OVERCOMING LEGAL AND INSTITUTIONAL BARRIERS TO THE IMPLEMENTATION OF INNOVATIVE ENVIRONMENTAL TECHNOLOGIES

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INTRODUCTION

Communities in the United States face growing challenges to effective stormwater management as a result of aging infrastructure,[1] increasing urbanization,[2] changing climate,[3] and shrinking budgets,[4] among other factors. These changes have increasingly stressed existing "static" stormwater management systems such as pipe networks, retention ponds, and detention ponds, that are intended simply to convey storm flows to nearby receiving waters without regard to overall system conditions.[5]

Dealing with these stressors may require innovative solutions such as real time control (RTC) or "dynamic" stormwater management systems.[6] RTC systems are typically automated or semi-automated and "involv[e]

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[1] *See, e.g.*, Christopher Kane, *Integrated Solutions for America's Aging Water Infrastructure*, 49 No.4 ABA TRENDS 7, 7 (2018) ("[M]uch of our water infrastructure has now outlived its useful life span–by a lot.").

[2] *See* Lisa Grow Sun, *Smart Growth in Dumb Places: Sustainability, Disaster, and the Future of the American City*, 2011 BYU L. REV. 2157, 2166 n.47 (2011) (noting that increasing urbanization has resulted in increased impervious area, causing higher flood risks).

[3] *See, e.g.*, Rebecca Kessler, *Stormwater Strategies: Cities Prepare Aging Infrastructure for Climate* Change, 119 ENVTL. HEALTH PERSPECTIVES A514, A514 (Dec. 2011) ("[E]xtreme weather calls for extreme plans.").

[4] *See* Michael A. Pagano & Christopher W. Hoene, *City Budgets in an Era of Increased Uncertainty: Understanding the Fiscal Policy Space of Cities,* METROPOLITAN POL'Y PROGRAM AT BROOKINGS, July 2018, at 7 (examining decreasing federal aid to cities and noting that infrastructure financing "will likely rely heavily on state and local contributions").

[5] *See* Branko Kerkez et al., *Smarter Stormwater Systems*, 50 ENVTL. SCI. & TECH. 7267, 7267–68 (2016).

[6] R. Celestini et al., *The Development of Integrated Real Time Control to Optimize Storm Water Management for the Combined Sewer System of Rome*, 139 WIT TRANSACTIONS ON THE BUILT ENV'T. 317, 317–18 (2014) (RTC is "proving more and more promising to dynamically regulate the system capacity in response to intense rainfall").

applications of sophisticated dynamic models to design and operate controls in real time," such as modifying setpoints to open and close valves, or routing storm water differently under particular system setpoints.[7] The goal of an RTC system is to continuously regulate the flow in the various branches of a network based on real-time information related to system capacity and weather conditions, thus reducing the magnitude of outflows during storms and relieving other stresses on the system.[8]

Yet RTC systems have not been widely adopted. Some analysts have blamed historical resistance to innovation, especially among governmental system operators responsible for protecting public health and safety.[9] One recent study identified six factors that inhibit innovation: the risk-averse nature of water managers, the long life expectancy and significant complexity of most water systems, geographic and functional fragmentation, water pricing practices, absence of incentivizing regulations, and insufficient access to venture capital.[10] This paper examines the possible reasons that stormwater management system operators (typically municipalities) have generally been reluctant to adopt RTC technology.

Our interdisciplinary team of law faculty, engineering faculty, and graduate students from both disciplines studied dozens of examples involving RTC implementation in the United States and abroad.[11] We also

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[7] Timothy P. Ruggaber et al., *Using Embedded Sensor Networks to Monitor, Control, and Reduce CSO Events: A Pilot Study*, 24 ENVTL. ENG'G SCI. 172, 172–73 (2006).

[8] *Id.* at 173–74.

[9] Newsha K. Ajami et al., *The Path to Water Innovation*, THE HAMILTON PROJECT DISCUSSION PAPER, Oct. 2014, at 20; *see also* Tim Sowell & Johanne Greenwood, *Smart Cities: Real-Time Infrastructure Control Systems,* ELEC. & CONTROL, Mar. 2016, at 6 ("[C]ity operational teams tend to be risk averse.").

[10] Ajami, *supra* note 10, at 20.

[11] Domestic implementation examples we studied included South Bend, Indiana (Ruggaber, *supra* note 8, at 177); Austin, Texas (Brandon Klenzendorf et al., *Water Quality and Conservation Benefits Achieved via Real Time Control Retrofit of Stormwater Management Facilities near Austin, Texas,* STORMCON (2015)); and Portland, Oregon (Richard Boyle et al., Commentary, *Watershed Scale Evaluation of Stormwater Real Time Controls*, CALIFORNIA STORMWATER QUALITY ASS'N (2015)). International sites included Paris, France (Stephane Entem et al., *Real Time Control of the Sewer System of Boulogne Billancourt – A Contribution to Improving the Water Quality of the Seine,* 37 WATER SCIENCE AND TECHNOLOGY (1998)); Reutlingen, Germany (Manfred Schütze et al., *Real Time Control of a Drainage System, Applying the New German RTC Guidelines,* NOVATECH (2010), https://pdfs.semanticscholar.org/fbe8/92c7213609e72bc24a72d778b6f55c9c971b.pdf?_ga=2.116794959.818695105.1584988422-2007127250.1584803266); Aarhaus, Denmark (Arne Møller et al., *Real Time Monitoring, Modeling and Control of Sewer Systems,* SEVENTH FRAMEWORK PROGRAMME (2014), http://www.prepared-fp7.eu/viewer/file.aspx?FileInfoID=539); London, Great Britain (Richard Body et al., *Real-Time Operational Modelling of Sewers: A Case Study,* INNOVYZE (2013)); Tokyo, Japan (Kiyohito Kuno

examined the literature detailing institutional barriers to RTC innovation. Finally, we reviewed numerous legal decisions related to municipal liability for stormwater management (or mismanagement).

From this foundation, we distilled several institutional and legal barriers that prevent municipalities from embracing this particular type of innovation. Key institutional barriers include regulatory fragmentation, workforce readiness, resistance to innovation, data management, cybersecurity, and cost.[12] Municipalities considering RTC innovations must be ready to address those challenges.

On the legal side, two factors should concern a stormwater management system operator considering RTC: first, that by actively making decisions to control and route the flow of stormwater in its system, it increases the likelihood of liability for negligence or nuisance claims; and second, that the sheer amount of data collected by RTC networks effectively puts the municipality on notice of problems within its system, increasing the likelihood of legal liability connected with future claims. The paper suggests a variety of strategies to combat these institutional and legal barriers to smooth the transition to RTC systems.

Some of the lessons learned in overcoming these barriers may be applicable to analogous situations involving other innovative technologies capable of improving public health and the environment.

I. OVERCOMING BARRIERS TO IMPLEMENTATION

Both institutional and legal barriers have slowed or prevented broad-scale implementation of RTC systems. Our review of the available literature addresses both categories.

A. Institutional Barriers

The literature related to previous RTC implementation efforts reveals numerous institutional barriers including cost, workforce readiness and related labor issues, distrust of the technology, data management and cybersecurity problems, and technology barriers such as the lifetime of sensors. Overcoming these challenges will require significant cross-sector

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& Tadao Suzuki, *Availability of CSO Control and Flood Control of Real-Time Control System in Urban Pumping Station,* PROCEEDINGS OF THE WATER ENVTL. FED'N (2009)); Rome, Italy (R. Celestini et al., *The Development of Integrated Real Time Control to Optimize Storm Water Management for the Combined Sewer System of Rome*, 139 WIT.TRANSACTIONS ON THE BUILT ENV'T. 317 (2014)); and Quebec City, Canada (Hubert Colas et al., *Application of Real Time Control for CSO and SSO Abatement: Lessons Learned from 6 Years of Operation in Quebec City,* WORLD WATER AND ENVTL. RES. CONG. (2005)).

[12] *See infra* Part II.A.

collaboration within a fragmented regulatory framework.

1. Overarching Regulatory Fragmentation. – To install and operate any stormwater management system, whether it includes RTC technology or not, municipal officials must clear several regulatory hurdles.[13]

First, a municipality must obtain required permits pursuant to the Clean Water Act. The Act requires qualifying municipalities to obtain Municipal Separate Storm Sewer System (MS4) permits and to develop stormwater management programs.[14] Operators must also submit periodic reports documenting compliance with the permit requirements.[15] In some cases, other state agencies such as the Department of Transportation and the Department of Commerce may also review and approve the permit.[16] Complying with permitting requirements thus also often requires coordination between segmented city government arms such as public health and water management agencies, yet communication is often difficult or nonexistent between the various agencies that make up the local government.[17]

Watersheds are often also subject to vertical and horizontal cross-boundary fragmentation; they cross regulatory decision-making boundaries between local, state, and federal governments, and span multiple municipalities or counties.[18] In still other cases, private land is critical to stormwater control, further complicating management options.[19]

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[13] Luis Casado & Eric Rensel, *Examining Common Barriers to Smart City Implementation,* WATER FIN. & MGMT, (Aug. 21, 2017), https://waterfm.com/examining-common-barriers-smart-city-implementation/ (concluding that "few municipalities are embracing" smart technologies because of three hurdles: "institutional barriers, limited funding, and data integration").

[14] 33 U.S.C. § 1342(p); *see generally Stormwater Discharges from Municipal* Sources, EPA (Jan. 6, 2020), https://www.epa.gov/npdes/stormwater-discharges-municipal-sources; WIS. ADMIN. CODE NR §216 (2004).

[15] *Id.*

[16] William H. Clune, *Implementing Sustainable Stormwater Management Strategies as part of Green Urban Development: Economic and Institutional Challenges, Barriers, and Opportunities*, in THE IMPACT OF URBAN AREAS ON GREAT LAKES WATER QUALITY*,* appx. 3 at 182 (Great Lakes Science Advisory Board, et al., 2009) (evaluating Wisconsin's regulatory structure), https://www.ijc.org/sites/default/files/E45.pdf.

[17] Casado, *supra* note 14.

[18] Leo P. Breckenridge, *Water Management for Smart Cities: Implications of Advances in Real-Time Sensing, Information Processing, and Algorithmic Controls*, 7 GEO. WASH. J. OF ENERGY & ENVTL. L. 153, 154–55 (2016). For example, the Milwaukee River Basin in Wisconsin spans seven counties, thirteen cities, thirty-two towns, and twenty-four villages. *See Milwaukee River Basin*, WISCONSIN DEP'T OF NATURAL RES. (Dec. 18, 2019), https://dnr.wi.gov/topic/Watersheds/basins/milw/. In turn, that basin is itself divided into six watersheds containing about 500 miles of perennial streams, over 400 miles of intermittent streams, thirty-five miles of Lake Michigan shoreline, fifty-seven named lakes, many small lakes and ponds, and wetlands encompassing over 68,000 acres. *Id.* And it is not even Wisconsin's largest basin. *Id.*

[19] Breckenridge, *supra* note 19, at 155.

Heavily populated or older areas often exhibit significant dependence on extensive "gray" infrastructure,[20] often governed by separate and distinct entities, for drinking water, sewage disposal, stormwater management, and flood protection.[21] These interests are administered not solely by government agencies but also "quasi-governmental" agencies and private utilities.[22] These competing interests and multitude of roles create what Eric Freyfogle called the "tragedy of fragmentation."[23]

Installing RTC systems within the fragmented regulatory environment demands careful planning, extensive cooperation, and information sharing between regulators who may not be accustomed to such efforts.

2. Workforce Readiness. – RTC systems demand substantive knowledge and operational agility that existing storm water management personnel may be unready to provide.[24] Project staff will be required to manage a broad range of functions and competencies rather than operating in traditionally well-defined roles.[25] RTC systems will create a constant flow of information that must be managed via interdisciplinary and function-based teams.[26] These teams should be able to act predictively so that they may mitigate the problems before they reach the level of public harm.

The rise of digital natives[27] and impending baby-boomer retirement[28] will aid in the operation of the data-driven systems. Some city service managers estimate that 80% of their team will retire in the next five to ten years.[29] Ensuring adequate training for new and current employees will be

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[20] *See* Jonathan Rosenbloom, *Fifty Shades of Gray Infrastructure: Land Use and the Failure to Create Resilient Cities*, 93 WASH. L. REV. 317, 317 (2018) (describing gray infrastructure as "engineered solutions, including pipes, culverts, and detention basins . . . [intended] to control, remove, and manipulate ecosystems").

[21] Breckenridge, *supra* note 19, at 155.

[22] *Id.*

[23] *See generally* Eric T. Freyfogle, *The Tragedy of Fragmentation*, 36 VAL. U. L. REV. 307, 322–31 (2002).

[24] Tim Sowell & Johanne Greenwood, *Smart Cities: Real-Time Infrastructure Control Systems*, *in* ELEC. & CONTROL 6 (Wendy Izgorsek ed., Mar. 2016).

[25] *Id.*

[26] *Id.*

[27] In 2001, Marc Prensky's groundbreaking paper *Digital Natives, Digital Immigrants* divided the world into two parts: those who have grown up "surrounded by and using computers, videogames, digital music players, video cams, cell phones" and other new technologies (the "digital natives") and older folks who were not born into that world but have adopted some parts of it ("digital immigrants"). Marc Prensky, *Digital Natives, Digital Immigrants Part 1*, 9 ON THE HORIZON 1, 1–6 (2001).

[28] Sowell & Greenwood, *supra* note 25, at 6.

[29] *Id.*; *see also* Keith Reester, Jr., *Dynamic Succession Planning: Overcoming the Baby Boomer Retirement Crisis*, 1 J. OF PUB. WORKS & INFRASTRUCTURE 97, 98 (2008) (estimating that high levels of engineering and utility managers will retire and need to be replaced soon).

critical in the success of an RTC project.[30]

Resistance to Innovation. Resistance to technological innovation is a longtime obstacle among utility mangers who often prefer a "tried and true" approach to matters involving public health.[31] The conservative nature of the water sector has been tied to "unrealistically low water rates, regulatory limitations, lack of access to capital, concerns about public health and possible risks associated with innovation… and the long life expectancy, size, and complexity of most water systems."[32]

Some observers have suggested that certain management cultures discourage innovation by rewarding "short-term achievements" rather than investing for the long haul.[33] Automated control systems and "smart" services do not render immediate rewards because they often do not result in simple and easily measurable outcomes.[34]

In some cases, the public will display a similar resistance to change. To combat this, some cities use social media to illustrate the negative impacts of uncontrolled runoff or to warn of impending storms.[35] Lack of public awareness and motivation to adopt the RTC stormwater system could be addressed through these types of effective and dynamic public relations work.[36]

The obstacles presented by the regulatory framework, workforce training, and resistance to innovation can be addressed with an approach centered on collaboration and flexible teams. The success of RTC implementation depends on several entities effectively working together achieved through adequate organization and thorough communication policy.

3. Data Management. – RTC systems generate significant amounts of data, and existing storm water or supervisory control and data acquisition (SCADA)[37] infrastructure may lack the instrumentation, automation and

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[30] Sowell & Greenwood, *supra* note 25, at 6.

[31] Ajami, *supra* note 10, at 20, 33; Sowell & Greenwood, *supra* note 25, at 6.

[32] Ajami, *supra* note 10, at 33.

[33] Pekka Töytäri et al., *Overcoming Institutional and Capability Barriers to Smart Services*, PROC. OF THE 50TH HAW. INT'L CONF. ON SYS. SCI., 2017, at 1646.

[34] *Id.*

[35] Shaojing Tian, *Managing Stormwater Runoff With Green Infrastructure: Exploring Practical Strategies to Overcome Barriers in Citywide Implementation*, COMMUNITY. AND REGIONAL PLAN. PROGRAM: STUDENT PROJECTS AND THESES UNIV. OF NEBRASKA-LINCOLN, 2011, at 58.

[36] *Id.*

[37] *See generally* Yulia Cherdantseva et al., *A Review of Cyber Security Risk Assessment Methods for SCADA Systems*, 56 COMPUT. & SEC. 1 (2016). CADA technology is often used to manage water and wastewater system operations. *See* Amin Rasekh et al., *Smart Water Networks and Cyber Security*, 142 J. WATER RES. PLAN. AND MGMT. 01816004-1, 01816004-2 (2016).

control to effectively leverage the data.[38] Redesigned systems must allow management teams to access and manage these data in real time.[39] This will require operational systems that can (1) manage and process large accumulations of unstructured, semi-structured, and structured data; (2) analyze the data into meaningful insights for public operations; and (3) interpret that data in ways that support evidence-based decision making.[40] One solution to this quandary could be to outsource data management infrastructure to dedicated, third-party service providers[41] or to invest in data analysis efforts enlisting machine learning or artificial intelligence.[42]

The regulatory and jurisdictional divisions identified above hamper clear and efficient governance and communication; the same barrier applies to data sharing. The inability to unify and coordinate teams with shared data can disrupt the purpose of the automated system.[43] Overcoming this requires cross-jurisdictional collaboration; thus, the success of an automated system depends not only on the technology, but also the citizens of the city and the workforce behind the project.[44]

A flexible work force with increased core competencies and increased data access can help to solve these problems proactively rather than reactively, better situating management teams to address flooding before it affects the public.[45] This "knowledge operation" structure may provide a solution to the operational barriers described above, and can be accomplished through function-oriented teams based in central operations centers, roaming teams, or even virtual experts.[46] Some jurisdictions might decide to share staff, while smaller utilities will need to meet the challenge of having one role for multi-disciplinary work.

Each type of team fills a different role. The roaming teams can be

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[38] Sowell & Greenwood, *supra* note 25, at 4, 5.

[39] *Id.* at 4.

[40] For a practical application of RTC in a large city's stormwater and wastewater management systems, *see generally* Kiyohito Kuno & Tado Suzuki, *Availability of CSO Control and Flood Control of Real-Time Control System in Urban Pumping Station*, PROC. OF THE WATER ENV'T FED'N 3347, 3347–3364 (2009) (analyzing RTC usage in Tokyo's infrastructure system).

[41] *See* Sowell & Greenwood, *supra* note 25, at 5.

[42] *See* Mehdi Mohammadi & Ala Al-Fuqaha, *Enabling Cognitive Smart Cities Using Big Data and Machine Learning: Approaches and Challenges*, IEEE COMM. MAG. 94, 96, 98–99 (Feb. 2018).

[43] Sowell & Greenwood, *supra* note 25, at 5.

[44] *Id.* at 6. For more on collaboration between jurisdictions, and collaboration that also includes other stakeholders such as academic and community groups, *see Charting New Waters: A Call to Action to Address U.S. Freshwater Challenges*, THE JOHNSON FOUND. FRESHWATER SUMMIT, Sept. 2010, at 18, 20, 26.

[45] Sowell & Greenwood, *supra* note 25, at 6.

[46] *Id.* at 6–7.

constituted and changed to efficiently address changing system demands; virtual expert teams might include non-government employees who offer decision support and provide efficient and accurate assistance; and central operational centers direct system activity supported by input from the roaming teams and virtual experts.[47] Overall, this structure seems likely to foster efficient system management and collaboration between cities. Regardless of the specific approach the stormwater team takes, division of expertise and flexibility will be critical to successful administration of RTC.

4. Cybersecurity. – Because the implementation of RTC requires a significant amount of data storage and transmission, municipalities must address a variety of data security threats both before and during RTC operations. Threats may originate from external sources such as lone hackers, disgruntled former employees, suppliers, vendors, internet hosting providers, and even other governmental entities, or internal sources such as accidental and intentional acts by employees, independent contractors, and interns.[48] Of course, relationships with special access create higher risk and greater target areas for hackers to infiltrate data through phishing and spam attempts.[49]

The digital infrastructure necessary to control RTC systems - and the data generated by them - creates new risks involving electronic security and requires an effective cybersecurity plan.[50] In the modern era, the infrastructure controllers are computers, allowing flexible configuration via web servers and digital communication with remote access and control.[51] However, even though computerized control systems have been used in water infrastructure management for decades, the security of those systems has not often been addressed.[52] Increasingly complex management software also has resulted in new software "bugs."[53]

Water systems–historically designed to be isolated systems–now

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[47] *Id.*

[48] NAS INS., CYBER RISKS IN INDUSTRIAL CONTROL SYSTEMS 5 (Oct. 2015), http://www.nasinsurance.com/var/documents/NASinsurance_ControlSystemsCyber_October2015.pdf. For a more specific analysis of cyber security related to water systems and controls, *see generally* Rasekh, *supra* note 38.

[49] *Id.*

[50] Rasekh, *supra* note 38, at 01816004-2 ("A fundamental shift in approach toward system security, both its design and implementation, is needed"). These security methods must address both "'low and slow' malware" and more rapid attacks. *Id.*

[51] Alvaro A. Cárdenas, *Research Challenges for the Security of Control Systems*, PROC. OF THE 3RD CONF. ON HOT TOPICS IN SECURITY, ARTICLE NO. 6 at 2 (2008).

[52] The literature contains little in the way of comprehensive historical analysis of water system cybersecurity apart from recitation of well-known incidents of cyber attacks. *See, e.g.* Rasekh, *supra* note 38, at 01816004-1 (detailing previous attacks in Pennsylvania, Florida, and elsewhere).

[53] Cárdenas, *supra* note 52, at 1-2.

typically feature control systems that are connected to the Internet, allowing both efficient operation and uncontrolled connections, enhancing the potential for new cyber vulnerabilities.[54] Indeed, exploitation of control systems and intentional cyber-attacks have occurred. Almost two decades ago, the most well-known SCADA cyber-attack took place on a sewage control system in Queensland, Australia.[55] The symptoms included multiple operational problems: pumps and communications functions failed, and resulting alarms went unaddressed spanning a total of forty-six individual attacks.[56] Months later, investigators discovered that a former system contractor was "spoofing" controllers in an effort to force the utility to hire him to fix the problems he created.[57]

Some national guidance exists to help municipalities manage cyber risks. Along these lines, the Department of Energy has released a risk management guideline to address the implementation or updating of a cybersecurity program within an organization, though it is primarily tailored to the electricity subsector.[58] Congress also recently directed the establishment of national standards for cybersecurity, although the effectiveness of that effort has been questionable.[59] The National Institute of Standards and Technology (NIST) created a cybersecurity framework in response to President Obama's Executive Order 13636, requiring the development of "risk-based standards" for cybersecurity of critical infrastructure systems.[60] Finally, the "America's Water Infrastructure Act of 2018" amended the Safe Drinking Water Act to require all community water systems serving a population of greater than 3,300 persons to conduct a "risk and resilience assessment" that must consider cybersecurity threats.[61]

In the utility context, the American Water Works Association (AWWA) compiled a guide of recommended controls based on the unique

[54] *Id.*; *see also* Rasekh, *supra* note 38, at 01816004-1-2.

[55] *Id.* at 2.

[56] *Id.*

[57] *Id.*

[58] U.S. DEP'T OF ENERGY, DOE/OE-0003, ELEC. SUBSECTOR CYBERSECURITY RISK MGMT. PROCESS (May 2012).

[59] The Cybersecurity Enhancement Act of 2014 (Public Law 113-274) calls on NIST to facilitate and support the development of voluntary, industry-led cybersecurity standards and best practices for critical infrastructure. But it addresses only one piece of the puzzle, as "no single piece of federal legislation exists that addresses cybersecurity threats and issues." John J. Chung, *Critical Infrastructure, Cybersecurity, and Market Failure,* 96 OR. L. REV. 441, 459 n. 87 (citing Kristin N. Johnson, *Managing Cyber Risks*, 50 GA. L. REV. 547, 577) (2016).

[60] Exec. Order No. 13636, 3 C.F.R. §13636 (2014); *see* NAT'L INST. OF STANDARDS AND TECH., FRAMEWORK FOR IMPROVING CRITICAL INFRASTRUCTURE CYBERSECURITY (2018).

[61] America's Water Infrastructure Act of 2018, Pub. L. No. 115-270, 132 Stat. 3765 (2018) § 2013 (amending 42 U.S.C. § 300i-2).

characteristics of a water utility.[62] It developed twelve major areas of control to reduce a utility's cybersecurity risks: governance and risk management (denoted as most important); business continuity and disaster recovery; server and workstation hardening; access control; application security; encryption; telecommunication, network security, and architecture; physical security of PCS Equipment; Service Level Agreements; Operations Security (OPSEC); Education; and Personnel Security.[63]

5. Cost. – Innovative technologies such as RTC are often immediately disregarded based on cost,[64] especially in an era of cash-strapped municipalities already struggling with budget concerns.[65] This places a heavy burden on would-be RTC adopters to show a positive return on investment from installation of RTC.

Some RTC system benefits may be unquantifiable "ecosystem services" related to water quality or flood management.[66] The difficulty in the quantification of environmental goods is not a new problem.[67] The process is complex because quantification of environmental goods requires collaboration between different fields of science.[68] Measuring and analyzing the relationships involved in natural systems is also complicated.[69] Because environmental goods are commonly not valued in the market, traditional modes of economic and social analysis may be unsuitable.[70] Many statutes, regulations, incentives, and programs include requirements, tools, or goals to measure the impacts and protection of environmental goods and services such as clean air and water.[71] Municipalities will have to navigate

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[62] *Process Control System Security Guidance for the Water Sector*, AM. WATER WORKS ASS'N (2014), www.awwa.org/Portals/0/AWWA/Government/AWWACybersecurityguide.pdf.

[63] *Id.* at 2–5.

[64] Chris Dunstan et al., *Institutional Barriers to Intelligent Grid: Working Paper 4.1*, INST. FOR SUSTAINABLE FUTURES, June 2011, at 29 (noting "bias in favour of choosing the lowest upfront cost option.").

[65] *What About Infrastructure?*, *in* 73 UNDERGROUND CONSTR. (Feb. 2018) ("Almost 80 percent of municipal personal list funding as their top concern for 2018" related to infrastructure), https://ucononline.com/magazine/2018/february-2018-vol-73-no-2/features/what-about-infrastructure.

[66] *Cf.* James Salzman, et al., *Payments for Ecosystem Services: Past, Present, and Future*, 6 TEX. A&M L. REV. 199, 200 (2018) (suggesting significant economic value derived from unquantified ecosystem services such as water quality and flood control).

[67] Lynn Scarlett & James Boyd, *Ecosystem Services: Quantification, Policy Application, and Current Federal Capabilities*, RES. FOR THE FUTURE DISCUSSION PAPER 11-13, Mar. 2011, at 10, https://www.rff.org/documents/314/RFF-DP-11-13.pdf.

[68] *Id.* at 10 (biophysical and social scientists).

[69] *Id.* (citing the need for collaboration, the complex interactions evident in natural systems, and the non-market nature of ecosystem goods and services).

[70] *Id.* ("[M]arket data, including prices and inventories, are not available.").

[71] *Id.*

this system and present a way to quantify the benefits created by RTC.[72]

Some communities have adopted an alternative rate structure to replace the flat fee that was charged to each individual dwelling for years.[73] Accurately assessed user fees allow the service beneficiaries to pay for only what they receive.[74] When there are reasonably accurate fee structures, activities that increase runoff volumes and pollution can be disincentivized.[75] Some breakthrough fee schedules even reward activities that "improve the system's performance or reduce its costs."[76] Similar approaches could help finance RTC installations.

In making this "business case" for RTC, water utility industry experts have suggested a set of six guiding principles that a typical municipality could use to develop a strategy for RTC implementation.[77]

First, municipalities must select projects based on system needs, not on "preconceived choices of technology."[78] The latter should serve the former rather than the reverse. Second, initial RTC measures must be simple and selected to drive cost efficiencies in the municipalities. More complex approaches can be incorporated in later stages after initial successes have been achieved, and after staff becomes familiar with managing the technology.[79] Third, initial RTC projects should be selected to minimize risk, and should feature traditional project management tactics to identify and track specific metrics of success to show the achieved benefits of RTC implementation.[80]

Fourth, RTC proponents should encourage broad-based and active stakeholder participation during the planning and implementation phases,

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[72] Some creative examples exist: one broad-based study by the Brookings Institution found that "every [dollar] invested in Great Lakes restoration" created at least [two dollars] in economic return through the creation of jobs, tourism, and development." ALLIANCE FOR THE GREAT LAKES, REDUCING COMBINED SEWER OVERFLOWS IN THE GREAT LAKES: WHY INVESTING IN INFRASTRUCTURE IS CRITICAL TO IMPROVING WATER QUALITY ii (June 19, 2012), https://greatlakes.org/wp-content/uploads/2016/08/AGL_Reducing_CSO__14_FINAL-1.pdf.

[73] Clune, *supra* note 17, at 186–88.

[74] *Id.* at 187.

[75] *Id.*

[76] *Id.* at 188.

[77] Srini Vallabhaneni & Eddie Speer, *Real-Time Control to Reduce Combined Sewer Overflows*, WATER WORLD (Feb. 2011), https://www.waterworld.com/home/article/16192327/realtime-control-to-reduce-combined-sewer-overflows.

[78] *Id.*

[79] *Id.* The success of initial projects is crucial, as has been demonstrated with respect to other novel "green" technologies such as green infrastructure. *See* David Strifling, *Integrated Water Resources Management and Effective Intergovernmental Cooperation on Watershed Issues*, 70 MERCER L. REV. 399, 430 (2019) ("[T]he success or failure of initial test projects is critical.").

[80] Vallabhaneni & Speer, *supra* note 78.

especially by operations and maintenance staff,[81] as well as engineering consultants, construction contractors, private landowners, environmental groups, and regulators. A well-structured participation process will ease the path to system acceptance by users. Fifth, the RTC technology selected should be flexible and should allow for adaptive management, should be easy to maintain and support, and should enable a "clear path to enhancements and upgrades."[82] As the utility gains experience, it can integrate its new expertise into subsequent phases of upgrades and maintenance.[83] Finally, RTC development and implementation should be integrated with long-range system planning goals, including those aimed at the elimination of sewer overflows.[84]

B. Legal Barriers

Some municipalities may also be unwilling to install RTC systems because of a perception that "smart" control systems may increase the likelihood of municipal liability in tort for flooding or other damage to private property. This may occur due to a perception that the operator is actively controlling the situation, making it a proximate cause of any resulting harms; or that the sheer amount of data collected by an RTC system would constructively put the operator on notice of problems with the system, an important factor in many legal decisions dealing with claims against municipal bodies.

Negligence claims are the most likely to arise in the municipal liability realm but claims of nuisance[85] and inverse condemnation[86] are also often

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[81] *Id.* Gaining acceptance of citizens, elected officials, and other stakeholders is also important. Strifling, *supra* note 80, at 430 (citing the importance of public perceptions as a critical factor in project acceptance).

[82] *Id.*

[83] *Id.*

[84] *Id.*

[85] *See generally* City of Gainesville v. Waldrip, 811 S.E.2d 130 (Ga. Ct. App. 2018); City of Mansfield v. Balliett, 63 N.E. 86 (Ohio 1902); Milwaukee Metro. Sewerage Dist. v. City of Milwaukee, 691 N.W.2d 658 (Wis. 2005); Wickham v. San Jacinto River Auth., 979 S.W.2d 876 (Tex. App. 1998); Physicians Plus Ins. Corp. v. Midwest Mutual Ins. Co., 646 N.W.2d 777 (Wis. 2002); Columbus, Ga. v. Smith, 316 S.E.2d 761 (Ga. Ct. App. 1984) (holding a municipality can be held liable for nuisance if it is chargeable with performing a continuous or regularly repetitious act, or creating a continuous or regularly repetitious condition which causes the harm); Hibbs v. City of Riverdale, 478 S.E.2d 121 (Ga. 1996).

[86] Hillcrest Golf & Country Club v. City of Altoona, 400 N.W.2d 493, 495–96 (Wis. Ct. App. 1986) (holding when a city manages a sewer system in a street subdivision that discharges water onto private property to the effect of eroding substantial portions of the land an action for inverse condemnation can be sustained against the city); Christ v.

raised. Two 1996 Supreme Court decisions helped shape the contours of the contemporary world of municipal liability: *Board of County Commissioners of Bryan County, Oklahoma v. Brown*, and *McMillian v. Monroe County, Alabama*.[87]

In *Brown*, the petitioner brought Section 1983 claims against a county related to the use of excessive force by the county's deputy, arguing that the county had hired the deputy without adequately reviewing his background.[88] The District Court denied the county's assertion that a policymaker's single hiring decision did not meet the threshold of a Section 1983 claim.[89] The Fifth Circuit affirmed.[90] The Court held that the county would not be liable for the sheriff's "isolated decision" to hire the deputy because the plaintiff did not demonstrate that the decision by the agency reflected a "conscious disregard for a high risk" that the deputy would use excessive force.[91]

The *McMillian* Court held that the states had "wide authority to set up their state and local governments as they wish."[92] In *McMillian*, the petitioner's capital murder conviction was reversed on the ground that the State had suppressed exculpatory evidence.[93] The petitioner then sued the county under Section 1983 for the unconstitutional suppression of evidence.[94] The District Court dismissed the claims holding that the sheriff's actions did not represent the county's policy, and the court of appeals affirmed, agreeing that a "sheriff acting in his law enforcement capacity is not a policymaker for the county."[95]

Together, *McMillian* and *Brown* establish the importance of state law in the significance of municipal liability. These cases created a doctrine requiring deference to the state courts and allowing for a jurisdiction-dependent regime. State courts use different language to describe two categories of municipal acts, creating a distinction between protected activities

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Metro. St. Louis Sewer Dist., 287 S.W.3d 709, 713 (Mo. Ct. App. 2009) (holding that for a sewer district to be liable for inverse condemnation, the petitioners must demonstrate an affirmative act by the government that caused the harm, not merely allege failure to prospectively maintain or inspect the sewers); Fromm v. Vill. of Lake Delton, 847 N.W.2d 845, 854–55 (Wis. Ct. App. 2014) (holding a governmental unit cannot be held strictly liable for a takings claim arising out of flooding due to dam operation).

[87] Bd. of Cty. Comm'r of Bryan Cty. v. Brown, 520 U.S. 397, 399 (1997); McMillian v. Monroe Cty., Ala., 520 U.S. 781, 795 (1997).

[88] Bd. of Cty. Comm'r of Bryan Cty., 520 U.S. at 399–400, 401.

[89] *Id.* at 402.

[90] *Id.*

[91] *Id.* at 415–16.

[92] *McMillian*, 520 U.S. at 795.

[93] *Id.* at 783.

[94] *Id.*

[95] *Id.* at 786.

for which there can be no municipal liability, typically described as "discretionary" or "governmental" activities,[96] and unprotected activities for which municipal liability is possible, variously described as "proprietary,"[97] "operational,"[98] or "ministerial."[99] Discretionary activity includes consideration of "financial, political, economic, and social effects" of a municipal effort.[100] Operational activities have been defined as "those which concern routine everyday matters, not requiring evaluation of broad policy matters."[101]

Two Ohio cases generally demonstrate this dichotomy, which Justice Frankfurter once described as "the 'non-governmental'–'governmental' quagmire that has long plagued the law of municipal corporations."[102] In *Hill v. Urbana*, tort liability attached when an employee of a company hired to construct improvements to the water system was injured during the installation.[103] The employee brought a negligence action against the city, and the court (citing a relevant Ohio statute) held that the general operation of a municipal-owned water utility is a "proprietary" function of a city and therefore enjoyed no statutory immunity.[104]

By contrast, in *Smith v. Cincinnati Stormwater Management Division*, a city's storm water management division was immune from liability for negligence in the design, construction, maintenance, and upkeep of its sewers because those are "governmental" functions.[105] The property owners sued the city and county when their residences were damaged from

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[96] Jon A. Kusler, *A Comparative Look at Public Liability for Flood Hazard Mitigation*, ASS'N OF ST. FLOODPLAIN MANAGERS FOUND., 2009, at 10–11, https://www.floods.org/PDF/Mitigation/ASFPM_Comparative_look_at_pub_liability_for_flood_haz_mitigation_09.pdf.

[97] Doud v. City of Cincinnati, 87 N.E.2d 243, 246 (Ohio 1949) (holding a municipality liable for damage to private property when it allowed gradual deterioration of a sewer by failing to exercise its duty of reasonable care); *see also* Kusler, *supra* note 97, at 10.

[98] Julius Rothschild & Co. v. Hawaii, 655 P.2d 877, 880–81 (Haw. 1982) (holding when a decision to reconstruct or replace a bridge requires an evaluation of broad policy factors on behalf of the government, the decision is discretionary and within the State Tort Liability Act); *see also* Kusler, *supra* note 97, at 17.

[99] Biernacki v. Vill. of Ravena, 664 N.Y.S.2d 682, 683-84 (N.Y. App. Div. 1997) (holding when private property owners allege failure to maintain a storm sewer, landowners must show the government affirmatively breached a duty owed or that it was actively negligent and such negligence caused the flooding); *see also* Kusler, *supra* note 97, at 14.

[100] Kusler, *supra* note 97, at 18.

[101] *Id.*

[102] Indian Towing Co. v. United States, 350 U.S. 61, 65 (1955).

[103] Hill v. City of Urbana, 679 N.E.2d 1109, 1111–12 (Ohio 1997).

[104] *Id.* at 1112.

[105] Smith v. Cincinnati Stormwater Mgmt. Div., 676 N.E.2d 609, 612 (Ohio Ct. App. 1996).

overflows.[106] The court found that in the absence of malicious behavior or bad faith on behalf of the government, the city's failure to adopt the recommendations for the system was immune from civil liability.[107]

Numerous courts have noted that the "demarcation line . . . . between a discretionary function and an operational level activity is not so easily drawn."[108] Decisions involving "evaluation of broad policy factors" are discretionary and immune from liability.[109] The factual context in which the issue has arisen will be significant.[110]

1. Application to RTC. – Because RTC is a relatively new technology that has not been widely implemented, no published cases involve claims against municipalities for liability associated with an RTC system. However, similar claims have arisen in the contexts of flood mitigation measures and sewer systems, as discussed next.

Whether the activity that caused the harm is protected under statutory authority or immunity is critical to the success of a claim against a municipality.[111] Courts consider several factors in determining governmental liability for flood mitigation. These include whether the government is acting as a landowner;[112] whether the government's actions increased natural hazards;[113] whether the government's conduct was reasonable, in light of the risks;[114] whether the government's conduct is exempt under the Tort Claim

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[106] *Id.* at 610–11.

[107] *Id.* at 612.

[108] Julius Rothschild & Co. v. Hawaii, 655 P.2d 877, 881 (Haw. 1982).

[109] *Id.* at 880–81.

[110] *Id.* at 881.

[111] *See supra* notes 88–92, 97-102, 105 and accompanying text.

[112] Smith v. Cincinnati Stormwater Mgmt. Div., 676 N.E.2d 609, 612 (Ohio Ct. App. 1996) (holding a city immune from liability when property owners alleged negligence in design, construction, maintenance and development of a sewer); Doud v. City of Cincinnati, 87 N.E.2d 243, 246 (1949) (holding a municipality liable for damage caused to the plaintiff's house due to gradual deterioration of a sewer, and for failing to inspect the sewer at reasonable intervals and exercise reasonable care in inspection); Biernacki v. Vill. of Ravena, 664 N.Y.S.2d 682, 683-84 (N.Y. App. Div. 1997) (holding that when a private property owner seeks to recover for flood damage from a village's storm sewer system, the plaintiff must show competent evidence demonstrating the flooding was caused by negligent inspection or action of the village).

[113] Belair v. Riverside Cty. Flood Control Dist., 764 P.2d 1070, 1076 (Cal. 1988) (holding a plaintiff's claim for inverse condemnation caused by flooding cannot be sustained when it is shown that the plaintiff's property was subject to flooding before the construction of a levee and the levee created no additional risk of flooding; instead, "the flooding occurred in spite of the flood control improvements, not because of them.").

[114] *Id.* at 1079–80 (citing Arvo Van Alstyne, Inverse Condemnation: Unintended Physical Damage, 20 Hastings L. J.

431, 455 (1969)) (reasonableness "represents a balancing of public need against the gravity of private harm.").

Act or other emergency management statutes or regulations;[115] whether the government exercised discretion;[116] and whether public policy favors liability.[117] Although much of this analysis is jurisdiction-dependent, the following paragraphs provide examples of unprotected and protected municipal activities in the context of stormwater management.

2. Unprotected Acts. – Courts have held that a municipality's decisions to construct structural flood control and erosion control measures such as dams, levees, and groins are "proprietary" such that liability attaches.[118] Such structures could increase the upstream or downstream flows, peak flows, flood depths, flood velocities, and point of discharge.

In *Doud*, the court emphasized that when a municipality has notice of defects in its utilities, it may be held liable.[119] The court reasoned that although there is not liability on behalf of the municipality for dangerous conditions that suddenly arise out of the operation of sewers until it has notice of the condition, a municipality does owe a duty of inspection.[120] Because the sewer is an instrumentality under the control of the municipality, it "becomes chargeable with notice of what reasonable inspection would disclose, including defects that may arise through the slow process of deterioration."[121]

Actual construction, operation, maintenance and project design are often classified as ministerial and therefore subject to liability.[122] A New York court held that construction and repair of sewers are "ministerial" duties, and the municipality may be sued for negligently executing those responsibilities.[123]

3. Protected Acts. – On the other hand, municipal governments have rarely been found liable for implementing nonstructural hazard loss

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[115] For emergency regulations *see* Oahe Conservancy Sub-District v. Alexander, 493 F. Supp. 1294, 1298–1300 (D.S.D., 1980). For Tort Claims, *see* generally Pinkowski v. Twp. of Montclair, 691 A.2d 837 (N.J. Super. Ct. App. Div. 1997).

[116] Julius Rothschild & Co. v. Hawaii, 655 P.2d 877, 881 (Haw. 1982); DeFever v. City of Waukesha and Waukesha Water Util., 743 N.W.2d 848, 851–53 (Wis. Ct. App. 2007).

[117] Butler v. Advanced Drainage Sys., 717 N.W.2d 760, 768–69 (Wis. 2006) (holding consideration of public policy factors precluded a claim for negligence and nuisance against a city and contractors when high-water problems of a lake caused damage to private property).

[118] Kusler, *supra* note 97, at 13.

[119] Doud v. City of Cincinnati, 87 N.E.2d 243, 246 (Ohio 1949); *see also* Tyler v. City of Cleveland*,* 717 N.E.2d 1175, 1177–78 (Ohio Ct. App. 1998).

[120] Tyler, 717 N.E. 2d at 1178–79 (municipality must exercise "reasonable diligence and care" to inspect sewer system for potentially dangerous conditions).

[121] *Id.* at 1178 (citing Doud, 87 N.E.2d. at 244).

[122] Kusler, *supra* note 97, at 14.

[123] Biernacki v. Vill. of Ravena, 664 N.Y.S.2d 682, 683 (N.Y. App. Div. 1997).

mitigation systems such as flood warning systems.[124] When property owners sued the city and county for damages to their residences resulting from creek overflow, alleging negligent design, construction, and operation of a storm water system, the court held that operating the storm water system was a "governmental function" of a municipality and therefore immune from liability.[125]

Some states have enacted statutes creating categories of governmental conduct to begin the determination of whether liability will attach and distinguishing legislative, quasi-legislative, judicial, and quasi-judicial functions.[126] In turn, state courts are required to determine how the acts complained of fit into those categories.[127]

In one case before the Wisconsin Supreme Court, a regional sewerage district brought suit against a city for negligence and nuisance in hopes of recovering the cost of rebuilding a sewer allegedly destroyed when a city water main collapsed.[128] The Wisconsin court emphasized that the statutory terms "legislative, quasi-legislative, judicial or quasi-judicial" are essentially synonymous with "discretionary" and no protection is to be afforded to "nondiscretionary" or "ministerial" acts.[129] A ministerial act involves a "duty that 'is absolute, certain and imperative, involving merely the performance of a specific task when the law imposes, prescribes and defines the time, mode and occasion for its performance with such certainty that nothing remains for judgment or discretion.'"[130]

The Wisconsin court further held that "[w]here, when and how to build sewer systems are legislative determinations imposed upon a governmental body."[131] The Wisconsin decision implies that at least in that jurisdiction,

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[124] Kusler, *supra* note 97, at 11.

[125] Smith v. Cincinnati Stormwater Mgmt. Div.*,* 676 N.E.2d 609, 611–13 (Ohio Ct. App. 1996).

[126] *See* WIS. STAT. § 893.80(4) (2013). *See also* WIS. STAT. § 893.82 (2014) (which also regulates certain aspects of claims against state employees).

[127] For example, Wisconsin courts do not find governmental bodies liable for acts they deem a "legislative decision" but immunity does not exist for negligent acts pursuant to a ministerial duty. Milwaukee Metro. Sewerage Dist. v. City of Milwaukee, 691 N.W.2d 658, 679–80 (Wis. 2005).

[128] *See generally id.*

[129] *Id.* at 677 (citing Envirologix Corp. v. City of Waukesha, 531 N.W.2d 357 (Wis. Ct. App. 1995)).

[130] *Id.* at 677.

[131] *Id.* at 678 (citing Allstate Ins. Co. v. Metro. Sewerage Comm'n, 258 N.W.2d 148 (1977)). Another Wisconsin decision established that post-installation grading done on a water main site was subject to immunity because it was an aspect of site planning and involved discretionary decisions about the overall design of the development. DeFever v. City of Waukesha and Waukesha Water Util., 743 N.W.2d 848, 852–53 (Wis. Ct. App. 2007).

decisions regarding the adoption, design, construction, and implementation of public works are discretionary acts that enjoy immunity, even if the system is poorly designed. The type of pipe used, the placement of the pipe in the ground, and the "continued existence" of the pipe amounted to discretionary legislative decisions therefore, the City was immune from the private nuisance suit related to those decisions.[132]

But this immunity is not ironclad. The Wisconsin court ultimately found that it was not clear whether the municipality had notice of the leaking water main, preventing summary judgment in its favor.[133] It is not clear whether the simple construction and operation of an RTC system, which necessarily involves significant amounts of data collection, would effectively put a municipality on notice of problems in the system. Further, immunity may be severed when a municipality is charged with negligent construction, operation, or repair of a system.

In another Wisconsin case, the same regional sewerage district was denied immunity against allegations that it negligently maintained a tunnel that created a known private nuisance when groundwater undermined the structural stability of nearby buildings.[134] The Wisconsin Supreme Court relied upon its reasoning in *City of Milwaukee* in evaluating the immunity of the sewerage district.[135] Therefore, even though the decision to *install* a sewerage system is discretionary, the duty to *maintain* the system in adequate order is ministerial.[136] Immunity is effectively severed once the operator has notice of a problem.[137] After notice, the operator must fix the problem, although it has discretion as to the manner in which to do so.[138]

Different liability rules may apply depending on the project stage reached at the time of the claim.[139] First, with little variation, courts have held that a municipality's initial decision to create (or not create) a flood mitigation measure is a "legislative," "discretionary," or "policy" decision

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[132] Metro Sewerage Dist., 691 N.W.2d at 679–80.

[133] *Id.* at 688.

[134] Bostco LLC v. Milwaukee Metro. Sewerage Dist*.,* 835 N.W.2d 160, 175 (Wis. 2013).

[135] *Id.* at 178.

[136] *Id.* at 177 ("Once the decision is made and the [system or structure] is erected, the legislative function is terminated and the doctrine of *Holytz* that imposes liability for want of ordinary care takes over.") (internal citation omitted).

[137] *Id.* at 181 (municipality must abate nuisance of which it has notice), 174–75 (municipality must abate negligently caused injury of which it has notice).

[138] *Id.* at 175 n. 25.

[139] Kusler, *supra* note 97, at 16 (individually analyzing decision to initiate project, selection of protection level, project design, project construction, project operation, and project maintenance).

that is not subject to liability.[140] Second, courts have commonly held that a municipality's selection of the level or amount of flood protection is also a discretionary decision immune from liability.[141] For example, the Hawaii Supreme Court explained that the primary factor in determining whether a governmental decision was discretionary is whether the decision to act or not to act involved consideration of "financial, political, economic, and social effects of a given plan or policy."[142] The court ultimately found that the reconstruction and replacement of a bridge would require this type of assessment and therefore is a discretionary decision.[143] The holding is generally consistent with those reached in other jurisdictions.[144]

Third, when the project reaches the stage at which the government selects specifics in project design, additional considerations come into play. For example, concerns arising out of the adequacy of design likely involve decisions made by engineers.[145] Claims against engineers for negligence often involve a "reasonable care" standard.[146] Claims involving municipal

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[140] *Id.*; *see also* Smith v. Cincinnati Stormwater Mgmt. Div., 676 N.E.2d 609, 612 (Ohio Ct. App. 1996).

[141] Kusler, *supra* note 97, at 17.

[142] Julius Rothschild & Co. v. Hawaii, 655 P.2d 877, 879 (Haw. 1982).

[143] *Id.*

[144] *See, e.g.,* United States v. Sponenbarger, 308 U.S. 256, 265 (1939) (when the government attempts to protect an area from a flood hazard, landowners whom the attempt fails to or cannot protect are not entitled to compensation under the Fifth Amendment); Wright v. United States, 568 F.2d 153, 157–58 (10th Cir. 1977) (design of highway bridge designed for a 25-year flood was a discretionary function and there was no liability when the bridge washed out in a 42-55 year storm and two occupants of a car attempting to pass over the bridge were killed); PDTC Owners Ass'n v. Coachella Valley Cty. Water Dist., 443 F. Supp. 338, 341 (C.D. Cal. 1978) (owners of land damaged by floods could not recover compensation from a county water district under the Fifth and Fourteenth Amendments for failure to construct a levee large enough to protect landowners from a 50-year flood, where levee was made of sand, was not riprapped, and provided protection only from a 30-year flood); Valley Cattle Co. v. United States, 258 F. Supp. 12, 19–20 (D. Haw. 1966) (decision to construct culverts capable of accommodating only the waters of 2-year storms held to be a discretionary act); Chabot v. City of Sauk Rapids, 422 N.W.2d 708, 712 (Minn. 1988) (city not responsible for failing to hold back water in natural holding pond to protect landowner's property despite city's engineering report that suggested the pond be increased in size); City of Watauga v. Taylor, 752 S.W.2d 199, 202 (Tex. App. 1988) (city undertaking storm sewer has no duty to provide facilities adequate for all floods that may be reasonably anticipated but can be held liable for negligently constructed or maintained facilities).

[145] Kusler, *supra* note 97, at 19.

[146] *Id.*; *see also* Affiliated FM Ins. Co. v. LTK Consulting Servs., Inc., 243 P.3d 521, 528 (Wash. 2010) (holding an engineering contractor assumed a tort law duty of care when it was responsible for operation of a city's monorail system); Pointe at Westport Harbor Homeowners' Ass'n v. Eng'rs Northwest, Inc., 376 P.3d 1158, 1163 (Wash. Ct.

agents may be statutorily circumscribed, as well.[147] Once construction has been initiated, municipal conduct in furtherance of the project is not usually cloaked as discretionary.[148]

The United States Army Corps of Engineers was liable for the negligence of a contractor when eight individuals drowned in a depression caused by Corps dredging.[149] The Corps was contractually responsible for the preparation, control, and supervision of the Hancock Seawall.[150] The court noted that the preparation of the contract may have been discretionary but the "controlling, supervising, contracting, and carrying out of the contract to repair" cannot be considered the same.[151] The court held that once the Corps agreed to repair the seawall and effectuate the design, plans, and specifications for the wall, the decisions were no longer discretionary and became operational.[152] Therefore, the district court ultimately held the United States liable for the drownings for failure to use "ordinary care" to leave the beach in a safe condition after the completion of the contract and for the failure to provide adequate notice and warning of the latent peril caused by the depression as a result of the Corps' dredging.[153] The reasoning behind the transition from discretionary to operational level is consistent in federal cases.[154]

4. Negligence. – When there is a claim of negligence on behalf of the government, the standard elements of duty, breach, cause and harm apply. *Milwaukee Metropolitan Sewerage District v. City of Milwaukee* clarified that "[w]hether immunity exists for nuisance founded on negligence depends upon the character of the negligent acts."[155] When the negligent conduct was pursuant to a "discretionary"-type function, immunity may

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App. 2016) (holding a structural engineer owed an independent duty of reasonable care to design a safe building).

[147] *See, e.g.*, WIS. STAT. §893.80(4) (2013); Kettner v. Wausau Ins. Cos., 530 N.W.2d 399, 404 (Wis. Ct. App. 1995) (governmental immunity statute cloaks agents, but not independent contractors); *but see infra* note 157 and accompanying text (independent contractors are entitled to immunity under some specific circumstances).

[148] Kusler, *supra* note 97, at 19.

[149] Price v. United States, 530 F. Supp. 1010, 1017 (S.D. Miss. 1981).

[150] *Id.*

[151] *Id.*

[152] *Id.* at 1017–18.

[153] *Id.* at 1018.

[154] *See also* United States v. Hunsucker, 314 F.2d 98, 102–05 (9th Cir. 1962); Costley v. United States, 181 F.2d 723, 724 (5th Cir. 1950).

[155] Milwaukee Metro. Sewerage Dist. v. City of Milwaukee, 691 N.W.2d 658, 679 (Wis. 2005).

apply.[156]

Going back more than a century, courts have held that municipalities are not liable for constructing projects that change or increase the flow of surface water

> by the construction of streets and gutters, nor because the sewer was inadequate by reason of negligence in adopting plans in the first place, or by reason of negligently failing to maintain the sewer in good working order thereafter to carry off the surface water . . . as fast as it accumulated.[157]

Another court held that in the event of ordinary or even heavy rainfall where a sewer fails to carry away all of the water, the city is not liable for the inadequacy.[158] The court distinguished the scenario in which the city first collects surface water in a sewer or drain and by reason of negligent construction or maintenance allows the water to flood nearby land. In the latter scenario, a court would more likely find municipal liability.[159]

After a project is complete, claims may arise for negligent operation or administration.[160] These cases generally turn on the facts of the case and jurisdiction-specific legal rules. Some operational decisions such as inspections and flood prediction have been deemed discretionary,[161] yet many jurisdictions find negligent operation to be subject to liability.[162] Courts have also found that ongoing project maintenance activities are subject to liability because they are considered ministerial.[163]

The Florida Supreme Court held that failure to maintain a stormwater pump that subsequently caused flooding of private property was an operational function and therefore not immune from liability.[164] The court determined that the plaintiffs had sufficiently alleged the city's failure to

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[156] *Id.* When negligence is alleged involving an independent contractor acting as an agent on a government project, the contractor may be entitled to immunity if: "(1) the governmental authority approved reasonably precise specifications; (2) the contractor's actions conformed to those specifications; and (3) the contractor warned the supervising governmental authority about possible dangers associated with those specifications that were known to the contractor but not to the governmental officials." Bronfeld v. Pember Companies, Inc., 792 N.W.2d 222, 227 (Wis. Ct. App. 2010) (internal citation omitted). The court held that contractor should not bear liability when simply acting as an agent of governmental authorities who retain ultimate responsibility for a project. *Id.* at 224, 226–27.

[157] Peck v. City of Baraboo, 122 N.W. 740, 743 (Wis. 1909).

[158] Bratonja v. City of Milwaukee, 87 N.W.2d 775, 777–78 (Wis. 1958).

[159] *Id.* at 778 (citing Peck, 122 N.W. 740).

[160] Kusler, *supra* note 97, at 21.

[161] *Id.* at 22.

[162] *Id.* at 21.

[163] *Id.* at 22; *see also* Bostco LLC v. Milwaukee Metro. Sewerage Dist., 835 N.W.2d 160, 175 (Wis. 2013); Biernacki v. Vill. of Ravena, 664 N.Y.S.2d 682, 683 (N.Y. App. Div. 1997).

[164] Slemp v. City of N. Miami, 545 So. 2d 256, 257 (Fla. 1989).

adequately maintain or operate the pumps that damaged their property.[165] It was decided that this was a question of proximate cause and should be submitted to a jury.[166]

5. Nuisance. – If there is a claim for negligent operation or administration, plaintiffs might also bring a claim for inverse condemnation or nuisance.[167] As with negligence, once there is notice of nuisance the government has a duty to act and immunity no longer exists.[168]

Stormwater disputes have often given rise to nuisance claims against governmental bodies. One court held that a city which approved a construction project resulting in increased runoff could be held liable for the damage caused to property from the flooding.[169]

Sovereign immunity is not a protection against non-negligent nuisance.[170] Non-negligent nuisance has been defined as a "condition created by the entity must in some way constitute an unlawful invasion of property or the rights of others beyond that arising merely from its negligent or improper use."[171]

A Minnesota court utilized a "reasonable use" test upon a claim that the diversion of surface waters by a municipal storm sewer system interfered with a plaintiff's use of property.[172] The court subsequently found that the test involves a case-by-case analysis; here, though, the court found that the municipality's obstruction of plaintiff's free use of its property by installing and maintaining water drainage systems was clearly unreasonable.[173]

A Georgia court held that:

> [t]o be held liable for maintenance of a nuisance, the municipality must be chargeable with performing a continuous or regularly repetitious act, or

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[165] *Id.* at 258.

[166] *Id.*

[167] Bostco LLC v. Milwaukee Metro. Sewerage Dist., 835 N.W.2d 160, 165-66 (Wis. 2013).

[168] Milwaukee Metro. Sewerage Dist. v. City of Milwaukee, 691 N.W.2d 658, 675–76 (Wis. 2005). Generally, a claim for public nuisance can stem from negligent or intentional conduct that creates a condition which substantially interferes with the use of a public place or the activities of a community. *Id.* at 669–70. The contours of a nuisance claim vary by jurisdiction. In some states, the definition is established by statute, with courts later smoothing the rough edges. *See, e.g.*, WIS. STAT. § 823.01 (1975). Generally, the plaintiff must prove that the defendant's conduct was a substantial cause of the existence of a public nuisance and that the nuisance was a substantial factor in causing injury to the public, which injury is the subject of the action. City of Milwaukee v. NL Industries, Inc., 691 N.W.2d 888, 892 (Wis. Ct. App. 2004).

[169] Columbus, Ga. v. Smith, 316 S.E.2d 761, 765–66 (Ga. Ct. App. 1984).

[170] Wickham v. San Jacinto River Auth., 979 S.W.2d 876, 880 (Tex. App. 1998) ("[S]overeign immunity is not a defense to a claim of non-negligent nuisance.").

[171] Golden Harvest Co. v. City of Dallas, 942 S.W.2d 682, 689 (Tex. App. 1997).

[172] Highview N. Apartments v. Ramsey Cty., 323 N.W.2d 65, 71 (Minn. 1982).

[173] *Id.* at 72.

> creating a continuous or regularly repetitious condition, which causes the hurt, inconvenience or injury; the municipality must have knowledge or be chargeable with notice of the dangerous condition; and, if the municipality did not perform an act creating the dangerous condition, . . . the failure of the municipality to rectify the dangerous condition must be in violation of a duty to act.[174]

The court did not find that the city exercised any control over the water flooding the private property and therefore had no dominion over what caused the harm.[175]

As with claims for negligence, courts have held that liability for public nuisance can be limited by public policy considerations. Some courts have established limiting factors:

> (1) The injury is too remote from the negligence; or (2) the injury is too wholly out of proportion to the culpability of the negligent tort-feasor; or (3) in retrospect it appears too highly extraordinary that the negligence should have brought about the harm; or (4) because allowance of recovery would place too unreasonable a burden on the negligent tort-feasor; or (5) because allowance of recovery would be too likely to open the way for fraudulent claims; or (6) allowance of recovery would enter a field that has no sensible or just stopping point.[176]

But a court applying these factors nevertheless found liability where a tree branch obscured the view of a stop sign causing an accident.[177] The court reaffirmed the principle that municipalities are not automatically shielded from liability for maintaining a nuisance.[178] When a nuisance claim is based upon negligence, the defenses used in negligence action are applicable.[179] Notice to the municipality is still required by the plaintiff, regardless of whether the nature of the harm is public or private.[180]

6. Inverse Condemnation. – Landowners have also invoked the doctrine of inverse condemnation to seek compensation from a municipality where storm runoff from municipal projects causes damage to their private

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[174] City of Gainesville v. Waldrip, 811 S.E.2d 130, 132 (Ga. Ct. App. 2018) (citing Mayor of Savannah v. Palmerio, 249 S.E.2d 224, 229-30 (Ga. 1978)).

[175] *Id.* at 133.

[176] Coffey v. City of Milwaukee, 247 N.W.2d 132, 140 (Wis. 1976).

[177] Physicians Plus Ins. Corp. v. Midwest Mutual Ins. Co., 646 N.W.2d 777, 803–07 (Wis. 2002).

[178] *Id.* at 801.

[179] Milwaukee Metro. Sewerage Dist. v. City of Milwaukee, 691 N.W.2d 658, 665 (Wis. 2005).

[180] *Id.*; *see also* Bostco LLC v. Milwaukee Metro. Sewerage Dist., 835 N.W.2d 160, 174 (Wis. 2013) ("The *duty to fix the pipe*, if the City knew [the pipe] was leaking, was 'absolute, certain and imperative'–in other words, ministerial–even though a *particular method* of repairing the leak was not 'absolute, certain and imperative.'").

property.[181] The claim is based on the premise that the accumulated runoff amounts to a taking in the form of a drainage easement.[182] In order for private landowners to recover damages there need not be physical entry by the public entity or statutory allowance of compensatory damages.[183] Inverse condemnation proceedings are supported by the theory of individual rights to government compensation for the taking or damaging of property.[184]

In the stormwater context, liability for unintended physical damage can be alleged when property damage resulted from a public entity's ownership, maintenance, or use of a public improvement.[185] A governmental agency must understand and estimate the potential risk of damage to private property.[186] This type of calculated risk must be addressed when implementing a system that can cause serious flood damage upon failure.

The doctrine may also permit landowners to obtain compensation from a municipality where storm runoff from municipal projects is diverted across private land on the premise that this amounts to a drainage easement, even without physical entry.[187]

However, courts have rejected such claims where the plaintiff failed to show that a sewer district inadequately maintained a sewer.[188] Absent an affirmative act on behalf the agency, the court refused to sustain an action for inverse condemnation.[189] A municipality cannot be liable for issues based on an alleged failure to "prospectively maintain or inspect the sewers."[190] Similarly, after a flood destroyed private property, thirteen residents brought an inverse condemnation claim against a municipality that maintained a nearby dam.[191] The court found no affirmative action on

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[181] *See generally* 1 URBAN STORM DRAINAGE CRITERIA MANUAL, URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, at 2-7 (2016) (hereinafter URBAN DRAINAGE MANUAL); Fromm v. Vill. of Lake Delton, 847 N.W.2d 845, 854–55 (Wis. Ct. App. 2014).

[182] URBAN DRAINAGE MANUAL, *supra* note 181, at 2-7.

[183] *Id.*

[184] J. David Rogers, *Flood Damage: Evolving Laws and Policies for an Ever-Present Risk*, SAN FRANCISCO INS. CLAIMS FORUM (Apr. 1997), https://web.mst.edu/~rogersda/umrcourses/ge301/Evolving%20Laws%20for%20Flood%20damage%20Litigation.html.

[185] *Id.*

[186] *Id.*

[187] URBAN DRAINAGE MANUAL, *supra* note 181, at 2-7.

[188] Christ v. Metro. St. Louis Sewer Dist., 287 S.W.3d 709, 713 (Mo. Ct. App. 2009).

[189] *Id.* at 713.

[190] *Id.*

[191] Fromm v. Vill. of Lake Delton, 847 N.W.2d 845, 848 (Wis. Ct. App. 2014). Wisconsin follows federal law on this point: a taking requires: "(1) an actual physical occupation of private property or (2) a restriction that deprives an owner of all, or substantially all, of the beneficial use of his [or her] property." *Id.* at 850.

behalf of the government; a requirement for a valid takings claim.[192]

In the end, decisions regarding the management of a stormwater system likely will fall into the discretionary function category.[193] Decisions regarding the maintenance, repair, and construction of the system will likely be operational activities which may incur liability.[194]

7. Lessons for Potential RTC Adopters. – As detailed above, common institutional barriers to RTC implementation identified in the existing literature included cost, workforce readiness and related labor issues, distrust of the technology, data management and cybersecurity problems, and technology barriers such as the lifetime of sensors. Overcoming these challenges will require significant cross-sector collaboration within a fragmented regulatory framework. Municipalities considering the technology should be ready to face these challenges.

On the legal side, an entity undertaking RTC must ensure that its conduct is "reasonable," as courts have required of other municipalities attempting to reduce naturally occurring hazards.[195]

Given the case law, RTC operators should have two primary concerns. First, that by actively making decisions to control and route the flow of stormwater in its system, the operator *is* a proximate cause of eventual harm to a claimant. For example, RTC operators could be faced with negligence or nuisance claims as a result of an alleged failure to properly operate or maintain system equipment or components. This increased potential for liability might be considered a cost or risk of actively participating in real-time stormwater management decisions, as opposed to a static system with little intervention by the operator but with greater liability protections. As a result, before installation begins, operators should consider the possible impacts of failure, and impress upon staff the importance of effective

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[192] *Id.* at 852; *cf.* United States v. Dickinson, 331 U.S. 745, 749 (1947) (government had to compensate property owner for erosion resulting from government damming of a river); Owen v. United States, 851 F.2d 1404, 1405–06, 1416 (Fed. Cir. 1988) (Corps of Engineers dredging of a river, resulting in erosion and a house falling into that river, was a taking); Quebedeaux v. United States, 112 Fed. Cl. 317, 319–20 (Fed. Cl. 2013) (Corps of Engineers spillway operation, resulting in flooding of plaintiffs' properties, could support a takings claim); Cotton Land Co. v. United States, 75 F. Supp. 232, 235 (Ct. Cl. 1948) (compensation due for flooding of plaintiff's property by dam construction and operation).

[193] *E.g.*, Julius Rothschild & Co. v. Hawaii, 655 P.2d 877, 881 (Haw. 1982).

[194] *E.g.*, Slemp v. City of N. Miami, 545 So. 2d 256, 257 (Fla. 1989) (holding a city's failure to maintain and operate a sewer system is an operational activity subject to traditional tort analysis).

[195] *See* Tri-Chem Inc. v. Los Angeles Flood Control Dist., 132 Cal. Rptr. 142, 145 (Cal. Dist. Ct. App. 1976) (after industrial district flooded, court found no governmental liability because there was no evidence that the conduct of the government entities and the flood control system proximately caused the damage).

operations.

On the other hand, RTC operators can perhaps take comfort in knowing that most of the case law dealing with stormwater has to do with flooding damages and not water quality. Thus, where RTC measures are simply designed to improve water quality, then their failure to do so is less likely to create legal liability due to the absence of direct damages, at least of the magnitude often caused by floods.

Second, a municipality considering RTC should question whether the sheer amount of data collected by an RTC system may constructively put the municipality on notice of problems within the system. In operational terms, that is the whole point of collecting data via an RTC system. Although there is not yet much case law on this point, RTC operators should remain abreast of legal developments related to constructive notice. For example, if a municipality receives notice via its RTC system that equipment has failed and flooding is ongoing, must it act immediately to remedy the damage? These and other questions will be dealt with in future cases.

Because RTC is so new, no cases explore these possibilities. At present, a municipality operating an RTC system should take reasonable steps to resolve any problem it becomes aware of through data collected by its RTC system.