Finally, in our analysis of our interviews, we found four overarching themes among the obstacles that impede potential improvements to water quality in the Raritan Basin. Many of these challenges occur in the realm of policy, particularly at the state and local levels. These four themes are:

- **Enforcement**

Regulations are adopted at the state level, but enforcement typically is left to local governments. Municipalities may not fully enforce regulations because often they simply do not have the capacity.

- **Integration**

The challenge of working with so many individual governing units at county and municipality levels, which can lead to the lack of effective program integration.

- **Knowledge Gaps**

Knowledge among those executing implementation of the core functions water protection policies in New Jersey varies greatly. This is especially relevant among local elected and appointed officials, staff and consulting municipal engineers, and other local staff.

- **Resistance to Change**

Underlying all these challenges is a resistance to change at the institutional and individual-level, unless the change is forced via regulation.

Introduction

The Raritan River watershed is the largest river basin contained entirely within the State of New Jersey. The watershed is comprised of seven counties and 98 municipalities, which are partially or wholly contained. (SRRI, 2016) The river and its tributaries provide drinking water to more than one million people. (Deak, 2015) The watershed's geographic diversity, ranging from the peaks in the Highlands region, to the Piedmont, to the tidal coastal plain, adds to the complexity of managing water quality and planning at the local, regional, and state levels. New Jersey Department of Environmental Protection (NJDEP) divides the state into five watershed planning regions and twenty watershed management areas. The Raritan Basin contains three Watershed Management Areas (WMAs): The Upper Raritan, containing the North and South Branches of the Raritan River above their confluence; the Lower Raritan, containing the Raritan River, Bound Brook, South River and Lawrence Brook; and the Millstone, containing the Millstone River and Stony Brook. (RBWMP, 2002)

Purpose of Report

Water quality in all three WMAs face multiple threats, including surface water pollution, loss of riparian areas, biological impairment of streams, groundwater losses, water supply limitations and stormwater impacts. While public perception about water quality impairments tends to invoke point-source pollution and toxic materials, impairments from non-point source pollution have the greatest impact on watershed health. (EPA, 2017b) The imperfect overlap of natural and political geographies, as well as existing state and local policies, create problem-solving opportunities and challenges at all levels of government.

Solutions at the state, county, and municipal levels each have unique advantages and disadvantages. This report will focus on how municipal and county-level policies can complement and enhance state-level regulation and law aimed at improving water quality in New Jersey and the Raritan Basin. We also summarize the water quality management policy landscape in New Jersey, and incorporate lessons learned in New England and other Mid-Atlantic states. These lessons, paired with original research conducted through extensive stakeholder interviews, inform recommendations on specific policies that can improve water quality within the Raritan Basin.

Uses for this Document

This report supplements existing research reports on watershed health and water quality indicators in the Raritan River Basin. We connect specific water quality challenges with policy solutions that can be implemented at a variety of levels of government. We highlight needs and challenges, and provide avenues for implementation. Our goal for the report is to serve as a guide for decision-makers who may be wary of taking initial steps toward adopting different measures to meet water quality targets. It is our hope that the research contained within this report will fill knowledge gaps and assist a wide range of policy professionals, researchers and advocates implement water quality improvement solutions.

Our research uncovered many potential ways municipalities could improve water quality through policies, but these solutions often are politically contentious or economically prohibitive. Therefore, the findings from this report were developed with an eye toward realistic implementation. Stakeholders interviewed noted how the persistent challenge of a lack of funding and resources creates substantial barriers to actions that improve water quality. As such, research that highlights the successful use of solutions can act as a resource that helps stakeholders leverage funding.

In the next section, we discuss the Raritan River Basin in terms of watershed health indicators, population trends and land use changes. Then, we provide sections outlining existing water quality policies and some of the key costs associated with the problems facing the region. We continue by explaining our research methodology. Then we examine a set of municipalities and major river basins as policy case studies to demonstrate how other regions diagnose their water quality issues and address them, both considering state and federal regulation and in response to resident concerns. This is followed a discussion of observed policy challenges we uncovered in our research that decision-makers and stakeholders face. We conclude the report with two sets of recommendations, which include an explanation of their relative impacts and feasibility.

About the Raritan River Basin and its Challenges

The Raritan River Basin covers about 1,100 square miles of land. About 1.3 million people in 98 municipalities, and seven counties, live in the watershed. The basin is also home to dozens of species of plants and animals that are protected under endangered species laws and regulations. Precipitation is the primary source for most the water that enters the river and its tributaries each year; rain and snowmelt supply an average of roughly 900 billion gallons of water per year to the river system. The river itself provides drinking water to over one million people. Key indicators of water quality and watershed health, for the Raritan Basin, have been deteriorating since the original data were collected in 1986. (SRRI, 2016)

Two trends, in particular, are responsible for the decline in water quality and watershed health in the basin; population growth and its impacts, and a reduction in the natural elements that support filtration capacity, such as wetland cover, upland forest cover, and groundwater recharge. Despite state level stormwater regulations that are regarded to be among the most stringent in the U.S. as the result of revisions in 2005, watershed health indicators in the Raritan Basin continue to trend downward. (SRRI, 2016) However, statewide, water quality itself has remained constant or has improved, based on the New Jersey 2014 Integrated Water Quality Assessment Report.

General Scope of Raritan Basin Watershed Impairments

As of 2014, 303 water bodies in the basin were considered impaired based on their inclusion on New Jersey's Impaired Waters Listing. (NJDEP, 2015) This is up from 121 water bodies listed in the 2002 report (RBWMP, 2002), however this increase is likely more indicative of more waterbodies sampled by 2014 than had been done in 2002. Waterways on the impaired waters listing are subject to additional regulation by NJDEP's Office of Water Resources Management Coordination. The goal of this additional focus is to find ways to improve water quality so the waterway is no longer impaired. The office, whose role is to advance water quality management, sets and enforces standards, provides technical support, and assists with resource planning and implementation. It also conducts other coordination activities with county and local governments, residents, and businesses. This support is intended to better ensure water quality in New Jersey meets the mandated standards.

Primary Pollutants and their Sources

The primary source of pollution in the Raritan Basin is stormwater runoff and the primary pollutants of concern in the Raritan Basin are phosphorous and fecal coliform. These pollutants both frequently share human activity as their most common source. Stormwater runoff is the result of impervious surfaces blocking water from precipitation from being absorbed into the ground. Runoff flows directly into storm drains and waterbodies, carrying pollutants and waste with it.

Phosphorus is a naturally occurring nutrient which supports the aquatic ecosystem, but in excess it becomes considered a pollutant. Excessive phosphorous, often released from tilled soil and agricultural runoff, contributes to eutrophication, which "causes algae to grow faster than ecosystems can handle." (EPA, 2017a, para. 4) The Environmental Protection Agency explains "significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive." (EPA, 2017a, para. 4) The reduction of oxygen and elevation of toxins in the water damage both the nature, life, and human health.

Fecal coliforms come from the digestive tracts of mammals and are known to cause diseases and harmful increases in dissolved oxygen in water.

Other pollutants of concern include temperature, dissolved oxygen, pH levels, excessive macrophyte growth, sedimentation, and mercury in fish tissue. (RBWMP, 2002) These pollutants collectively affect human health, damage ecological systems, and impose significant social costs on the residents of New Jersey such as costly watershed cleanups, reduced availability of natural resources and other negative externalities.

Key Indicators of Watershed Health

Using data from 1986-2012, watershed health in the Raritan Basin was ranked by the New Jersey Water Supply Authority (NJWSA) and the Sustainable Raritan River Initiative (SRRI) using a consistent set of multiple indicators. The key indicators used by the SSRI and NJWSA, and included in the 2016 State of the Raritan Report, are: population, housing units, urban land use, impervious surface, wetlands, upland forest, prime agricultural land, groundwater recharge, stream integrity, riparian area integrity, and known contaminated sites, and groundwater contamination. Of these indicators, population growth and land use change have the most profound impact on water quality.

Population Trends

Increasing population typically leads to reduced watershed health and water quality. This is because many primary watershed pollutants are the result of human activities (e.g. fecal coliform from sewage, nitrates from fertilizer etc.) The population in each of the Raritan Basin's three watershed management areas has grown substantially in the past few decades, increasing by 25 percent since 1990. The population in the Millstone watershed has almost doubled since 1990. Although growth has slowed compared to 1990-2000 rates, the New Jersey Department of Labor predicts that populations will continue to increase in the area. (NJDLWD, 2015) To accommodate a growing population, the number of housing units in the basin continues to increase, with an overall increase of nearly 25 percent since 1990. In the Millstone watershed, the number of housing units has increased by 41 percent since 1990. Population growth has outpaced housing growth by 5 percent in the Millstone Watershed and 2 percent in the Lower Raritan. (SRRI, 2016) This suggests a shift toward higher density housing that may follow smart growth principles.

Land Use Changes

Increasingly urbanized land uses have contributed significantly to changes in the water quality and health of the Raritan basin. About 44 percent of the Raritan basin is classified as urban land, "densely developed territory, encompassing residential, commercial, and other nonresidential urban land uses

within which social and economic interactions occur," with urban land use being common in the Lower Raritan and Millstone areas at nearly 60 percent and 41 percent respectively. (U.S. Census, 2011; SRRI, 2016, p. 17). Overall land use conversion trends primarily were from agricultural to urban land uses, and to a lesser extent, from wetlands and forest. (SRRI, 2016) Conversions from more natural uses that allow rainfall and snowmelt to infiltrate into the soil from the ground surface) to urban land where impervious cover is substantial, is detrimental to watershed health and water quality. (Raritan Basin Watershed Management Project, 2002)

Impervious surfaces, such as streets, buildings, and parking lots, do not permit water to enter the ground as it naturally would, causing an increase in volume and speed of runoff during storms. As previously mentioned, when stormwater runoff moves across impervious surfaces and bare soil, it picks up pollutants, including phosphorus, nitrogen, sediment particles, and oil and other chemicals. When impervious surfaces cover more than 10 percent of the total watershed area, water quality degrades. Impervious cover that is more than 25 percent in a watershed causes severe degradation. (SRRI, 2016) Since 1995, impervious surface cover has increased across the basin at a consistent rate. In 2012, the entire basin had about 12 percent impervious cover, placing it at risk of degradation, while about 23 percent of the Lower Raritan WMA had impervious cover. (SRRI, 2016)

Changes to the Natural Environment

Shifts in land use directly impact groundwater and rates at which aquifers are replenished or recharged, which are critically important to the health of the Raritan basin. The quality of groundwater, and the rate extracted from the ground. (NJDEP, 2017b) Impervious surfaces are the primary cause for reduced groundwater recharge rates, with the highest recharge rates found in the Upper Raritan watershed area at which it is replenished is important given that almost half of daily water consumption in New Jersey is where there is more forest land cover, and the lowest in the Lower Raritan Area, where there is the highest proportion of impervious surfaces. Given the importance of recharge rates to the hydrologic cycle, human health, and industry, reduced recharge can have severe implications in the future. The waters of the Raritan Basin are contained within several geographically distinct habitats; these are defined as follows:

> ***Wetlands*:** Wetlands are a critical component to the natural processes that take place in the Raritan basin. These unique land features assist in water filtration, water management, and supporting fish and wildlife. Despite their importance, the total area of wetlands continues to decline, primarily due to land use changes. Currently, wetlands constitute 13.4 percent of the basin, and since 1986 the Raritan basin has lost 13.3 percent of its wetlands, totaling about 14,500 acres. (SRRI, 2016) The Lower Raritan watershed area experienced the largest decline in total wetlands coverage over the past quarter century, largely due to development.
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> ***Upland forest*:** Upland forest is crucial to maintaining water quality standards and watershed health, particularly in the Upper Raritan watershed area, given the ability of upland forests to "reduce soil erosion, filter runoff and increase groundwater recharge and therefore elevate and protect water quality." (SRRI, 2016, p. 33) The Sustainable Raritan River Initiative found that about 18,800 acres of upland forest was converted to urban land use, with a net loss of over 83,000 acres from 1986 to 2012. (SRRI, 2016)
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> ***Prime Agricultural Land*:** Prime agricultural land "consists of better soil quality, [longer] growing season, and soil moisture suitable for production of food, forage, and fiber with a sustainable yield" relative to land less suitable for agriculture (SRRI, 2016, p. 36). The same qualities that make

the land preferable for farming assist in water filtration and groundwater recharge. Overall, the amount of prime agricultural land available throughout the watershed has decreased, primarily due to urban development. More than 20 percent of prime agricultural land was developed through the entire watershed for urban purposes from 1986- 2012. The largest conversion was observed in the Millstone watershed area. In total, about 42 percent of prime agricultural lands in the basin were converted to other land uses. (SRRI, 2016)

These various habitats, each with their own unique set of qualities and challenges, must be considered when looking at the entire Raritan Basin. It is also important to understand the variety of landscapes when trying to grasp the relevant laws and policies.

Major Laws and Regulations Affecting Water Quality

The Federal Clean Water Act (CWA), passed in 1972, established a basic structure for regulating pollutant discharges in the waters across the country. The CWA allows the EPA to implement pollution control programs, such as setting wastewater standards and regulating pollution discharge by point sources into waterways. (EPA, 2017b) The regulation of discharge by point sources is enforced through the National Pollutant Discharge Elimination System (NPDES), which is a permit program allowing industrial, municipal, or other facilities to discharge into waters only if they obtain a permit. The CWA also allows EPA to implement water pollution standards for various types of impairments as well as maintain a listing of waters considered to be impaired. The EPA and state regulatory agencies then can work together to develop a study that identifies the Total Maximum Daily Load of specific pollutants or impairments and use that study to identify ways to improve water quality.

In New Jersey, other laws exist to regulate water quality and stormwater management. The major laws include the Water Quality Management Planning Rule, the Freshwater Wetlands Protection Act, the Water Supply Management Act, the Water Pollution Control Act, and the Flood Hazard Area Control Act.

The Water Quality Management Planning Rule (N.J.A.C. 7:15) describes the components of water quality management plans and wastewater management plans at the state, regional, or county level. The Planning Rule also provides a set of procedures that create consistency between wastewater management plans. (NJDEP, 2017a)

The Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A) describe the activities that may or may not be conducted in and adjacent to freshwater wetlands and open waters. (NJDEP, 2017a) The state implemented this law after deciding federal programs protecting wetlands were not strong enough. (Association of New Jersey Environmental Commissions, 2004) The EPA delegates implementation of Section 404 of the CWA to the state government.

The Water Supply Management Act (N.J.A.C. 7:19) establishes a regular process for water planning in the state and to determine the regulatory use of water, including thresholds limiting the amount of water that can be diverted from waters of the State. (NJDEP, 2017a)

The New Jersey Water Pollution Control Act (N.J.A.C. 7:14) contains requirements for the construction of wastewater treatment facilities. The WPCA also establishes more significant penalties for violations to the CWA than were originally implemented at the federal level. (NJDEP, 2017a)

The Flood Hazard Area Control Act (N.J.A.C. 7:13) was established in 1975 as a result of intense flooding throughout the state in previous decades. (USGS, 2016) It regulates development in floodplains by creating permitting standards and procedures for projects conducted in those areas. (NJDEP, 2017a)

The New Jersey Stormwater Management Rules (N.J.A.C. 7:8) are the regulations implementing the stormwater management components of multiple pieces of legislation, including Acts listed above. These regulations were updated in June 2016 and establish a comprehensive framework for addressing water quality impacts associated with existing and future stormwater discharges. (NJDEP, 2016a)

These state regulations preempt local control and establish a minimum required level of compliance. Counties and municipalities can enforce more stringent requirements for projects under their jurisdiction. At the local level, municipalities are responsible for implementing and enforcing local ordinances that comply with state laws. However, in practice, implementation and enforcement of such ordinances is based on each municipality's own priorities. The regulations with the largest impact on water quality implemented primarily by municipalities are the stormwater management rules. The stormwater management rules only apply to residential development. For non-residential local developments, the rules are not applied unless a municipal ordinance is passed adopting such standards or unless the development requires a permit from the Division of Land Use Regulation. (NJDEP, 2016a) Additionally, not all new residential development needs to abide by the rules. These rules only apply if the new development will result in a disturbance of one or more acres of land or increases the impervious surface of an area by ¼ of an acre or more. (NJDEP, 2016a) These specifications are known as major development triggers. Municipalities have the authority to adopt more stringent triggers than those previous mentioned, but cannot lessen them.

The Stormwater Management Rules also consists of separate, but related provisions. First, the permits related to nonpoint source pollution under the New Jersey Pollutant Discharge Elimination System (NJPDES) Rules address and reduce pollutants associated with existing stormwater runoff. They establish a regulatory program for existing stormwater discharges as required under the CWA and govern the issuance of permits to entities that operate small municipal separate storm sewer systems (MS4s). (NJDEP, 2017a) Municipalities must secure permits to comply with statewide basic requirements that reduce nonpoint source pollution as established by the NPDES Rules. The most important requirement involves the development of a municipal stormwater management plan and associated implementing ordinances. Later in this report we will provide examples of existing model municipal plans. Another critical provision under the Stormwater Management Rules builds off the NJPDES program by setting forth the required components of regional or municipal stormwater management plans. Included in this rule are design and performance standards for new development. (N.J.A.C. 7:8, 2016) Examples of design standards can be found in the 2004 New Jersey Stormwater Management Best Practice Manual (NJDEP, 2017c).

Finally, New Jersey Water Quality Management Planning (WQMP) rules are used as a framework for water quality and quantity planning based on the federal CWA. The most recent amendments to the rules, made in October 2015, replace and repeal the previous rules with the intention of eliminating duplicative requirements in other wastewater planning and permitting programs. (NJDEP, 2017a) The WQMP Rules outline specific roles given to the DEP, designated wastewater planning agencies, and county and municipal authorities. Wastewater, along with stormwater, runoff, and pollution are all problems that the above laws attempt to correct, but conflicts between authoritative bodies can hinder that process.

Social Costs of Poor Water Quality

Poor water quality imposes very large costs on New Jersey. It is beyond the scope of this paper to monetize these costs. This section seeks to identify and describe these costs in qualitative terms for policymakers and advocates (as opposed to providing an economic impact evaluation). As described above, the primary pollutants in the Raritan basin are phosphorous, fecal coliform, and sedimentation. While Combined Sewer Overflow (CSO) points in the Raritan Basin are limited to Perth Amboy, this issue is more acute elsewhere in the state. But each of these issues and factors adds social and economic costs to the community, local government, and state.

High levels of phosphorus can result in numerous ecological impacts. These consequences include, but are not limited to, algae blooms near drinking water intakes, fish population instability due to lack of dissolved oxygen in the water, loss of recreational activities in waterways, habitat degradation in nearshore wetlands and tributaries, and riverbank erosion and damage. The indirect costs associated with these problems can include negative health impacts, ecosystem and fishing industry disruptions, and property value and tourism revenue declines. The resolution of these issues carries with it a sizable economic cost to municipalities. (Healthy Lake Huron, 2011)

Fecal coliform bacteria amounts in the Raritan River also cause major impairments that affect recreational use. Fecal coliform is a type of coliform bacteria that exists in the feces of people and animals. It enters waterways from multiple sources, including through agricultural runoff, pet waste runoff, untreated sewage discharges from failing septic systems, and sewage overflows from municipal infrastructure. The presence of fecal coliform in treated drinking water can cause serious health impacts and it indicates that other pathogens might also be present. The levels of fecal coliform are tested as an indicator because it is much less expensive than testing for numerous different pathogens. (Washington State Department of Health 2016) Human consumption of pathogens can have a variety of different health impacts. The pathogenic strain of Escherichia coli (E. coli O157:H7) is one common and problematic example. A severe E. coli outbreak can bring undesirable outcomes including widespread gastrointestinal issues and public alarm. (Leeds, Grenville, and Lanark District, 2017)

Sedimentation is another form of water quality impairment, and one that does not have an existing mandated water quality criteria. Sedimentation is caused by erosion--a natural process which is typically expedited by human land use. Depending on the severity, it can limit recreational uses, increase the cost of treating drinking water, smother benthic aquatic life, and stunt the growth of fish.

Increased water temperature, lower dissolved oxygen levels, changes in pH levels, and excessive macrophyte growth--which can result from a variety of factors--are important indicators of watershed health and can cause critical disturbances. (USGS, 2017) These four factors determine what aquatic species, if any, can live in a water body. Severe imbalances in any of these indicators can trigger chain-reactions which can result in many of the same cost-implications associated with phosphorus, pathogens, and sedimentation.

Another challenge is the improper design and maintenance of septic systems. In New Jersey, over one million people rely on individual septic systems. (Association of New Jersey Environmental Commissions, 2002) Septic systems consist of a septic tank that digests organic matter and separates solid matter from wastewater, and a drainfield that slowly absorbs the associated effluent. (EPA, 2016b) As early as 1977, an EPA report found that improper septic system design, installation, and maintenance can lead to surface and groundwater contamination. The density of septic systems in an area greatly influences the possibility of groundwater contamination by contaminants like bacteria, viruses, ammonia, nitrates, chlorides,

phosphates, and sodium. (Dunlap, 1977) Because over half of the state's population relies on groundwater for water supply, it is important that individual owners and local authorities take steps to prevent septic leakages.

Research Methodology

We undertook a variety of research and analytical activities. The general background knowledge underlying the report was gleaned from a close reading of water quality and management literature at the federal, state and Raritan-local levels. We also examined reports about water quality issues to river basins in other Northeastern and Mid-Atlantic states. These readings included selections from the Clean Water Act, SRRI's most recent State of the Raritan report, and reports by the New Jersey Water Supply Authority, the three Raritan watershed management associations, and peer-reviewed academic research.

The primary data collection effort consisted of a series of water-quality-policy-directed interviews with watershed advocates, in and out-of-state public officials across multiple levels of government and private sector firms in natural resource management. We made several attempts to contact numerous municipal-level officials in the Raritan Basin but there was little response. Interviews were solicited via email request with a follow-up request protocol that included up to three emails. Interview subjects were selected first by direct referral from both SRRI staff and then from interview subjects or individuals team members identified independently. Interviews primarily were conducted via telephone with at least two working group members present to ensure accurate response recording. The other interviews were conducted in person with at least two recorders present. Individual respondent confidentiality was offered to assure candid responses. The interview format and foundational questions can be seen in the appendix. Follow-up questions were asked as necessary depending on interview subject responses.

Team members also attended the 2017 Raritan Integrated Water Quality Assessment Shareholder Meeting facilitated by the Sustainable Raritan River Initiative at Duke Farms, a New Jersey water quality policy presentation by a professor with considerable knowledge on water quality, and the Rutgers Raritan River Consortium Luncheon.

Water Quality Policy Case Studies

Outlined below are case studies illustrating how two New Jersey municipalities are addressing water quality improvements through policy and action, as well as other river basins in the Northeast and Mid-Atlantic that have similarities to the Raritan. These case studies highlight how others have implemented simple, yet effective, ordinances, green or new grey infrastructure practices, or educational platforms. Our selection of each municipality or waterway was based on its relevance to the Raritan and its feasibility of being transferred to the Raritan Basin. The information provided is based on extensive research and interviews with representatives of nonprofit organizations working in the areas.

Cranbury Township, New Jersey

Expanding Vegetated Buffers to Protect Waterways

Cranbury Township is located in southern Middlesex County and is bordered by South Brunswick, Monroe, East Windsor, and Plainsboro. It lies within the Raritan Basin Watershed, specifically the Millstone Watershed Management Area. Cranbury is 13 square miles with a population of approximately 2,300 residents. (Town Charts, 2015) Cranbury Township is a mix of industrial, commercial, residential, and

farmland, although development has been growing in the industrial, commercial, and residential sectors. Development, stormwater runoff and pollution have increased while groundwater recharge has decreased. (Township of Cranbury, 2005) In 2005, municipal officials in Cranbury began to implement ordinances that addressed the impacts of development on water quality and quantity in the township and Raritan Basin.

Members of the township's Environmental Commission, with whom we spoke, recognized the negative impacts that water quality problems had on the community and their planning efforts led to the implementation of some of the most effective stream corridor and stream protection ordinances in the state, according to an employee of the Stony Brook-Millstone Watershed Association. The township's first step was to create a municipal Stormwater Management Plan, developed in coordination with the DEP to better manage the stormwater and runoff issues. While every municipality is required to create their own management plan, Cranbury used specific practices from the New Jersey Stormwater Best Practice Manual to incorporate design standards and maintenance responsibilities for new development into Land Development Ordinances, making it exemplary. These ordinances will ultimately address soil erosion control, groundwater recharge, stormwater quality, and stormwater quantity impacts.

One of the Land Development Ordinances adopted protects water quality in a way that far exceeds state minimum standards. State-level minimum standards require that stream corridor, or riparian zone, buffers only extend 25 to 50 feet depending on the waterbody class and type. However, Cranbury requires that all development must end 150 feet away from all water bodies, regardless of class and type. (Township of Cranbury, 2009) Category One waters are protected by a 300-foot buffer, as required by state law. This policy is easy to implement and enforce. This practice allows for increased filtration and infiltration, and lessens impervious surfaces. The township also prioritizes enforcement, which is essential to the policy's success.

Newark, New Jersey

Inspiring a City with a Stormwater Problem to Do It Green

Newark, N.J. is the county seat of Essex County and the state's most populous city. The city, with a square area of about 26 miles, is densely populated, and has a long industrial history. Newark, like most older industrial towns, has an aging water and sewer infrastructure that can't keep pace with modern usage. To better understand Newark's approach to water quality improvement, we did documentary research and spoke with an employee of the Department of Water and Sewer Utilities, as well as an individual from an advocacy organization that has closely worked with the city, in order to create this case study.

Newark's aging and overwhelmed combined sewer system sends untreated sewage and stormwater through combined sewer overflow points into nearby rivers. (Amar, 2014) The combined system also causes street flooding when it is overwhelmed during heavy rain storms. While nearly all towns in the Raritan Basin do not have combined sewer systems, stormwater flooding does occur. Newark needs hundreds of millions of dollars to restore and upgrade its infrastructure in the near- and long term. The most obvious solution to Newark's problems was to invest in expensive "gray" infrastructure such as pipes, holding tanks, and other treatment facilities. However, Newark is looking to use green infrastructure instead.

Gray infrastructure consists of conventional infrastructure like pipes and tanks made of concrete or steel. Conversely, green infrastructure utilizes natural components to solve infrastructure challenges

through the use of ponds, wetlands, rain gardens, bioswales, and permeable pavement. The EPA defines green infrastructure as, “a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits”. (EPA, 2016d, para. 1)

Newark is taking the initiative in implementing green infrastructure practices that will greatly help reduce flooding impacts on water quality. At present, Newark has a stormwater ordinance in place that requires all new development, or a significant portion of redevelopment, to capture 100% of stormwater runoff on site. (Together New Jersey, 2015) This water is then slowly released into city sewers. This ordinance is much more stringent than those in other towns and does not require the use of green infrastructure, but does strongly encourage using green infrastructure methods.

Newark Doing Infrastructure Green (Newark DIG) is a nonprofit organization "committed to continuously improve the quality of life, health, and viability of the City of Newark and its residents" according to its mission statement. (Newark DIG, 2013a) The primary goal of this organization is to establish green infrastructure as the first line of defense to better manage stormwater runoff, improve water quality and resiliency to flooding, and reduce combined sewer overflows, with a focus on the Passaic River and its tributaries. (Newark DIG, 2013b) Since its creation, Newark DIG has implemented over 35 projects that use green infrastructure methods. These projects range from the creation of multiple community gardens, streetscapes that use pervious pavement, to the inclusion of bioswales/rain gardens into already developed areas.

Charles River, Massachusetts

Court-Ordered Commitment to Clean Water Through Science and Communication

Through research and an interview with a nonprofit environmental advocacy organization, we explored the problems and solutions related to the Charles River in Massachusetts. The Charles River runs approximately 80 miles through 23 towns and cities in eastern Massachusetts into Boston Harbor. (CRWA, 2014a) The river long has been a crucial driver of economic development for Massachusetts and the larger New England region. It is the most densely populated river basin in New England, with 35 towns and cities attached to its watershed, which consists of nearly 80 brooks and streams in the 308-square miles of drainage area. (CRWA, 2014a) By the mid-19th century, the Charles was one of the most industrialized areas in the United States.

The cumulative effects of insufficient regulations and sewage overflows led to a federal court ordered cleanup process in 1985, and the establishment of the Massachusetts Water Resources Authority (MWRA). (MWRA, 2015) Water quality has improved substantially over the last three decades, with the Charles deemed safe for swimming in 2013 -- the first time in 50 years. Today, MRWA is a public authority that provides “wholesale water and sewer services to 2.5 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities.” (MWRA, 2017, p1)

The Charles River Watershed Association, formed in 1965, has been a central partner in the cleanup and continues to work in an organizing and advocacy capacity; they are now involved in every major decision affecting the health of the Charles River. (CRWA, 2014b) The MWRA was initially tasked with restructuring Boston’s wastewater system. One of the more famous projects is the Deer Island sewage treatment plant, the third largest facility in the country. This central system is connected to several smaller plants, via new drainage pipes, which have been updated with new gray infrastructure. The enhanced infrastructure, although not as forward thinking as possible, was bolstered by large investments, effective management and has significantly improved the water quality for the region. The cleanup lead to

economic benefits including new businesses, higher property values, and more recreational uses of the river and waterfront. Untreated runoff is now the biggest issue in the Charles after sewage, leading to a focus on eutrophic areas of the Charles.

Although this case involves a federal mandate, there are still lessons to learn from the cleanup of the Charles. First, CRWA considers itself as a science oriented advocacy group that depends on the best science and data collection and monitoring. Scientific data provide tangible information that undermine assumptions and provide guidance for measured policy intervention. Second, "in defense of engineers and municipalities, they are trained to be risk-averse. They like using things that have already been used and proven successful," the CRWA interviewee said. Like engineers and municipalities, taxpayers are risk-averse, making undemonstrated projects not politically palatable. In short, without a mandate or a vocal constituency, new things are not likely to happen. The Charles River was fortunate to have both. Third, increased communication between municipalities facilitates the opportunity for collaboration and efficiency, through exposure to new ideas and demonstrated work.

The federal court case affiliated with this cleanup issued its last report in April 2016, removing federal oversight of the Charles River.

James River, Virginia

Environmental Improvements Through Grassroots Support

To develop this case study, we conducted background research on the river and interviewed an individual with a water quality advocacy organization that has expertise on the James River. The James River is the largest river in Virginia, flowing 340 miles and fed by 15,000 miles of tributaries. The river, which stretches from the Appalachian Mountains in the West to its end in the Chesapeake Bay, is one of the longest rivers in the United States that begins and ends in the same state. (JRA, 2016) The roughly 10,000 square miles of the James River watershed are home to approximately three million Virginians and part of the larger Chesapeake Bay watershed, which reaches north all the way up through Pennsylvania to New York State. (JRA, 2016)

Much of the river's watershed is agricultural in nature and primary pollution problems include nitrogen, phosphorus, and sediment. In 2010, the EPA established the Chesapeake Bay Total Maximum Daily Load study and, in subsequent years, watershed-level implementation plans, which made it possible for organizations, such as the James River Association (JRA), to assist in the statewide implementation of pollution control and river protection. (EPA, 2016a) Over the past six years the state has been on track for the Chesapeake Bay cleanup goals. The JRA issues the State of the James Report Card every two years assessing the overall health of the river. The last Report Card, published in 2015, gave a grade of B-, the best grade yet, indicating an increasingly productive effort on the parts of local and state agencies. (JRA, 2015)

Grassroots organizing and the development of broad coalitions have been vital to the improvement of water quality and health in the James River, interviewees said. For example, where it is voluntary to install and maintain riparian buffers along streams, efforts to do so were driven by grassroots commitments. Given constraints on financial and staffing resources, if there is not adequate interest in the citizen base, change will not happen.

Outreach from groups such as the JRA and education coordinators from local water and soil conservation districts have been instrumental in educating residents and representatives on water quality

issues. This has contributed to the development of an informed and vocal constituency. Past successes in water quality improvements suggest that the most effective path forward is a strong partnership between the state and local governments, and active involvement of stakeholders.

The Stormwater Local Assistance Fund is a tool that facilitates state and local grantmaking. This state-level program "matches grants to local governments for the planning, design, and implementation of stormwater best management practices that address cost efficiency and commitments related to reducing water quality pollutant loads." (VADEQ, 2016, p. 1) A JRA staff member described the Fund as a game changer to get projects on the ground at the local level.

Anacostia River, Maryland

Illustrating Impacts of Green Infrastructure and Low Impact Development

The Anacostia River runs nearly 9 miles from Maryland, from eastern Montgomery County through northern Prince George's County, into parts of Washington, D.C. where it joins with the Potomac River estuary. The river's 176 square-mile watershed includes relatively pristine forest, densely populated suburban neighborhoods, and heavily urbanized neighborhoods. In the river's lower tidal reaches, dense urban areas come up directly to the water's edge, which eliminates natural buffer and filtering capabilities of forested areas. Due to the river's slow tide in the estuarine parts, pollutants historically stay in one place for longer than is typical. (Turentine, 2016) Our decision to include the Anacostia as a case study stems from the results of an in-depth literature review about the watershed and its restoration planning.

The Natural Resources Defense Council (NRDC) began to address the pollution and public health issues through an initiative called the Urban Waters Federal Partnership. (EPA, 2013, p. 8) The partnership connects over a dozen federal agencies to local RiverKeepers, like the Anacostia Riverkeeper, and other conservation groups to collaborate on cleanup efforts, and to push to facilitate the Anacostia Watershed Restoration Plan. (Turentine, 2016) The Anacostia Riverkeeper works to address pollution, trash, stormwater runoff, CSOs, all with a perspective of environmental justice. (Anacostia Riverkeeper, 2015) The Anacostia Watershed Plan focuses on 8 restoration strategies, including retrofits, restoration, and remediation, accompanied by 13 larger policy recommendations.

Anacostia River planners, similar to those working on the James and Charles rivers, pair river restoration with economic development through the Anacostia Waterfront Initiative. This 30 year, $10 billion initiative, which seeks to turn the Anacostia into an amenity and asset, is overseen by the Washington DC government as well as 19 regional and federal agency partners. (Anacostia Waterfront Initiative, 2015)

Reducing stormwater runoff has been a major focus on the Anacostia, given that runoff is responsible for 75-90 percent of the river's pollution. Low impact development is encouraged and now demonstrated in the region, especially in Washington DC, leading to "millions of square feet of green roofs in the District, for example, and several high-profile development projects are employing a wide range of green techniques to manage their runoff." (Turentine, 2016, para. 10) A green roof is a type of covering on the top of the structure that allows grass and other plantings to naturally soak up precipitation, thus reducing stormwater runoff. Area planners depend on low impact development and green infrastructure in order to minimize runoff that pollutes the river, as well as focused government action and involved citizens.

Research Findings

We conducted nearly two dozen interviews, including the interviews that form the basis of the case studies above, in a two-month period with various Raritan River basin stakeholders and water quality experts in New Jersey and elsewhere. Our interview subjects identified many challenges and had numerous proposed solutions. Our recommendation list began with the suggestions we heard during these conversations. From there we proceeded to assess the potential impact and feasibility of the suggestions in order to create a list of recommendations. We list our recommendations below. But, before addressing them, it is critical to understand that many of these solutions have common barriers.

Many interviewees cited political barriers at the state level that interfere with the revision of regulations, regulatory oversight, and issue prioritization. Interview subjects also noted that politics have influenced the level of enforcement of current clean water policies. In addition to politics, several key themes involving the challenges facing water quality policy emerged over the course of the interviews. They can be categorized into four topic areas: Enforcement, integration, knowledge gaps, and resistance to change. Before describing our recommendations, we felt it would be useful to catalog these overarching themes and barriers.

Overarching Policy Challenges

There are many obstacles impeding potential improvements to water quality in the Raritan Basin. Many of these challenges occur in the realm of policy implementation, particularly at the state and local levels. What follows is a summary of the challenges most often cited by interview subjects.

Enforcement

Just as there is an inherent tension between state governments and the federal government, tension exists between New Jersey's state and local governments. Regulations are adopted at the state level, but enforcement typically is left to local governments. Conflicts between differing levels of government exist in the monitoring and enforcement of the major laws and regulations surrounding water quality and management. Multiple interviewees cited the lack of collaboration between state and local governments as one cause for enforcement problems. The possibility exists that municipalities may fail to fully enforce regulations. This may happen because local leaders do not agree with the policy, but is more likely because they simply do not have the capacity and resources to properly conduct enforcement. These resources affect not just municipal-level staff, but also consultants hired to execute some local functions, volunteer planning and zoning boards that grant approval and waivers, and elected officials that are not versed in the nuance of water quality and environmental policies.

This perceived lack of enforcement often expresses itself in the form of waivers granted to developers that allow them to violate existing policies. State-level verification of local-level enforcement is thin, with interviewees noting changes in state-level political priorities and lack of staffing within the enforcement arms of NJDEP. Several interviewees noted that all municipalities submit self-reported verification documentation to the state, but do so knowing it's unlikely that state regulators will verify beyond checking that the basic paperwork is completed. As a result, there may be an incentive in many municipalities to not include extensive documentation or to provide sweeping, but non-substantive, descriptions of local enforcement efforts.

Interviewees seemed optimistic that the state's upcoming elections may lead to a different direction in water quality and other environmental priorities.

Integration

New Jersey's tradition of home rule leads to the perception and practice that municipalities drive policies and resist anything they see as an unfunded mandate. As such, the state -- while having substantial regulatory authority and oversight -- may be sensitive to what could be perceived as overreach. Counties and municipalities can exceed state minimum standards through regional or local ordinances, but their willingness to do so is based on local priorities. Additionally, lack of resources and capacity -- along with the challenge of working with so many individual governing units at county and municipality levels -- may lead to the lack of effective program integration. Municipalities may struggle working with county and state-level officials and regulators, and municipalities may not communicate with their neighbors or peers. County-level workers lack oversight authority, and may not be effective at connecting state and municipal priorities and challenges. State-level regulators may not have sufficient capacity to ensure effective program integration. What results is a system of implementation that varies as local elected and appointed officials change. In severe cases, the lack of collaboration between the state, counties, and municipalities leads to lose implementation of regulations, or none at all, which ultimately leads to water quality degradation.

Knowledge Gaps

Knowledge among those executing implementation of the core functions of water protection policies in New Jersey varies greatly. This is especially relevant among local elected and appointed officials, staff and consulting municipal engineers, and other local staff. As noted above, solutions addressing stormwater management fall into two categories: "Gray", or designs that use hard surfaces to funnel water off the land and into waterways quickly, and "green" or designs that mimic nature by allowing water to infiltrate or slow down runoff. Interviewees pointed out that those who have worked on stormwater management design and engineering typically are more comfortable with gray solutions for a multitude of reasons. Design firms typically use "off the shelf" designs that are proven to meet basic regulations and will not delay regulatory approval. As a result, these firms may be uncomfortable incorporating green solutions because they aren't as well-known or tested. Their concerns about "green" solutions often include concern that they may require more maintenance, may not work as well in the future, or may delay approval because regulators are not familiar or willing to approve designs that are not as well-tested.

Resistance to Change

Underlying these challenges is a resistance to change at the institutional and individual-level, unless the change is forced via regulation. There are several reasons for this. First, for example, officials are reluctant to change from known "gray" designs when developers and local engineers know they can get permits for them. Additionally, those whose professional training came before green solutions were discussed may be more resistant to learning new techniques. This may be because of general human nature, professional burnout, or institutional culture that does not foster professional development. Our interviewees also noted that consulting firms tend to operate in the mindset of doing the work for the least amount of time and money and learning new techniques may cost more time and money to perfect and make part of their professional process.

Policy Recommendations

We have formed our recommendations with an eye toward realistic implementation, with a focus on policies that can be adopted at the local level without additional state-level legislation or regulation. However, we include several recommendations that can make a significant difference in water quality in the Raritan and were discussed by stakeholders as solutions to various problems, but require that more significant barriers be overcome. Our recommendations are therefore broken into two categories: high feasibility and longer term.

High Feasibility Recommendations

We consider the following five recommendations to be relatively feasible. We formed these recommendations using suggestions from our interviewees, findings from our case studies, analysis of the various water quality challenges, examinations of the benefits and challenges of such policies, and the likelihood they can be successfully implemented in New Jersey municipalities based on existing regulatory authority and the current political environment.

Recommendation: County and municipal level incentives to developers to use green infrastructure.
Who has done it: Sarasota County, FL, Chicago, IL

Discussion: Incentives are a direct way to encourage developers and builders to use green infrastructure methods when they are not required to do so. Such a program could leverage permitting time or waivers for certain building designs in exchange for the developer using pervious pavement, green roofs, rain gardens, and other methods to control stormwater on site. Currently, no incentives exist in New Jersey for developers to use green infrastructure over gray infrastructure. This can be changed by localities or counties implementing an ordinance or a local policy that allows or encourages such a program.

Multiple interviewees, including developers and planners, discussed the idea of using incentives to encourage green infrastructure or other higher level stormwater management practices. Developers are unlikely to use stormwater management methods that cost more than the minimum necessary to complete their work. However, saving them time on securing a permit would allow them to see profits much sooner and these increased profits may outweigh the higher upfront costs. The most substantial challenges in New Jersey with such a program would be ensuring that all permitting agencies are on board. Some projects require state or county approval, which is out of the purview of municipalities. In order for this type of incentive program to work on these types of projects, all permitting authorities would need to agree to expedite applications.

Incentive programs have been successfully implemented elsewhere around the U.S. Sarasota County, FL, passed an ordinance that gave developers a number of beneficial incentives for using green infrastructure techniques. (Sarasota County, 2005) If they agreed to use green infrastructure, developers were allowed expedited permitting, reduced building permit fee, priority inspections, and a package of marketing and promotional materials that were provided by the County. Developers who were constructing new residential or commercial buildings along with the remodeling or retrofitting of residential buildings received these incentives.

In Chicago, incentives also were used to expand the use of green infrastructure. The city's Department of Buildings created the Green Permit Program (Chicago, 2012) which uses the incentive of expedited permitting or reduced building permit fees, to encourage developers to include green practices, such as green roofs, rainwater harvesting, or LEED certification, into their design plans.

Recommendation: Septic Pump-Out Requirements Tied to Permits
Who has done it: Chatham, Byram, Sparta, Hopatcong, West Milford, Jefferson, Montville, Mt. Olive, Montgomery, and Frankford, N.J., and Fairfax County, Virginia.

Discussion: Two prominent solutions exist to the problem of groundwater contamination from septic system leakage. The first involves basic homeowner awareness. Currently, all New Jersey municipalities, including the ones listed above, are responsible for simply educating owners of septic systems every three years on the proper maintenance and operation of the system. (ANJEC, 2017) The most common way this is done is by mass mailing pamphlets to residents with all relevant information. Municipalities are not required to mandate system pump-outs at regular intervals. To combat this problem, municipalities throughout the Raritan could adopt ordinances that require more frequent and routine pumping of septic tanks.

In Fairfax County, Virginia, population increase led to rapid development of poorly designed and maintained septic systems. To combat this problem the county adopted an ordinance requiring septic systems to be pumped every five years while alternating the drainfields to limit oversaturation of the soil by effluent. (EPA, 2012) The county health department enforces this ordinance. Homeowners and service providers are required to provide documentation of the pump-out to the health department, which maintains a database listing maintenance dates and reminder notices. Since implementing this ordinance, many systems that may have aged out are still functioning well. According to the same study, drainfield lifespans have increased as well. The ordinance has also saved homeowners from paying for costly repairs or complete reinstallation of their septic systems because malfunctions are noticed early rather than when the problem becomes too big. (EPA, 2012)

Because many towns throughout New Jersey are densely populated, implementing a similar ordinance that requires more frequent maintenance of private septic systems could drastically improve the quality of groundwater

A similar solution related to operating permits has been used in New Jersey to improve groundwater quality. Residents must obtain operating permits that require the private septic system owner to provide proof of system maintenance every three years. Operating permits reward high performing septic system owners with extended permit renewal periods, but punish poorly performing system owners by requiring shorter permit times and more frequent system inspections.

According to a 2017 Association of New Jersey Environmental Commissions (ANJEC) report, there are ten New Jersey municipalities that use operating permits. The towns include Chatham, Byram, Sparta, Hopatcong, West Milford, Jefferson, Montville, Mt. Olive, Montgomery, and Frankford. While none of these towns are in the Raritan Basin, they each have implemented useful ordinances that could be used in towns surrounding the Raritan. Some of these towns have grandfathered in existing systems which has made the passage of an operating permit ordinance more politically feasible. However, this also limits the effectiveness of improving water health. Attached in the Appendix is the full ordinance used in Chatham Township, which requires both new and existing systems to obtain permits. According to that ordinance, the town Board of Health issues permits every three years to owners of individual septic systems. It costs $15 every three years to renew the permit after proof of a pump-out is provided. (Chatham, 2009) Owners are notified three months prior to the permit renewal date and if the renewal is late, the owner faces an additional $10 charge. In Montville, permits are also issues every three years by the Board of Health.

Attaining the initial registration permit costs $25, but permit renewals are free. However, repair permits or new construction permits can range from $75-$200. (Montville, 1999)

Recommendation: Local ordinances to expand riparian buffer requirements beyond state minimum requirements
Who has done it: Cranbury, Washington Township, Mount Olive Township, Tewksbury Township, Lebanon Borough, High Bridge, Clinton Town, and Clinton Township

Discussion: The term "riparian zone" refers to the vegetated, and often forested, area of land immediately adjacent to a waterway. These areas are often statutorily protected from development because they provide shade to the streams, which moderates water temperatures, and protects pollutants from flowing into the water from nearby land. Preserving riparian zones serves to improve and protect water quality, protect aquatic species, and ensure environmentally responsible land-use. (NJDEP, 2008) These areas also shield streams from excessive stormwater runoff volume and velocity, which lowers the propensity for downstream flooding and reduces the potential for stream-bank erosion.

State stormwater rules set a minimum no-development buffers of 50, 150, and 300 feet for various classes of surface water bodies. Category One waters—those waters that are deemed by the state's Surface Water Quality Standards to have significant ecological, recreational, water supply, or fisheries resources—have buffers of 300 feet on both sides of the waterway. A 150-foot buffer is applied to all waterways (including tributaries and upstream waterways) which sustain healthy trout populations or contain trout spawning areas. This buffer is also applied to waterways that flow through the habitat of an endangered or threatened plant or animal species and waterways that run through areas containing acid producing soils. All other waterways, except the Atlantic Ocean, manmade lagoons, and retention basins, are protected by a riparian buffer of 50-feet. (N.J.A.C 7:13, 2016)

While these standards are required by the state, lower levels of government are free to create their own policies with more stringent criteria. As explained in the Cranbury Township case study, Cranbury has implemented 150-foot riparian buffer zones along all waterways, rather than the minimum 50-foot buffer. Similarly, as part of its Regional Master Plan, the Highlands Council--the implementing body of the New Jersey Highlands Water Protection and Planning Act of 2004--requires a 300-foot riparian buffer standard for all surface water bodies, including those that would only require 50 and 150 foot buffers under state criteria, for all municipalities in the Highlands Preservation Area. They also recommend that this standard be voluntarily adopted by those municipalities that exist within the Highlands Planning Area but outside of the Highlands Preservation Area. Some Highlands Planning Area towns have taken the Council's advice, while many have not. The Raritan-basin municipalities that exist entirely or partly within the Highlands Planning Area, and have voluntarily adopted (by way of city ordinance) the Council's recommended riparian buffers, include: Washington Township, Mount Olive Township, Tewksbury Township, Lebanon Borough, High Bridge, Clinton Town, and Clinton Township. (New Jersey Highlands Water Protection and Planning Council, 2017) The Council cites habitat and ecosystem preservation, water quality improvement, temperature moderation, and channel integrity as likely positive impacts of the superseding policy.

Many interviewees cited riparian buffer ordinances as an area of potential improvement. The feasibility of riparian buffer ordinances that exceed state standards, however, varies by town. Municipalities that place a high priority on the development that is adjacent to riparian zones may view increased restrictions as a barrier to economic development.

Municipalities interested in improving or maintaining the water quality of the Raritan River can create ordinances that supersede the requirements of the Flood Hazard Area Control Act Rules. We suggest that those drafting such ordinances refer to the Highlands Council's 2008 Regional Master Plan, Chapter 4, Part 1, Subpart B for guidance. (Highlands Council, 2008)

Recommendation: Local stormwater management ordinances that are more stringent than state minimum standards.
Who has done it: Cranford, Princeton, Newark

Discussion: All municipalities can adopt, implement, and enforce stormwater management ordinances that are more stringent than the state requires. In this recommendation, we highlight two types of policies that have been implemented by communities in New Jersey. The state's Stormwater Management Rules currently require stormwater management for major developments that involve a disturbance of 1 acre of land or 0.25 acres (approximately 11,000 square feet) of new impervious surface.

Cranford, N.J. adopted a trigger ordinance (Cranford, 2014) that defines a major development as one that creates at least 1,000 square feet of impervious cover. It requires an on-site stormwater management plan, however, for developments of any size. The requirement incorporates a volume-per-area (cubic feet of stormwater per square foot of impervious cover) standard.

Meanwhile, Princeton is considering a draft stormwater management ordinance that requires onsite stormwater management for all developments that have more than 400 square feet of impervious surface (including both residential and non-residential), on a gallons-per-square-foot basis. The draft ordinance, if passed, would require developers or property owners to manage 2 gallons of water on-site for every 1 square foot of new impervious cover.

Newark also has implemented a stormwater ordinance that requires all new development, or a significant portion of redevelopment, to capture 100% of stormwater runoff on site and is beginning to require the use of green infrastructure rather than gray. (Together New Jersey, 2015)

Recommendation: Local ordinances requiring green infrastructure use as part of stormwater management
Who has done it: Princeton is considering it. New Jersey Future is developing a model ordinance

Discussion: Green infrastructure is a relatively new stormwater control method in New Jersey. As a result, municipalities, counties, and individual developers struggle with emphasizing or incorporating these methods because they're newer and not as well tested or established. However, interviewees noted that research consistently shows that green infrastructure methods work as well, if not better, than many gray infrastructure methods at reducing stormwater-runoff and eliminating pollutants. In some cases, these methods cost less that gray methods, but may require more maintenance. But because gray methods are more familiar to local officials, developers, and consultants, those methods tend to take precedence.

Multiple interviewees noted that green infrastructure use would increase if builders and developers were required to use it. Princeton's draft stormwater ordinance requires that developers use green infrastructure or nonstructural techniques to comply with the new gallons-per-square-foot stormwater

management standard. These techniques must be approved as part of the initial design proposal. If the developer believes that using green infrastructure techniques causes an undue burden, they must make the argument in writing and propose an alternative stormwater management strategy.

New Jersey Future, a planning and smart growth advocacy organization, is working with three communities across the state to require and expand the use of various green infrastructure methods. The organization also is developing a model ordinance that can be used by municipalities to require green infrastructure methods as part of stormwater management.

Longer Term Recommendations

We consider the following three recommendations to have greater barriers to implementation than the ones discussed above, but are still worth considering because of their potential for significant long-term improvement. These recommendations address some of the four cross-cutting challenges discussed above. These recommendations involve changing regulations or other requirements, and therefore must be done at the state level, have substantial political challenges, require additional study, and/or require professional organization involvement to implement.

Recommendation: Require green infrastructure and stormwater management education (and continuing education) for professional engineers, developers and/or those appointed to planning boards
Who has done it: All efforts currently voluntary; requirements unprecedented

Discussion: As discussed above, interviewees noted that green infrastructure methods are not standard for new developments. While the state includes green methods in the New Jersey Stormwater Best Management Practices Manual (NJDEP, 2017c), there is no state requirement for their use. One of the barriers we noted regarding the lack of green infrastructure implementation is education and awareness, which can lead to behavior changes. That is why we suggest addressing two specific types of training requirements: Continuing Education requirements for professionals and consultants, including engineers, planners, and architects, and mandatory training for those appointed to planning and zoning board, or elected to local office in New Jersey municipalities.

Continuing education requirements are specific to each certifying organization and are typically written in a way such that they are broad and can be met easily. While green infrastructure training where participants can earn credits are common, there is no specific requirement that all of those with a certification must have some form of green infrastructure education. Working with organizations, such as the American Planning Association, or the American Society for Civil Engineers, could help make this a formal requirement.

With regard to local appointed and elected officials, interviewees noted that this target group has a frequent turn-over and receives limited training on all issues and training on green infrastructure or the importance of effective stormwater management on local water quality is not necessarily a key topic area. Including this topic area in the required training, or implementing some type of continuing education for these officials, can help improve awareness, especially among those who have the power to grant waivers and approve developments.

Another way to implement green infrastructure education requirements for professionals is to develop either a local policy or adopt an ordinance that requires the municipality to require green infrastructure certification for all bidding contractors conducting work for the municipality.

Recommendation: Stormwater utility fees based on stormwater generated on property
Who has done it: 39 states, New Jersey is not one of them

Discussion: The implementation of stormwater utility fees could offer many benefits with few detriments. The largest problem New Jersey faces in implementing stormwater utility fees is that county and local governments lack the statutory authority to create such fees. While this fixing this would require a statutory change, we believe that through our extensive literature reviews and interviews, stormwater utility fees remain an important tool to protect water quality in the Raritan Basin.

A survey done by Western Kentucky University in 2016 (Campbell, 2016) found that only 11 states do not use stormwater utility fees; New Jersey is one of them. The states that implement the fees do so at various governmental and non-governmental levels; the fees are implemented by county and local governments, watershed regions, and even conservancy districts. The WKU survey found that the smallest municipality with a stormwater utility in place had a population of 88, while the largest city had a population of 3 million, showing that it is possible for towns of all sizes throughout New Jersey to implement stormwater fees.

Many different fee structures exist that could be used throughout our state. The most commonly used structure in the US is the Equivalent Residential Unit (ERU) system. (Campbell, 2016) The ERU system is based on the average amount of impervious area for a single family residential lot. Fees for non-residential properties are proportional to the ratio of the lot impervious area to the ERU. The second most commonly used structure in the US is a flat fee where every lot pays the same stormwater fee. The national average of the fee was found to be $5.14 per month according to the survey, although some fees ranged from $0-70 per month.

Newark currently is in the process of conducting a feasibility study on the use of stormwater utility fees in that area. According to an employee from New Jersey Future, one of the biggest problem associated with stormwater utility fees in the state (other than a lack of statutory authority) is the notion that the fees can be unfair. However, there are many different municipal fees paid by residents that can be lessened in order to achieve a fair stormwater fee. Many variations of fees exist that can achieve an equitable balance among residential and non-residential owners as well.

Recommendation: Conduct a study to closely examine individual municipal ordinances and rank effectiveness based on peer-reviewed research.
Who has done it: New Jersey Water Supply Authority

Discussion: In 2009, the N.J. Water Supply Authority assessed local water protection ordinances in four Hunterdon County municipalities to better understand the impacts of existing plans, policies, and regulations. (NJWSA, 2009) The author of the report developed a simple scoring system to formally assess the overall level of protection each of the four municipalities provided based on various ordinances related to development and land disturbance. The simple scoring system was effective in helping illustrate the impacts of various watershed health protection ordinances to the municipalities in the study. While this survey was a relatively basic measure, it could point the way to doing such work more broadly and

more scientifically. Conducting a similar study at the Raritan River watershed level, with a scoring system based on scientific research may be beneficial when conducting outreach to municipalities about adopting watershed health protection ordinances that exceed state standards. An interviewer noted that a science-based assessment of existing policies in each community establishes an even playing field when advocating for the tightening of ordinances by municipal decision-makers.

Conclusion

The Raritan River and its watershed play an important role for New Jersey and its residents. We rely on it for clean drinking water, recreation, and to support many different ecosystems. When there is a decline in watershed health, there are associated social costs for communities and the state overall. In this report, we covered many ways in which we contribute to the destruction and pollution of the Raritan. Additionally, we reviewed relevant laws and regulations that are in place to try to curb that destruction. We found that there were opportunities for more effective implementation of these laws and regulations. As we have shown through our case studies and recommendations, there are a variety of methods to address the regulatory gaps at the local level. Attitudes and behaviors about water quality must change and any effort to address these will require hard work on the part of nonprofit organizations, state and local government officials, and community members.

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Appendix I: General Interview Protocol

Interview Introduction:

My name is ___, and I am a graduate student at Rutgers University's Bloustein School of Planning and Public Policy. I am part of a group working with the Sustainable Raritan Research Initiative on a research project.

The primary goal of the project is to identify specific policies and practices that, if applied at various levels of government, can improve and positively affect watershed health. We are seeking to gather data to help inform policy and constituents in the Raritan Basin.

I am contacting you because ___. Would you be willing to talk to us about ___, and agree to allow us to use your responses in our project? Your responses will be confidential and we will not reveal your name unless having your permission first.

We expect that the call will take no more than a half hour.

Thank you.

Foundational Questions:

(If you know that they worked on Raritan, say Raritan, if not use the more general question)

1. Can you tell us about your current job and past experiences working on water quality?
2. Which policies do you think have been the most effective in improving (local) water quality?
3. What was your role in the development or implementation of these policies?
4. Could such policies be applied elsewhere, why or why not?
5. What challenges or gaps do you see that could be addressed by locally driven policies?
    a. Examples: stormwater management requirements, building code adjustments, redevelopment requirements for retrofitting
6. Do you know of any policies elsewhere that you think might be a good idea for the Raritan Basin area?
7. Of these policies, which policies do you think might be most feasible and why?
8. Can you talk about what sort of limitations might exist in adopting these policies?
9. What else should we be asking about?
10. Who else should we contact?

Appendix II: Select Municipal Ordinances

Chatham Township- Individual Sewage Disposal System ordinance
http://clerkshq.com/default.ashx?clientsite=Chatham-nj

Township of Cranford. (2014). Land Development Ordinance No. 2014-25. Retrieved from
http://cranford.com/wp-content/uploads/2016/03/Cranford-Zoning-Ordinance-approved-12-16-2014.pdf