Water-Related Economic Development Opportunities in the Hudson & Mohawk River Valleys

Preliminary Report[1]

Executive Summary

Given the global challenges around access to clean water and the growth of a global water technology market, the region's water assets should be valuable to the private sector as a part of manufacturing processes (e.g., semiconductors), an input for value-added products (e.g., food), and as a catalyst for water-related product (e.g., desalination) and service (e.g., tourism) based businesses. The goal of this research was to better understand how existing policy and practice are encouraging or inhibiting the formation of businesses (and therefore local economies) that depend upon water infrastructure in the Hudson and Mohawk watersheds in a way that helps to remediate and maintain regional water resources over time. Analysis was framed from the perspective of whether and how upstate water resources could be leveraged more effectively for the development of private sector firms which, in turn, would depend, take advantage of, promote, and protect those same resources. Key findings include:

- The region's existing network of water companies, R&D capabilities, capacity for supporting technology commercialization, and expertise in financing, there is an opportunity to promote development of a water cluster of companies focused on meeting the growing global demand for water-related technologies – a $500 billion market expected to expand 3-5% annually (8-10% annually in emerging markets) over the coming decade.

- Unlike destinations such as the Rideau Canal in Ontario, Canada, New York does not effectively manage its waterways as a world-class, destination tourism asset which can support a strong service sector.

- Significant barriers that will hinder establishment of new ventures as well as retention or attraction of exiting firms to the region include real and perceived water quality issues, undervaluation of water assets by the private sector, underinvestment in infrastructure to meet manufacturing needs, a comparatively unfavorable business environment for encouraging new business development and investment, poor communication and coordination among the region's stakeholders, and the impacts of drought and flooding expected from climate change.

[1] This draft report was prepared by Professor Mark Milstein and John Tauzel of Cornell University's Center for Sustainable Global Enterprise at the Samuel Curtis Johnson Graduate School of Management through generous funding and support from the Water Resources Institute.

Introduction

The purpose of this project was to examine how unique water resources in the Hudson and Mohawk River Watershed (the Watershed) could be leveraged to catalyze economic development opportunities beneficial to the State of New York.

Two centuries of significant pollution in parts of the Watershed severely limit its economic generation capacity, particularly in terms of residential or commercial water consumption and recreational development. 7% of the total river miles (both the Mohawk River and its many tributaries) are so impaired that they cannot support appropriate uses. This includes over 40 miles on the Mohawk River itself where fish consumption is limited due to PCB contamination. The Mohawk includes parts of Adirondacks where an ongoing concern is lake pollution by atmospheric deposition (i.e., acid rain).

Now a new environmental challenge is on the horizon. Climate change will impact the Watershed in ways that are difficult to predict, requiring government, communities, and businesses to consider the long-term economic potential of the region's water resources. At present, though, it is expected that increased rainfall will add to the value of those resources in the coming decades as other parts of the United States struggle with drought and water shortages.

A review of secondary data sources combined with primary data collection through interviews with representatives in the private sector, municipal government, and organizations focused on promoting economic development in upstate New York, both inside and outside the Watershed provided a more detailed understanding of economic development opportunities related to the State's water resources.

Methodology

In order to determine how water could drive economic development we reviewed secondary research, including associated reports and case studies. This initial step provided background information and an awareness of the current discussions around the nexus of water and economic growth as well as a more nuanced understanding of the economic and environmental situation within the watershed.

We then conducted a series of interviews with a wide spectrum of experts to obtain a comprehensive understanding of the ongoing efforts around water and economic development. These interviews provided some perspective on how private firms view water supply and some of the issues associated with providing water to businesses.

Based on both an understanding of existing successful efforts around water and business development as well as an understanding of the existing business climate within the watershed area, recommendations were created for groups to implement and expand business opportunities through the Hudson and Mohawk Region.

Economic History

The Hudson and Mohawk Rivers have been a significant catalyst for economic development in upstate New York for over three hundred years, dating back to the Iroquois trade of pelts with Dutch and English fur buyers.

Geologically, the Mohawk River is one of the few natural breaks in the Appalachian Mountain Range making it a natural conduit of commerce in the expanding United States. This physical attribute enabled the watershed to serve as the base of the Erie Canal connecting the East Coast of the United States with the Great Lakes and Mid-West and providing economic growth to communities located along the rivers. Through the history of the United States, the rivers have continued to serve in supporting business, community expansion and industrial activity.

Geography & Demographics

The Watershed can be broken into three specific geographic areas: the Lower Hudson River which includes the watershed area south of Catskill, NY; the Upper Hudson River which includes the Capital District; and the Mohawk River. These designations generally match both existing environmental and natural boundaries. They also reflect the existing economic development borders in terms of New York State's regional economic development councils. The watershed connects to the Great Lakes, the Finger Lakes, Lake Champlain and the Saint Lawrence River through a network of canals. This report does not address issues associated with parts of the watershed located in the New York City water supply watershed.

There are significant differences in economic conditions across the Hudson and Mohawk Rivers watershed which impact the potential opportunities for water-related development. The recently created Regional Economic Development Councils provide a comprehensive approach and analysis of the major economic trends of the three geographic segments of the watershed, as well as areas of growth for each sub-watershed region.[2] A brief overview of the three regions – Lower Hudson, Upper Hudson, and the Mohawk Valley – are detailed below.

Lower Hudson[3]

With approximately 2.3 million inhabitants, the Lower Hudson is the most economically affluent, highest educated, and enjoys the highest population growth rate in Upstate New York. Median household income in the region of $69,000 exceeds the US median of $51,400.[4] Major private sector employers in the region include computer, electronic and chemical manufacturers. In Dutchess County, 8% of the jobs

[2] See http://regionalcouncils.ny.gov/
[3] Additional information about the Lower Hudson region can be found at http://regionalcouncils.ny.gov/content/mid-hudson
[4] See Federal Reserve Bank of New York: Mid-Hudson District Profile, http://www.newyorkfed.org/regional/profile_midhudsonvalley.html

are devoted to high-tech manufacturing, or ten times the national average.[5] Additionally, the region is home to over 200 firms involved in the biotechnology space. Other significant sectors include solar energy companies, infrastructure construction firms, broader finance and insurance industries, professional services, education and health care. Having such a high proportion of technology-related jobs helps to drive education and training rates in a region where 37% of adults hold a college degree (exceeding both state and national averages).

The Lower Hudson's proximity to New York City can provide more economic opportunities than regions isolated from urban centers, but it also results in higher energy costs as well as higher costs of living. The median home price in Orange County is $318,000 and over 50% of Hudson Valley residents commute outside their county of residence to work.[6] The region lacks a major academic research institution which could otherwise be a driver for technology R&D.

Upper Hudson[7]

With a population of over 1 million, the Upper Hudson includes the state capital of Albany which is the fastest growing metropolitan area in Upstate New York. The region's economy is dominated by public sector employment which acts as a buffer during economic down cycles. High tech contributes to the region's economy in partnership with higher education which together form a regional cluster that includes Global Foundries' semi-conductor manufacturing plant, SUNY Albany College of Nanoscience, and Rensselaer Polytechnic Institute (RPI). GE has both its Power & Water division headquarters in Schenectady and its global research lab in Niskayuna. The region also specializes in clean technology, with Albany possessing the highest percentage of jobs being dedicated to a green economy (6.8%) of any metro region in the country.[8] Tourism provides economic diversification in the Upper Hudson that provides $2.1 billion annually into the region.

Median household income in the Upper Hudson stands at $57,000 and the region has a comparatively well-educated workforce with 33% of adults in the Upper Hudson possessing a college degree.[9]

Mohawk Valley[10]

With an aging population of only 450,000, the Mohawk Valley faces a more challenging economic picture. Historically, the region had strength in manufacturing, including textiles and machine tools. Over time, however, manufacturing has gradually moved south and overseas where production costs are lower. Today, there still remains a high concentration in manufacturing of both primary and fabricated metals. Additionally, civil engineering, food processing, back-office operations and health

[5] Ibid.
[6] Ibid.
[7] Additional information about the Upper Hudson region can be found at http://regionalcouncils.ny.gov/content/capital-region
[8] Sizing the Clean Economy: A National and Regional Green Jobs Assessment (2011), The Brookings Institution, available at http://www.brookings.edu/~/media/series/resources/0713_clean_economy.pdf
[9] See Federal Reserve Bank of New York: Albany-Schenectady-Troy Metro Area District Profile, http://www.newyorkfed.org/regional/profile_albany.html
[10] Additional information about the Mohawk Valley region can be found at http://regionalcouncils.ny.gov/content/mohawk-valley

care dominate the private sector in the Mohawk Valley. The region is more focused on economic development potential in cutting edge industries that include: advanced manufacturing, aviation and aerospace, biosciences, IT and cybersecurity, distribution and logistics, finance and insurance, and (micro)electronics manufacturing.[11] The former Griffiss Air Force Base research lab is seen as providing unique infrastructure for aviation and cybersecturity, in particular. Over the past decade, state and regional interests have invested heavily to develop educational, training, and physical infrastructure in collaboration with SUNY's Institute of Technology and College of Nanoscale Science and Engineering.[12] Additionally, the Mohawk Valley has tourism assets, including historical and recreational destinations, which make the sector the third largest employer in the region.

20% of the region's population is over 61 years old, outpacing the national average of 16%. Only 20% of the adult population in the Mohawk Valley has a college degree, which also lags the national average.[13] The median annual household income of $45,000 is also lower than the US average. The Mohawk Valley's 14.4% poverty rate is higher than both the state (13.8%) and national (13.5%) averages.

Water's Role in Economic Development

Given the global challenges around access to clean water and the growth of a global water technology market, the region's water assets were considered in terms of its role as a part of private sector manufacturing processes (e.g., semiconductors), an input for value-added products (e.g., food), and as a catalyst for water-related, product (e.g., desalination) and service (e.g., tourism) based businesses.

The State of New York's Business Climate

A number of studies suggest that New York's business climate is not conducive to business growth. Regional Economic Development Councils in the Upper Hudson, Lower Hudson, and Mohawk Valley all point toward high land and labor costs, high taxes, aging populations, decaying infrastructure, and legacy costs such as contaminated brownfield manufacturing sites as barriers to business growth. New York's fragmented approach to government is also cited as a barrier to economic development due to regulatory and bureaucratic requirements for operating businesses in the state. The state was recently ranked 50th in the nation for taxation[14] and 49th for business climate[15]. Economic development officials also point to high taxes as a major barrier in attracting companies to the state.[16] Existing economic

[11] According to interviews with Mohawk Valley Economic Development Growth Enterprises Corporation (EDGE, see http://www.mvedge.org/) representatives
[12] See http://lutherforest.org/
[13] See Federal Reserve Bank of New York: Utica-Rome Metro Area District Profile, http://www.newyorkfed.org/regional/profile_utica.html
[14] The Tax Foundation; see http://taxfoundation.org/state-tax-climate/new-york
[15] Chief Executive Magazine; see http://chiefexecutive.net/new-york-is-the-49th-best-state-for-business-2013
[16] According to interviews with Mohawk Valley Economic Development Growth Enterprises Corporation (EDGE, see http://www.mvedge.org/) representatives

development programs tend to offer tax reductions to new companies, which can shift tax burdens to existing businesses and New York State residents.

The Hudson/Mohawk Watershed

The Hudson/Mohawk Watershed covers approximately 13,000 square miles. The Hudson River was formed prior to ice-age periods, but glaciers played a significant role in forming the current path and geology of the river. Similarly, the Mohawk River was formed as the outlet to the large Glacial Lake Iroquois which eventually shrunk to modern day Lake Ontario. The violent water flows from the historic Mohawk resulted in significant geological formations, including the large gravel disposition that makes up the Great Flats Aquifer, a key source of regional municipal groundwater.[17]

While the Upper Hudson is reported to be in good condition, a combined lack of awareness and a disregard for the environmental impacts of industry resulted in significant water quality degradation in the watershed in the 20th century. In particular, the region is plagued by PCB contamination that occurred from the 1940s to the late 1970s.[18] In an attempt to ameliorate the problem, General Electric is currently overseeing a massive river dredging project in Hudson Falls and Fort Edwards which involves hundreds of companies and costs hundreds of millions of dollars.[19]

Similarly, while the water quality of the Mohawk River is also designated as relatively high, 7% of the total river miles of the Mohawk River and its tributaries are so impaired that they cannot support appropriate uses. This includes over 40 miles where fish consumption is limited due to PCB contamination.

In the Lower Hudson, the water quality is significantly more degraded than other parts of the watershed. The Hudson River has limits on swimming as well as the amount of fish that can be consumed from it due to contamination concerns. Over 43% of the lakes in the Lower Hudson have fish consumption restrictions because of atmospheric deposition of contaminants which persist in several of the Lower Hudson's major tributaries.[20] Recent monitoring suggests that significant amounts of pollution continue to exist in several of the Lower Hudson's major tributaries.[21]

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[17] Johnson, T.M. 2009. Responsible Planning for Future Ground Water Use From the Great Flats Aquifer: Two Case Studies: The Gepenergy Project and the Sigreen Fuels Boiler Project. In Cockburn, J.M.H. and Garver, J.I. (Eds.), Proceedings from the 2009 Mohawk Watershed Symposium, Union College, Schenectady NY, 27 March 2009. Available at http://minerva.union.edu/garverj/mohawk/symposium/14_Johnson.pdf.

[18] Bureau of Watershed Assessment and Management, Division of Water, NYS Department of Environmental Conservation, The 2003 Upper Hudson Basin Waterbody Inventory and Priority Waterbodies List, May 2007, available at http://www.dec.ny.gov/docs/water_pdf/pwluhud07.pdf

[19] See http://www.hudsondredging.com/local-businesses/

[20] Bureau of Watershed Assessment and Management, Division of Water, NYS Department of Environmental Conservation, The Lower Hudson River Basin Waterbody Inventory and Priority Waterbodies List, August 2008, available at http://www.dec.ny.gov/docs/water_pdf/pwluhud07.pdf

[21] Kemble, W. J., Riverkeeper Report May Spur More Monitoring of Creek Pollution in Mid-Hudson Region, Daily Freeman, Tuesday, July 9, 2013 available at http://www.dailyfreeman.com/articles/2013/07/09/news/doc51db65f7c85bf095880508.txt

Regional Water Issues

To understand how water can impact economic development in the region, it is important to consider issues related to water availability, access, and quality. Water in the region is not always easy to access. For example, a long-standing water issue in the Watershed has been water allocations from the Hinckley Reservoir near Utica, which has been recognized for the efficiency with which it collects water as compared to costlier drilled ground-water wells. Completed in 1915, the Reservoir was developed specifically to serve as a water supply for the Erie Canal. Since 2003, the Reservoir has also served as the sole source water supply for the 130,000 customers of the Mohawk Valley Water Authority. Over the past five years, an ongoing legal issue has existed over the ownership of the water rights of Hinckley and the use of the water in the reservoir for different purposes. The Mohawk Valley Water Authority would like additional water to expand their client base; the Canal Corporation has a responsibility to maintain the Erie Canal system at specific levels to support water-based tourism; and a downstream hydropower station needs a guaranteed flow-rate to remain in operation.

Water is neither available nor accessible equally throughout the Watershed. Left over from gravel deposits during the draining of Glacial Lake Iroquois, the Great Flats Aquifer is located around the city of Schenectady. The city and surrounding towns have the ability to withdraw as much as 65 million gallons per day (MGPD), but currently only use around 25 MGPD. With food processing plants needing 100,000 GPD and semi-conductor manufacturing plants needing 4 MGPD, the communities in the region have a tremendous water resource. The city and Schenectady County have started to seek ways to benefit from the resource by courting manufacturers who seek access to clean, reliable water for their products and processes as a basis for regional economic development.

However, the water wealth for Schenectady stands in stark contrast with that of Greene County. The eastern side of the county lies in the Catskill Mountains where the terrain makes it less favorable to large-scale development. At the same time, the western part of the county lies in the flatter, more accessible Hudson Valley where major transportation networks (rail and thruway) make it more ideal for development. But the tight clay formations in Greene County dramatically reduce ground-water availability in the area and lead to expensive water infrastructure projects. Often wells need to be very deep (500 feet below the surface), have very low flow rates, and contain very high fine-particle content rendering it problematic for high volume manufacturing processes.

There are real and perceptual issues around water quality in the region. Differences in geology contribute to water treatment issues. The Hinckley Reservoir is surface water which can become contaminated with significant amounts of sediment and needs investments in specific treatment methods to meet US Environmental Protection Agency standards. For example, the Mohawk Valley Water Authority recently invested in a new system that uses pocked carbon to meet EPA standards, but required an additional $1 million per year in operational costs to the water authority budget. The Great Flats Aquifer has very pure water, but the county has to expend resources on aquifer protection efforts to maintain its existing quality. Creating an understanding around aquifer protection is a major challenge which involves not only awareness among aquifer users, but also among those on lands above the aquifer and its watershed.

Even water removal directly from the Hudson River presents unique challenges. Ongoing water quality issues make some parts of the Hudson unusable as a drinking water source. Along certain parts of the river where water quality is good enough to serve a water source, technical barriers often create issues in water access. The Hudson Valley geology (heavy clay) and Hudson River flow patterns means that significant amounts of silt exist in certain areas of the river. This limits the ability to use direct intakes for water supplies and instead requires more complex systems. For example, the Town of Bethlehem developed a water infiltration gallery to attempt to overcome silt issues but has faced problems getting the technology to work correctly.

Additionally, the historical pollution legacy of the Hudson River limits consumer acceptance of the water sourced from it. The Town of Bethlehem's efforts to use the Hudson River as a drinking water source has been limited by residents' refusal to drink water based on persistent beliefs that water quality fails to meet standards even though it does. Until recently, the Town had to expend resources to maintain two different water systems. The water from the Hudson River could only be used for industrial purposes while residents were served by other water sources. This meant that the 6 MGPD capacity Hudson River source was only pulling 1 MGPD.

Compounding these issues is a lack of knowledge about true water availability. New York State only recently enacted a water use reporting law.[22] Prior to that, there was no comprehensive way to know how and where water was being withdrawn within the watershed. This limited an understanding of where water surplus existed and how best to plan for water-based economic development. The new reporting system may lead to creation of a much needed data set to allow track data in the future.

The ability to actually supply water and both the existing and long-term capacity of existing water treatment and wastewater treatment systems in the watershed is a concern. The New York State Department of Health estimates that New York State will need to spend more than $38 billion over the next 20 years to repair, replace and improve the state's drinking water systems.[23] Lack of capacity to absorb new users can limit the desirability of sites from water-use companies as well as the ability of communities to entertain interested companies.[24] A recent study examining existing capacity of several sample waste water systems throughout the Hudson and Mohawk Watershed indicates a wide range of capacities across the region with some sub-watersheds having over 200 years of wastewater capacity (given current population trends) and other having just a few decades.[25] Understanding where there is existing water capacity in the watershed could help communities better market specific locations to large water-use businesses and better utilize existing capacity.

[22] See http://www.dec.ny.gov/lands/313.html

[23] New York State Department of Health, Drinking Water Infrastructure Needs of New York State, November 2008 available at http://www.health.ny.gov/environmental/water/drinking/docs/infrastructure_needs.pdf

[24] Opinions expressed in interviews with staff from Mohawk Valley EDGE and Luther Forest Technology Campus.

[25] Rahm, B.G., S. Vedachalama, J. Shena, P.B. Woodbury, and S. J. Riha. 2103. A Watershed-Scale Goals Approach to Assessing and Funding Wastewater Infrastructure, Journal of Environmental Management, 129: 124-133.

Climate Change

Climate change has the ability to change the value of the water resources for the Hudson/Mohawk watershed and diminish advantages the resources would otherwise hold for the region. The U.S. Global Change Research Program (USGCRP), a Federal program that coordinates and integrates global change research across 13 government agencies, synthesizes research develop U.S. regional climate scenarios.[26] The Hudson River saltwater front – where the river's fresh water converts to salt water (defined as 100 mg/L chloride concentration) – currently moves regularly within an 80 mile range, occasionally reaching North just beyond Poughkeepsie. Studies suggest that rising sea levels will push the front farther North over time. This will be problematic for communities dependent upon the Hudson River for fresh water supplies. Those communities will need to install expensive desalinization systems and/or existing water intake structures to areas beyond the salt-line.

Climate change forecasts also predict that the Hudson/Mohawk Watershed will see increased heavy precipitation events. For example, one climate change model has predicted that, in Albany, the average precipitation per month between 2050 and 2070 will be larger than the average monthly precipitation amounts from 1982 through 2002; as will the maximum precipitation (9.28 inches in one month compared to 7.87 inches). Projections of early spring snowmelt, suggest flooding will become more common within the watershed. More water and more flooding will require investment to help communities remain resilient. Increased flooding has the potential to disrupt water supply and wastewater treatment systems which are often located near the river and can contaminate it during high water events when pumps or electrical boxes could be subject to damage from submersion in a flood situation.

Increasing frequency and intensity of floods will also create added costs and instability for both businesses and the communities that depend on them for jobs. For example, in 2006, when the Beech-Nut plant in Canajoharie, NY was severely damaged by floods, the company had to relocate the facility to another part of the watershed. This resulted in lost jobs, lost tax revenues, and empty building stock prone to additional flooding events, in the Village of Canajoharie. It also reduced demands on water supply and wastewater treatment infrastructure, increasing costs to remaining users and possibly decreasing system efficiency.

In addition to increased rain events, climate change models also suggest that while the region will see longer dry periods and increased short-term droughts. Specifically, according to the US Global Change Research Program, by late this century, "short-term (one to three-month) droughts are projected to occur as frequently as once each summer in the Catskill and Adirondack Mountains." Such conditions will exacerbate flooding and runoff, compromising the water quality of the watershed. Additionally, drought frequency increases can impact operations of companies that rely on water for cooling.

[26] See http://www.globalchange.gov/

The Value of Water for Business

While the region has current – and potentially future – water resources, the value of those resources to the business community is less clear. In a region where attracting manufacturing has been a central component for economic development plans, water has not proved to be a strong attractor to the area. Companies consider water an advantage in siting decisions, but long-term water access is not a major determining factor in firm siting decisions. Interviews with industry leaders and economic development professionals indicated siting preferences were not impacted by a given community's overall water resources. In certain cases, such as semi-conductor manufacturers, a critical site requirement is the immediate access to large amounts of readily available water and power which would be a prerequisite for a site to be considered by real estate consulting firms, such as Jones Lang LaSalle, that are hired by large companies to identify appropriate new locations.

Communities competing for attention by such firms must be ready to deliver large amounts of water (e.g., current microchip-fabrication plants require upwards of 8 MGPD of capacity) before they can even put forth a competitive proposal. This often requires local communities to invest in new infrastructure and ensure water treatment and wastewater treatment system capacity is expanded, almost prior to having a company even express interest in a location. This is a significant risk and cost to local communities.

An example of this situation in the Watershed is the GlobalFoundries computer-chip or semiconductor manufacturing plant, Fab 8, located in Malta, New York where each chip produced is washed nearly 1,000 times during the production process. The GlobalFoundries fabrication unit required over $2billion in government economic incentives to encourage its location to Malta. Water access played an important role in attracting GlobalFoundries to the watershed. The current fabrication site uses over 2 MGPD and has capacity, thanks to a new $67MM Saratoga County funded water line, to use up to 4 MGPD. Estimates place total water demand after construction of the second chip fabrication plant at almost 12 MGPD. The demand for water fluctuates throughout the day, however, so that the water supply system has excess capacity to last for over 200. To attract GlobalFoundries, the county needed to reorganize its water municipalities into a county water system. A new water treatment plant needed to be built to pull water from the Hudson River and expensive water lines needed to be constructed to the Luther Forest Technology Campus where the fabrication plant is located. This all needed to be done by the local government in order for GlobalFoundries to commit to moving to the region. While GlobalFoundries' water contract is initially priced higher on a per gallon basis than many of the local villages that have now joined the water system, the company has no additional stake in the water system. This leaves the full responsibility on the local ratepayers over the long-term. For example, the loan to connect the Village of Stillwater with the larger county system has a 38-year term which is likely to far exceed the life of the fabrication plant.

Firms relying on water for manufacturing processes need to meet certain operational parameters. For example, water used by GlobalFoundries pulled from the Hudson River must be treated for sediment and nutrient loading that can impact semi-conductor output which requires ultra-pure water. After being treated by the county water authority, water then undergoes ultra-purification thought filters at

the GlobalFoundries facilities which are specifically calibrated to address Hudson River contaminants. GlobalFoundries also requires a secondary water supply which was initially conceptualized as coming from a local private well. But because of the differences between surface and ground water, this would have required two sets of ultra-purification systems. The issue remained unresolved until recently when GlobalFoundries issued over $70MM in bonds, some of which will be used to build a water storage tower at the plant to ensure a continual flow of usable water.

As manufacturing process evolve, water needs become more complex and expensive. In the Hudson/Mohawk watershed at Marcy, NY, where the State hopes to attract another semi-conductor chip fabrication, the current infrastructure provides a limited capacity of up to 3MGPD even though the current generation of chip manufacturing plants requires close to 8MGPD. Unless local communities and the state agree to make investments to expand capacity of the existing system – a baseline expectation for firms evaluating sites – it is unrealistic to expect firms to locate their plants in the region. This is holding constant other factors including taxes, incentives, transportation, workforce education, cost-of-living and proximity to existing facilities – which are evaluated when companies consider new locations.

Further complicating this issue is that water tends to be less heavily weighted in the firm decision making process than other factor. Water is generally undervalued because many existing water supply systems are not charging customers enough to cover their true costs. Many of the existing water treatment systems were built by federal grants or have vastly outlived their projected life-spans. Given political resistance to rate increases, many water systems have simply been charging users for operation of water treatment systems. They have not been including charges for long-term replacement or renovation of the systems. The undervaluation of water is amplified in the analysis used by firms to evaluate capital investments and can be difficult to incorporate into financial models. Net present value calculations do not easily account for change to water access or quality, let alone fluctuations expected with climate change. Existing regional climate models don't even provide outputs until 2050 which is well beyond the outer horizons of financial models that ascribe very little value beyond 7 years.

Company attitudes, though, may be changing as they begin to consider upgrades to existing locations and more efficient resource use as opposed to relocations. For example, Intel is partnering with the City of Chandler, AZ to develop new water reuse systems and has spent over $200MM on public infrastructure including water and wastewater facilities.

Water in and of itself is less of a driver for companies than the overall business climate. We examined businesses at other sites around the country that mirrored firms in the Hudson/Mohawk Watershed – specifically the pharmaceutical and life-science sector in the Lower Hudson Valley, the semi-conductor industry in the Upper Hudson and the food processing sector, most notably the Greek-style yogurt production in the Mohawk Valley – where water issues were part of siting considerations. Specific sites included Intel's large chip-fabrication plant in Chandler, AZ, Pfizer's production site in Sanford, NC and Chobani's recently built yogurt plant in Twin Falls, ND. As shown below in Table 1, it is clear that temperature trends were consistent everywhere (rising), precipitation trends were equal to or worse than those predicted to occur in New York, but the business climate in New York fared much worse against other locations, with the exception of North Carolina.

Long-term climate change and water access is not something that most companies – more concerned about other financial matters – are considering. However, large firms are beginning to think about the risks and costs associated with exposure to water availability. Some companies (e.g., Intel, Pfizer) have developed water strategies linked to water footprint analyses that seek to understand and quantify the total amount of water used in production of its products; some of these are as a result of shareholder pressure.

There is a growing recognition by investors that water access has and will increasingly have an impact on company performance. This has led to groups like MSCI, a company providing analysis and support tools to investors to develop a water sustainability index of companies engaged in water treatment technologies. This is designed to allow the market to reward companies that are including water solutions as part of their business. MSCI has also considered several sector specific analyses. For example, the group overlaid maps of projected water shortage areas on maps of existing power plants. The end result was a tool that provided which power plants—and therefore which power companies—were threatened by water shortages. This should theoretically add risk the stock of those companies, reducing some investors' willingness to hold the stock, selling to the market and overall decreasing the price.

Perhaps one of the largest efforts to start the conversation around water risk has been the water risk reporting process introduced by the Carbon Disclosure Project (CDP). The CDP began as a way for investors to understand the risks that large publicly traded corporations faced from carbon emissions. A not-for-profit organization, CDP has 722 institutional investors representing over $87 trillion in investment funds. About ¾ of those investors have also requested that companies disclose water risk as part of the 2013 survey. In 2012 there were 191 companies of the 318 water related that reported existing risks. Over half of these firms experienced some sort of detrimental water-related business impacts and over 71% of the companies have an awareness of supply chain risk related to water. Having companies think about water risk is the first step to getting them to act on reducing water risks and thinking about moving to areas where there is easier water access.

Throughout interviews, people readily expressed and agreed with the idea that the Hudson/Mohawk Watershed was a water-rich region and that this water resource could be used as a competitive advantage for encouraging economic development. However, a more nuanced understanding suggests that while water availability will be greater in the watershed than many other places in the United States, accessing the water in a beneficial

way presents challenges. Although the Hudson/Mohawk region has large amounts of water, the overall low value of water limits how important water access is in firm-level decision making. Water could stand as a competitive economic development asset for the Hudson/Mohawk in the future, but it will require deliberate, strategic positioning to cultivate an image of the region as a go-to place for valuable water assets and knowledge. To make water an economic development tool, the Hudson-Mohawk Watershed will need to place a higher priority on water planning, encourage conversations about water risk and begin water marketing.

Placing a higher priority on water planning is very important to ensure water access throughout the watershed. This is important to provide developers interested in moving to the region with enough flexibility on site location and to spread the benefits of water driven economic development throughout the watershed. Planning begins on the state-level with rigorous analysis of new water use data and working with federal partners such as USGS to gain a better understanding of the exact water resources in the Hudson/Mohawk Watershed. It continues to the county and local level where county economic development agencies and local officials need to think about water in a more comprehensive manner. Many times interviewees noted, water is often one of the last considerations in economic development projects. Creating local water strategic plans, which include discussions around water retention and climate change are the steps needed from local governments.

Getting large firms to think about and reduce water risk is important in helping them see how desirable it would be locate in a water-rich area. Investor activism, including the CDP, is the one existing vehicle that has helped spur leading companies to consider water issues. The New York State Common Retirement Fund (CRF) could play a role in encouraging investors to address water risk—again, one part of which is moving operations to areas where there is water-access. As the third largest pension fund in America, the CRF currently is valued at $160.4 billion. Recognizing the threat that lack of water can play in harming corporate profits and eventually fund returns, the CRF is already a signatory on the CDP water risk report. However, the Comptroller's Office, as the CRF sole trustee, could take an even more aggressive approach in getting firms to consider water risks. For example, hosting water investment conferences and sponsoring and supporting shareholder resolutions around the development of corporate water risk management policies. These are both actions the CRF has routinely undertaken around climate change and carbon emission issues. Extending that leadership to water issues will reduce water risk and encourage economic development in New York.

While many water-use firms are not yet thinking about long-term water availability, some have started the process. In pursuing new companies to locate in the Hudson/Mohawk watershed, regional economic development groups should focus on those companies that have expressed concern in water-access. While these firms still may not choose to locate in New York, there is a higher likelihood that they will favor the region compared to those firms that place more weight on the overall business climate. Beginning to market the region from a water access perspective (assuming that the local issues can be solved) puts New York on the map early on in the water resource branding race.

Development of an Upstate New York Water Cluster

Whereas water has historically been viewed as a cost to business, expanding global opportunities exist for companies supplying water solutions. Our regional neighbors have begun support for this emerging business opportunity. New York should also act on developing a water technology business ecosystem.

Water: A growing sector

Increasing urbanization, aging infrastructure and climate change have resulted in a growing recognition of the water technology sector. Water, including water treatment, efficiency, wastewater treatment and reuse and transportation of water is a major global business. According to a comprehensive report by leading firm Global Water Intelligence, the world market for water treatment technologies in 2010 was $500 billion (see Figure 1).[27] This included capital and operating expenses for water and wastewater utilities ($396bn) as well as water treatment by industrial users ($28bn).[28] Interestingly, the irrigation technology segment, which provides services and products to the largest water user, agriculture, only accounts for 2% of the market. Comparing the water market to other sectors, global semi-conductor and electronic revenues in 2012 were estimated at $713 billion[29] and US brand-name pharmaceuticals revenues in 2012 were estimated at $165 billion.[30] Annual growth in the water market is expected to average 3-5% globally with emerging markets experiencing an 8-10% annual growth rate over the next few years.[31]

A Consolidating Industry

Over the past twenty years, the water technology market has become dominated by several large firms (see Figure 1). Large water providers—those actually engaged in water delivery—such as Suez and Veolia were joined by technology supply firms like ITT (now Xylem), Siemens and GE Power & Water who entered the market and expanded through acquisitions of smaller water companies. An example of this strategy was GE's acquisition of leading membrane filtration firm Zenon. Today the top ten water firms account for over $50 billion in water related revenues.[32] These firms are joined by companies like TrojanUV, a water technology business focused on water treatment that started as a water treatment technology company and has expanded significantly through acquisitions.[33] The reason for the shift in

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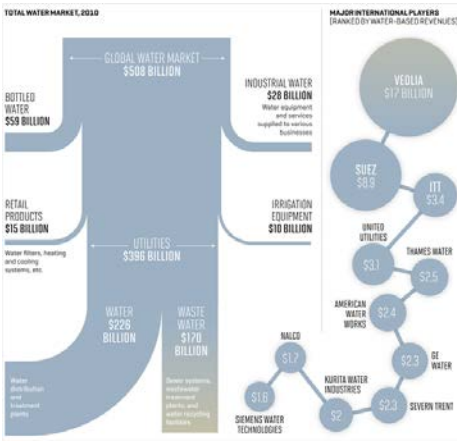
[27] Global Water Intelligence. 2010. ***Global Water Market 2011: Meeting the World's Water and Wastewater Needs Until 2016***.
[28] Ibid.
[29] ***Global Semiconductor and Electronic Parts Manufacturing***, IBISWorld Industry Report C2524-GL, August 2013
[30] ***Brand Name Pharmaceutical Manufacturing in the US***, IBISWorld Industry Report 32541a, August 2013
[31] Xylem presentation, Baird Annual Industrial Conference, November 2012, Chicago, IL accessed at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CDkQFjAC&url=http%3A%2F%2Fphx.corporate-ir.net%2FExternal.File%3Fitem%3DUGFyZW50SUQ9MTYwNTAyfENoaWxkSUQ9LTF8VHlwZT0z%26t%3D1&ei=arQ4UoCEF5TUyQGQuYGAAQ&usg=AFQjCNGnRZX07NxrwPCEOe2QLYGaJ2dJfA&sig2=MTLihfdC6UYuM8ihZ2rHeQ&bvm=bv.52164340,d.aWc
[32] Goldman Sachs, The Essentials of Investing in the Water Sector; Version 2.0, March 24, 2008 accessed at http://www.excelwater.com/2008-goldman-sachs-water-primer.pdf
[33] Water Technology Market Trends & Technology Directions of 2012, BlueTech Research Webinar. See http://www.bluetechresearch.com/webinars/water-technology-market-trends-technology-directions-of-2012-free-end-of-year-webinar/

company structure and the success of larger firms has been driven by changes in the water technology customer. Clients no longer are seeking an engineering and consulting model to a water technology supplier model but rather an off-the-shelf approach. Because water solutions are location dependent, companies that use water seek water technology companies that can provide specific technology solutions, making it critical for water technology companies to have a wide technology portfolio to provide solutions as diverse as clean water for laboratory work to sewage treatment.[34]

The water technology sector continues to evolve. ITT announced in 2011 that it would split into three separate companies with its water treatment segment becoming the firm Xylem. The rationale behind this split was that the ITT's other divisions, including defense technologies, were holding back the water segment valuations. Water was seen as such a promising market that it was believed higher returns could be garnered by splitting the company into a separate entity.[35]

Figure 1: Total Water Market & Major International Players



Source: CNN Money

While water represents an emerging market, entry and success in the field does present challenges. With much of the market being municipally or utility owned, downturns in public finance can reduce performance. Xylem for example reported lower earnings than expected in the fourth quarter of 2012 due primarily to lower spending by utilities.[36] In the most recent water technology news, Siemens is seeking to divest its water treatment technologies division citing slow utility spending rates over the past three years.[37]

A number of interviews confirmed the industry-held understanding that the low value of water represents a significant barrier in developing new water technology businesses. Lack of demand by water-use firms means less incentive for new research and development in water treatment technologies. Additionally, because such a large segment of the water technology market targets public water and wastewater infrastructure, the perceived low value of water is also a significant barrier to new technology adoption. Since much of the infrastructure in the United States was built through federal support, water utility users have never had to pay the full price for water and wastewater treatment. Utilities generally pay for less than half of their capital investments through

[34] Ibid.
[35] ITT Completes Split Into 3 Separate Companies, Bloomberg Businessweek, October 31, 2011 accessed at http://www.businessweek.com/ap/financialnews/D9QN93380.htm
[36] Xylem Inc. Reports Fourth Quarter and Full Year 2012 Results, Announces 15 percent Dividend Increase, Xylem, http://investors.xyleminc.com/phoenix.zhtml?c=247373&p=irol-newsArticle&id=1782685
[37] Don't Let History Repeat Itself, Says Ex-Siemens Manager, American Water Intelligence, http://www.americanwaterintel.com/archive/4/1/insight/dont-let-history-repeat-itself-says-ex-siemens-manager.html

operation revenue.[38] Because it has been politically unpopular, rate payers have generally not been required to pay for the true cost—including eventual replacement—of water systems. Attempts to increase fees are often met with political resistance, eventually limiting the potential pricing water technology companies can charge.[39]

However, as existing systems constructing with the help of subsidies increasingly reach the end of their useful life, rate-payers will need to become accustomed to paying higher rates as system infrastructure improvements are incorporated into monthly water bills. As Pat Mulroy from the Southern Nevada Water Authority recently noted at a water summit "the federal support that built our nation's infrastructure is gone, forever."[40] While this change may provide opportunity for water technology companies to charge more for their product, it also means less costly water technology solutions are imperative to meet ever expanding demand and may be more politically palatable.

Innovation in the Water Space

Approximately 30% percent of the water market by use is responsible for 98% of the market value.[41] Ongoing urbanization will continue to drive this demand and solutions that address water and wastewater treatment for residential and industrial uses are projected to continue to be the main focus of water innovation.[42]

From a supply perspective, solutions around water treatment must be local in focus. Transporting water is expensive and often inefficient. Technologies that can be implemented in smaller sizes will be more successful. Another area of supply innovation includes developing "water services" without water. A simple example of this is hand sanitizer. In addressing water treatment demand, a large focus is being placed on rethinking efficiency. Historical systems have been significantly engineered. Building more appropriate sized systems focused on efficiency is viewed as important in reducing treatment costs.

One of the largest specific areas of growth for water treatment is desalinization. This process of removing salts from water is increasingly being utilized to create potable water from ocean sources. Particularly for coastal regions, the solution is seen as the best way to expand supply. Desalinization is expensive, requiring large amounts of energy to remove salt from the water. Despite this limitation, desalinization capacity globally expanded 276% between 2001 and 2009 and the current market is growing by 12% per year.[43]

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[38] Global Water Intelligence. 2010. ***Global Water Market 2011: Meeting the World's Water and Wastewater Needs Until 2016***.
[39] Water Costs Gush Higher, USA Today, http://www.usatoday.com/story/money/business/2012/09/27/rising-water-rates/1595651/
[40] Quote from @jeffeger at Goldman Sachs #H2OSummit, February 9, 2013, https://twitter.com/jeffaeger
[41] Water Technology Market Trends & Technology Directions of 2012, BlueTech Research Webinar.
[42] Ibid.
[43] Desalination Has Grown 276% in 10 Years, Business Environment Network, February 18, 2013, http://www.ben-global.com/StoryView.asp?StoryID=795157382

Experts predict that the rapidly expanding shale-gas market will also drive desalinization innovation.[44] Hydraulic fracturing (fracking) is a technique that uses water to blast layers of shale deep underground. These shale formations have tiny natural gas pockets that are released through the blasting action. The blasting water is then returned to the surface. A significant concern about the fracking process is appropriate disposal of the briny water that is returned to the surface. Recognizing that this water has an environmental impact, regulators are continuously tightening water treatment requirements. It is believed that this increased regulatory pressure that will drive companies to find better desalinization solutions.[45]

Other significant areas of water technology research include biosolids removal, industrial cooling, water purification, micropollutant removal, ballast water treatment and smart water (increasing the efficiency of the existing water delivery system). Some of the leading technologies areas to address these concerns include ultra-violet treatment, advanced oxidation, membrane filtration and ceramic based filtration.[46]

Encouraging Water Technology Innovation

Given that large water technology firms have tended to grow through acquisition rather than internal research and development, innovation in the water space is originating from start-up companies involved in water treatment. With New York being home to a number of large water technology companies including the Hudson and Mohawk Valleys having the headquarters of both GE Power & Water and Xylem, the question arises about whether supporting water technology start-ups and small water technology businesses present an opportunity for economic development in New York. Given that 64% of net new jobs in the US between 1993 and 2011 were created by companies with less than 500 employees,[47] focusing on start-up and growing water technology companies may be an effective economic development strategy.

In considering how best to support water technology companies, participants at an Ontario Water Summit noted that having a supportive water "innovation ecosystem" was critical to driving innovation and providing advancement of water start-ups. In examining barriers to existing water companies, they developed a framework which identifies key areas that are needed for a robust innovation ecosystem. These areas include a connection to demand drivers, access to capital, research and development capabilities, vehicles to commercialize technology and actual entrepreneurs. Both the Ontario Water group and further interviews suggest a number of specific hurdles that limit water technology start-up activity related to each of the specific ecosystem areas. In general, again, perhaps the largest barrier for encouraging water technology firms is the low value of water.

[44] Interview with ImagineH2O personnel
[45] Ibid
[46] Water Technology Market Trends & Technology Directions of 2012, BlueTech Research Webinar
[47] Frequently Asked Questions, U.S. Small Business Administration, http://www.sba.gov/sites/default/files/FAQ_Sept_2012.pdf

Demand

The low cost of water has meant that water-use firms are only now beginning to focus on the importance of water quantity and quality. Over the long-term it is likely that the water technology market will grow significantly. Water-use firms are beginning to place a higher value on water-use solutions. This is particularly true for those projects that can be implemented in line with the firm's internal payback standards. As the value of water used as an input to a water-use company's production increases, the payback period for installation of water conservation, reuse or filtration technologies becomes shorter.

While companies are increasingly placing a higher value on water and the current $27 billion industrial and commercial water technology market seems large, the nature of existing customers provides more limited opportunities. Because water-use is spread across a wide, diverse set of industrial sectors around the world, small companies have a hard time developing a large enough customer base to sell their technologies. This is another reason why large firms, with the ability to provide solutions globally are such significant players in the sector.

For water and wastewater utilities, particularly in the United States, aging infrastructure suggests investment in replacement systems will increase dramatically. However, an overall focus on reduced government spending and taxpayer perceptions on the value of water suggest that public funding through either federal grants or increased service revenues will be harder to obtain. Since installed systems have a significant life-span, using new, innovative technologies that are less certain to last for an extended period of time may be less favored compared to existing, proven technologies. While many believe that higher levels of regulation can act as a spur for innovation, it may also hinder adoption of new technologies in creating significant risk aversion approaches by regulated utilities. For example, rather than face a consent order from a failed new technology, a wastewater treatment plant may simply install an older but less-risky technology.

Capital

Investment capital is critical to developing new water technology companies. However, the low value of water, slow adoption rates of new technologies and high cost of capital for new purchases can reduce investor interest for water technology start-ups. This is particularly true given that many investors are not familiar with the water market, which tends to achieve returns and demand exit strategies that are different than other technologies.

The result of these differences is that fewer investment dollars are currently deployed in the water sector than other Cleantech sectors. In 2010, the total amount of venture capital investment made in Cleantech firms was around $8 billion. Only 3% of these funds (approximately $257MM) was invested in water technology compared to 24% in solar and 16% in energy efficiency. Over the past 24 months the top ten investors in the water sector have made 46 investments compared to 116 investments by the top-ten investors in energy storage.

In many ways, investments in water technology start-ups are following a similar path as other Cleantech sectors. Non-profit and NGO groups such as the International Finance Corporation are leading the way

in water investments. This helps provide knowledge around the risk associated with an unknown investment space. As more knowledge and experience around water technology investments becomes available, specific water focused investment firms are being established. These firms, such as XPV in Canada play an important role. By serving as the lead investor for water technology companies, these firms use their understanding of the space to encourage and facilitate the entry of Cleantech VC firms such as Chrysalix Energy and SAIL Capital and funds with more diverse investment portfolios such as Kleiner Perkins into the space. Further enhancing the investment environment, several water firms have established investment groups, such as the Blue Orange fund set up by Suez Environment in 2010.

Research & Development/Commercialization Ventures

The water innovation ecosystem model requires a network of research and development to continually provide new ideas for commercialization. This network can include academic research institutions, private sector research and government supported research grants, centers and initiatives. In the water technology sector, an example such a network is the University of Wisconsin at Milwaukee School of Freshwater Science. Branded as the only graduate school in the United States dedicated solely to the study of freshwater issues, it is one of the foundations of the Milwaukee Water Council's efforts to become a leading region in global water technology development.

It is also important that the research being done around water also have a process to move to market. While specific technologies may be highly effective in a laboratory setting, it requires a significant amount of effort to move the technology to a product that can be sold to customers. Just as the actual technology needs a specific research infrastructure (laboratories, research funding, etc,) commercialization of a product also requires a support system. Specifically these needs include academic technology transfer offices, law firms versed in patent law as start-up specific commercial law as well as experienced accounts. Start-up companies also need an environment that encourages them to succeed. There are numerous incubator and accelerator models, including those focused on water, which seek to support entrepreneurs in their efforts. For water incubators to be successful, developing an incubator or accelerator programing needs to not just focus on supporting start-ups in general, but water technology specific firms and building a community around water.

One particular concern for water start-ups is the need for access to testing and certification processes. As mentioned above, the major value in the water technology market is the utility sector. These customers face significant regulatory burdens and must continuously guarantee a product that adheres to specific standards. For companies with new technologies that need real-world testing, it can be difficult to find real-world test sites that are both willing and the have capacity to prototype new solutions. Water entrepreneurs we spoke with suggested that even getting utilities to return phone calls was difficult. Beyond the need for real-world test sites, testing water at certified laboratories to ensure compliance with water quality standards can be burdensome.

Addressing the issue of quicker market time to market for water technologies is actually the major issue being examined by all of the newly developed water clusters. The Province of Ontario provides grants for pilot projects around new water infrastructure systems and has a testing and training facility for utility providers. Confluence, the water economic cluster in Cincinnati just completed an agreement with

the states of Ohio, Kentucky and Indiana to harmonize permits for water technology testing. In Massachusetts, SWIM is researching how Israel has developed the streamlined development process.

This barrier of real-world testing is not unique to the water technology sector. The Massachusetts Clean Energy Center constructed the first large scale wind testing facility in the United States. This facility provides companies the opportunity to perform recognized testing on the next generation of wind turbine without needing to maintain the expensive testing equipment. Here in New York, the Battery and Energy Storage Technology Consortium (NY-BEST) is constructing a new clean energy commercialization center in Rochester. The center will serve as a support center for companies involved in battery storage technology, provide access to testing equipment and allow for the production of larger scale quantities of product.

Talent/Entrepreneurs

Finally, building innovation in water requires a strong group of entrepreneurs and supporting human talent. Our conversations suggested not having enough people interested in commercializing water technologies was one of the largest challenges. The existing dearth of this group is likely caused by a number of factors. Most importantly, with water needs only recently receiving significant awareness, entrepreneurs simply haven't focused on the area. Imagine H2O, a nonprofit focused on water start-up development, is leading this effort through by providing business plans for start-ups and leading water entrepreneur training sessions at universities around the United States.

Many of the barriers discussed above including lack of investors, slow adoption rates and limited commercialization support, as well as the potential limited returns due to the current low value of water also discourage those interested in water technologies. Reducing or eliminating these barriers would help pull more entrepreneurs into the sector. These entrepreneurs would eventually fill the broader community by providing examples of successful commercialization, mentoring new entrepreneurs entering the space, taking their knowledge to investment firms and enhancing the water-technology start-up infrastructure.

Having an existing strong water technology community, even if it is not initially focused on start-ups, also encourages entrepreneurs. A recent survey by WaterTAP Ontario discovered that over forty CEOs of water technology firms in the province of Ontario had a career connection with Zenon or Trojan, the two pillar companies in the region. By creating a more supportive atmosphere for water technology start-ups, an ecosystem could use existing human knowledge and experience in water technology to develop new entrepreneurs. This is including an entrepreneur development program, such as those that incubators often offer is important to encourage water entrepreneurs.

Other Water Clusters

As noted above, recognition of water as an important resource has started to permeate firms that utilize significant amounts of water. This has led to a growing awareness of both the need to focus on water risks as well as the market that exists for water treatment technologies. While nascent, efforts such as the Carbon Disclosure Project water risk reports, are working as catalysts to find water risk reduction

solutions. As part of the overall growing awareness of firms about resource use, a number of water focused investment indices have been developed. Having large investors discussing water has further encouraged venture capital investors to being an understanding of and move into the water space. This same realization, that water technology is a business, has also started to enter the perspective of economic development professionals and policy makers and they sought to encourage water-technology companies through the development of water clusters.

Research has found that "clusters," or groups of closely related and complementary industries within a specific geographic region are better for overall economic growth. These clusters result in higher employment growth and growth in wages as well as an increase in the number of firms and patents within an industrial sector compared to non-cluster located firms. Generally, in order for these benefits to occur, an existing diversity of companies within a sector needs to be present. In other words, regions should build on sectors where they already have strengths, not try to start a new cluster. Investing in industries where the region has little existing knowledge or resources is less effective than focusing on building connections between different, related sectors that already exist in the region. The literature suggests that having "specialized institutions" that perform tasks such as training and that facilitate the development of an industry ecosystem and infrastructure can encourage the benefits of a cluster.

One additional recent finding around cluster economic development is that clusters do not necessarily adhere to political boundaries. This suggests that policies integrating efforts across multiple political designations, including states, can help improve the benefits of an industry cluster.

There are a number of existing water technology cluster. The nations of Singapore and Israel are very focused on water technology commercialization. In North America, a number of water clusters have been founded to encourage water technology companies. The most developed of these clusters include the Milwaukee Water Council, Confluence located in the Cincinnati and Dayton Ohio area, the Province of Ontario in Canada and SWIM, the Massachusetts water innovation initiative. In addition, non-profit ImagineH2O and projects such as the Artemus Top 50 are supporting the water technology ecosystem by creating networks, hosting business plan competitions and developing specific education programs for water entrepreneurs.

In examining the currently established water clusters, many of them mirrored the need for existing strengths by focused on their existing water technology companies. Both Israel and Singapore face significant water supply issues that have forced them to think about water technology and efficiency. Since water does not share borders, both countries have a historical focus on decreasing water dependence. For Israel this has included significant investment in desalinization technology. For Singapore, which seeks to reduce the water it imports from Malaysia from 50% of its current supply to zero by 2061, this means increasing storage and water efficiency.

While North America also has region facing significant water supply challenges, the existing North American water clusters are generally not located in areas where water supply is a concern. Rather, the North American clusters have developed as a result of historical strengths in manufacturing (Milwaulkee's beer brewing for example) that required water quality investments as a result of

increased regulation. The existing water technology firms in the cluster regions developed as a way to meet the local needs of water use companies. The disperse and diverse nature of water-use firms explains why there are a number of regions that have historical strengths in water technologies. In these regions, the initial value from having conversations about starting a cluster is an actually recognition of the existing strength of the water technology sector. For each of the emerging water clusters, studies identifying possible regional clusters have "discovered" a strong water sector. For example the Milwaukee regional economic development council identified the concentration of water businesses while the Confluence initiative began from an Environmental Protection Agency and Small Business Administration cluster identification exercise.

Regardless of who authors the initial study, in each case, the success of the water cluster has occurred because both government and private sector support drives the effort. For example, while the Massachusetts initiative is led and strongly supported by the Commonwealth government, the second annual symposium is being spearheaded by industry leaders.

Each of the water technology clusters has also followed a similar establishment strategy. The first steps are often identifying existing water technology firms or mapping regional assets. This exercise attempts to get to the first question or whether the region really has strength in water technology. This process also involves engaging the sector and getting the buy-in of existing water technology companies for a more formal relationship between existing water technology firms. This mapping process relates directly to the to the Ontario ecosystem ecosystem model by identifing the water community that will then be served and enhanced by efforts around the major forces of the ecosystem: R&D, commercialization, funding and increasing demand.

While each cluster has gained significant momentum, most have also been tasked with finding a long-term, non-government mechanism to fund their programming. This is perhaps the largest challenge facing the creation of a water cluster program. Because each of the existing clusters is relatively new, no group has developed a sustainable plan to date and each continues to explore new revenue streams.

Interviews and press articles provided details on each of the North American clusters and water programs.

Imagine H2O

Established in 2007, Imagine H2O is a non-profit that is leading efforts to support emerging water technology start-ups. Focused on building the water technology start-up community, the organization sponsors an accelerator program which assists winners of the annual Imagine H2O business plan competition. The contest, in existence since 2009, has received over 200 entries and provided support to more than 30 winning companies. Imagine H2O also partners with universities to lead campus workshops around the business of water and sponsors internships with water technology firms. The group envisions fundraising and water policy as two of their ongoing focus areas.

Milwukee Water Council

The Milwaukee Water Council is the oldest of the formal North American water clusters. The initiative began in 2005 when a regional economic development organization, the Milwaukee 7, began an

examination of regional economic strengths. An initial inventory completed as part of the process identified over 50 existing companies focused on water technology including five of the top eleven water firms. Firms such as A.O. Smith water heaters and Badger water meters are headquartered in the region and other large firms have a significant presence. This concentration had not been recognized previously, even by large consulting firms, because companies involved with water cross numerous industrial sector codes. Since the initial inventory, further efforts have revealed at least 130 companies in the seven counties surrounding Milwaukee and almost 300 companies across the state engaged in the business of water. This sector development likely occurred due to Milwaukee's historical strength in intensive manufacturing and brewing and the need for water treatment solutions for those sectors. The evolution of the strength was further enhanced as a result of water use firms needing to meet Clean Water Act requirements.

Water cluster development in Milwaukee has been driven by the private sector with executives from leading companies pushing for network development. In 2007, A.O. Smith and Badger hosted a water symposium to start the cluster initiative and in 2008, Milwaukee 7 established a full-time water focused position. The funds utilized for this position were from a federal economic development grant. The effort grew and has transitioned into the Milwaukee Water Council.

Efforts of the Council have included annual water symposiums, hosting international delegations and engaging state leaders to support the establishment of a graduate School of Freshwater Sciences in Milwaukee, the first program of its kind in the nation. Connecting industry with academia is a major goal of the Council in order to attract more research funds and commercialize new technologies. In 2009, the United Nation's designated Milwaukee a Global Compact City based on its work around water, further expanding the city's presence in the water world.

The core objectives for the Water Council include attracting water talent to the area and working with water technology start-ups. In July 2013, the Council will open its new $80 million International Water Technology Center. This facility will serve as a central location for water research, existing companies and will have a water accelerator program for start-up companies. The Center will also serve as a key component for Milwaukee's new water technology research park. An area for further Center expansion includes a focus on water policy. The Center is also expanding geographically to include Chicago and will be announcing a major initiative in the near future to expand the geographic scope of the Council to more arid zones.

The largest challenge facing the Council includes maintaining a defined organizational scope. Given the breadth of issues involving water, the Council focuses on maintaining its core mission of economic development in the Milwaukee Region. Ongoing financial support also is an issue for the Council. While grants, foundations and supporting companies have been very generous, a longer-term strategy is needed.

WaterTAP Ontario

In response to the global financial crisis, the Provincial Government of Ontario announced the Open Ontario Plan in early 2010. The plan placed specific emphasis on sectors including water, as well as food

processing and chromite mining. This emphasis came from a realization that Ontario had a strong water sector which employs 22,000 people and includes leading firms such as Xenon and Trojan Technologies (again from which over 40 water CEOs have been traced). Despite being arguably one of the top three water sectors (along with Singapore and Israel), the sector lacked connection. The Government also recognized that despite the Ontario water sector being one of the global leaders in water, there was no central leadership around the water sector.

The water sector in Ontario had developed as a result of historical manufacturing strength, as well as aggressive environmental regulation. Most recently, drinking water protection gained attention from the public following the contamination of drinking water supplies in Walkerton, Ontario. Over 2,300 people (about ½ the town) were sickened and seven people died as a result of E. coil 0157:H7 and Campylobacter jejuni entering the system. A judicial report found a number of areas that needed to be improved in drinking water oversight. This lead to a focus on improving drinking water standards including implementation of the 121 recommendations made by judicial report. One of those recommendations was the establishment of the Walkerton Clean Water Centre. The Centre serves as a training facility for water treatment operators as well host seminars and conduct research. The Centre was established in 2004 and was funded with at least CA$30 million.

Following the announcement of Open Ontario, the Provincial Government dedicated significant attention to the water sector. In May 2010 the Ontario Premier met with Israeli President Peres to discuss better connections around life sciences and clean water technology and in June 2010 spoke at the first annual Canadian Water Summit in Toronto. Provincial support for the water sector was formalized in November 2010 with the passage of the Ontario Water Opportunities and Conversation Act. The Act established the Water Technology Accelerator Program (WaterTAP).

The act also places a priority on water and water innovation. It requires municipalities to create water sustainability plans, creates household water efficiency standards and standardizes water reporting bills. The act provides significant funding for improving small public water systems, showcasing new water treatment technologies and assisting in technology commercialization.

WaterTAP is a quasi-governmental organization (formally defined as a non-crown corporation). While it is a non-profit, it is formally recognized in statute and is accountable to the Ontario Ministry of Economic Development and Innovation. Governing the organization is a Board of Directors. The Board, originally appointed through a public appointment process includes experts in sector development, public water leaders and water technology companies.

This unique governance structure has been one of the challenges in getting the organization started. It has required time for the organization to have a board appointed, draft by-laws and build the network. One again, given the breadth of issues related to water, the key in setting up a water cluster is to maintain a narrow scope and definition as well as performance expectations.

The goal of WaterTAP is to serve as Ontario's "water champion." The organization has focused on identifying the water assets in Ontario. This has resulted in a 700 page water asset map identifying 300 companies directly involved in water and over 900 companies with some connection to the water

industry. One finding of this process has been that lots of work is being done with water, it simply has not been communicated.

Moving forward the organization will be seeking to better understand the major drivers for the existing sector and how investment can be made in solutions for these issues. Major focus areas include the biogas sector, nutrient recovery, pipeline inspection and smart technologies.

WaterTAP received $5MM in seed funding from the Province of Ontario as part of the Water Opportunities Act. The organization is charged with being self-sufficient after three years and developing a strategy to fulfill this requirement is the major focus of the organization at this point.

Confluence

Over the past 2 years, Cincinnati has served as the hub for Confluence, a water cluster located along the Ohio River. The effort began through a project by the US Environmental Protection Agency and Small Business Administration to identify potential environmentally focused economic clusters. The two agencies focused on Cincinnati because it is the location of EPA Region III's water analytics lab. They received significant buy-in for the concept from business leaders, academia and private firms during stakeholder outreach meetings and further analysis suggested that the region had a number of assets that would support a water cluster.

A broad group or organizations including utilities, research institutions and private companies such as Proctor & Gamble, GE and Xylem supported the initial proposal which was formally announced on January 2012. At that point, the organization had a Board of Directors that had been appointed and that had provided funding for the new organization. The organization is currently waiting for confirmation of 501(c)3 status with future funding anticipated from membership fees, grants and other sources.

An initial focus of Confluence is to reduce the estimated 12 to 14 years it takes for a water technology to go from the lab to commercialization. The organization just facilitated the development of a memorandum of understanding between Ohio, Kentucky and Indiana that harmonizes test bed and approval requirements for new technologies. The idea is for firms with new technologies to have greater market access. Other working groups at Confluence focus on public policy barriers to water businesses, business development and firm support efforts as well as partnership expansion. The organization is putting together workshops including topics on water reuse, emerging markets and intellectual property management. A major effort of the group is to help get the story out and maintain the conversation about water companies.

Future efforts of Confluence include establishing a stable source of funding, identifying specific global needs around water and increasing relationships in the region and globally.

SWIM

In March 2011, Massachusetts Governor Deval Patrick traveled on a trade mission to Israel. In one of the trip meetings, the chairman of the Israeli Water Authority noted that Massachusetts had a very strong water industry that lacked coordination. He also noted that having a focus on water would create incentives for the location international water companies in the United States.

Encouraged by this conversation, the Governor and members of the trade-mission began examining the possibility of a water cluster in Massachusetts. With support from members of the clean-tech sector, the state hosted the Symposium on Water Innovation in Massachusetts (SWIM) in May 2012. This session brought together 150 CEOs from water firms to examine successful clusters and the possibility of a Massachusetts water cluster. Following this meeting, David Goodtree, an engaged member of the business community, presented the case for a Massachusetts water cluster at a TEDx Talk. This discussion concluded that Massachusetts had a significant number of water related patents and water focused research funds. Additionally SWIM resulted in a water asset map which identified over 200 companies in Massachusetts involved in water.

In December 2012, the SWIM group, which also includes the Massachusetts Clean Energy Center (MassCEC), held a trade-mission to Israel. The mission included 47 members of the Massachusetts water community visiting with leading Israeli water firms and organizations.

While the Governor's Office and volunteers have provided the momentum and organization for SWIM to date, the MassCEC is now moving forward with a full time Business Development Manager position to coordinate and build the water cluster.

The organization also seeks to expand a focus on research by bridging the gap with the life science community and large number of venture capital firms located in Boston. To encourage water entrepreneurs to start companies and remain in Massachusetts, efforts are also being made to encourage the water technology start-up community. For example, MIT recently began a water club and Babson College is a partner with Imagine H2O.

Other major issues identified for improvement by SWIM are creating mechanisms to pilot new technologies, providing water analytics and analysis for new firms and getting support from water utilities.

Efforts are also being made to include water focused firms in Innovate Mass funds and the new MIIP program as well which combines supports joint research between Massachusetts and Israeli companies.

A New York Water Cluster

The significant market size and potential global growth of the water technology sector presents a business development opportunity. Given that several of the regional economics boarding New York State are supporting water technology clusters, it makes sense for New York, specifically the Hudson and Mohawk Valleys, to evaluate whether water technology, delivery and service should be an area in which government and business encourage further investment. Our evaluation suggests that there enough existing resources to warrant a further, more in-depth analysis.

As discussed previously, the water technology ecosystem depends heavily on basic research and development to drive advances in understanding and new technologies for commercialization. Within the Hudson and Mohawk Valleys there is a significant research base. The lower Hudson Valley (Poughkeepsie/Newburgh and Middletown) has the 6th highest patent rate per capita according to the

Brookings Institution. Albany has been ranked 18th nationally for patents per capita and according to Forbes Magazine is the 15th most innovative city in the United States. For water innovation, the strong science and engineering research capabilities of Rensselaer Polytechnic Institute and SUNY Albany form a foundation for water technology development. Given that ultra-violet treatment is one of the major focus areas for water treatment technologies, Rensselaer's Lighting Research Center is well positioned to develop advances in treatment. For example, Crystal IS, a Green Island based firm, commercialized Rensselaer developed next generation UV technology which will reduce energy and costs to specific sized water treatment sites. While not specifically located in the Hudson Valley, Rensselaer's Darrin Fresh Water Institute provides specific training in freshwater ecology and microbiology.

Across the Hudson River from Rensselaer, SUNY Albany's lauded College of Nanoscale Science & Engineering presents the opportunity to find more cost effective water treatment options. Nanofiltration for example could improve existing filtration processes by removing both heavy metals and organic contaminants from water.

The strength of the Hudson Mohawk's research goes beyond academic institutions. The Air Force Research Lab, located in Rome at the former Griffiss Air Force Base, is one of six Air Force Research Labs across the country. Each of these labs specializes in a specific field. For example, the one in Dayton, Ohio, which the Confluence Water Cluster considers an asset, works on power systems and radar research. The Rome site is heavily focused on information technology and cyber-security. This focus is an excellent match for the water sector. With a rising focus on using large data sources to drive "Smart Water" initiatives, research focused on secure data analysis and usage will be an important component for successful water efficiency efforts. Beyond efficiency, there is a growing awareness of the need to protect water systems from cyber-threats. Water was actually the first infrastructure related service where cyber-attacks resulted in physical damage. In 2000 a computer-hacker released 800,000 liters of raw waste in Australia. Other cases, such as a 2006 malware infection at a water treatment plant in Pennsylvania and a 2012 incident where a California water system was compromised by hackers in a few hours, demonstrate how vulnerable current water systems are to cyber-attacks and why research strength in cyber-security could help spur new cyber-security products.

Private firm research investment is also important to consider. GE's Global Research Headquarters is located in Niskayuna. With a significant market presence in the water sector, GE is currently working on desalinization technology to cut costs 50% by 2020. They are also working on other processing and purification products for use in the oil and gas industries. Further down the Hudson River, IBM with its headquarters and research labs in Armonk, NY is leading the conversation about "Smart Cities" and real time data usage. The company has already made an impact on the Hudson and Mohawk Watersheds with its real-time monitoring pilot with the Beacon Institute.

Recognizing that, as noted above, clusters do not necessarily stop at political or even geographic borders such as watersheds, New York's strong research climate creates a healthy environment for basic water technology. Rochester was ranked 13th in patents per capita by the Brookings Institute and as the 14th most innovative city by Forbes. Ithaca has the 19th highest ratio in that nation for patents per capita. This overall innovation climate compliments numerous water specific programs across the state. Indeed

every area of New York has an academic connection to water. A sampling of these programs includes the Center for Membrane Technologies at Clarkson University, graduate studies in water resources engineering at the SUNY School of Environmental Forestry, the nationally ranked School of Marine and Atmospheric Sciences at SUNY Stony Brook, the Great Lakes Program at SUNY Buffalo and the Columbia Water Center at Columbia University. Cornell University's partnership with Israel's Technion Institute at the University's recently announced New York City Technology Campus creates connections to Israel's leading water research institute.

Clusters also seek to incorporate the knowledge and resources of additional regional strengths. For New York, the NYSTAR program provides support for applied commercialization research through specifically designated Centers for Excellence and Centers for Advanced Technologies. While these centers are not water specific, they focus on specific technology areas which are associated with water solutions. Some of the centers directly related to water include the Center for future energy systems at Rensselaer and Cornell, the Center for Advanced Ceramic Technology at Alfred and the Center for Excellence in Syracuse focused on sustainable buildings and human environment.

Other critical aspects for building a successful water technology ecosystem include demand and commercialization support. Our conversations suggest that for water clusters to be successful, not only must they have support from local water businesses and government, but water customers must also support the effort. For the Hudson and Mohawk Valleys, these customers include water suppliers. Because of quality issues related to pulling from a surface water supply, the Mohawk Valley Water Authority recently installed a new expensive carbon filtration process that increases its maintenance costs by over $1MM per year. In the lower Hudson Valley, United Water is currently proposing a $145 MM desalinization plant. Building the number and strength of water treatment and technology firms would help keep these sorts of expenditures in the Hudson Mohawk region, encouraging local employment.

While utilities form an important customer group for water technology companies, industrial users are also needed to drive local demand for water technologies. For the Hudson and Mohawk Valleys, focusing on water solutions would actually provide additional support for the region's major industries. In the lower Hudson Valley, the biotechnology and pharmaceutical sector use significant water, with water representing the largest ingredient in almost every drug produced. The semiconductor and nanotechnology industries, a focus of the Capital District, need water for their manufacturing processes. For example, one type of chip needs to be washed one thousand times during the manufacturing process. As noted previously, these plants require access to large amounts of high quality water. In the lower Mohawk Valley, the growing number of food and beverage processing facilities, including Beech-Nut and Fage yogurt, require ample water supplies.

Beyond the watershed boundaries, there are several significant demand drivers of water technology. New York City's water and wastewater system are highly innovative. Having recently been recognized by Global Water Intelligence for efforts to reduce system costs, the City's efforts to ensure clean water are considered leading by many in the water technology space. This drive by New York City to remain innovative is a positive market signal for local water technology companies.

The presence of shale-gas, particularly in New York's Southern Tier, also increases the demand for new water technologies. Gas companies need new solutions to address the briny wastewater that results from hydraulic fracturing. Given that increasing regulation makes proper wastewater management essential for gas-company daily operations, industry experts believe that demand from the natural gas industry will create significant momentum in finding desalinization and new water treatment solutions. Two New York companies, Sabre Energy Services in Slingerlands and Advanced Waste & Water Technology on Long Island are already providing water treatment services to gas drilling sites across the country.

A network to move new technologies from the research phase to commercialization and eventually meeting demand is critical. The major research institutions within the Hudson and Mohawk Watersheds, including SUNY Albany, Rensselaer and the Griffiths Air Force Lab have technology transfer offices and partners. These organizations however have responsibilities to develop their partner institution's full portfolio, not just those inventions related to water. This suggests the need for an additional support structure to focus on marketing water technologies developed by these institutions to potential entrepreneurs or existing water technology companies. A water cluster, in partnership with the existing technology transfer offices and Governor Cuomo's recently announced innovation network would help bring attention to possible water technologies.

Once again, the major issue in preventing the adoption of new technologies that has been identified by many of the water clusters is the need for a streamlined approval and adoption process. Water technology entrepreneurs that we spoke with agreed that getting utilities engaged in testing a new product is very difficult. Finding solutions to this issue, given the low acceptance of risk by utilities, remains elusive. As noted throughout the report, efforts including shared, multi-jurisdiction standards, test beds and grants for new demonstration projects are all examples of ongoing, but unproven, efforts to address this challenge. In New York, the strong engineering capacity of the DEC, funding capacity and infrastructure expertise of the Environmental Facilities Corporation and the innovative focus of the New York City Department of Environmental Protection creates a foundation for new capabilities. One idea, presented to us through an interview, is the creation of a Technical Review Team at EFC to evaluate and judge new technologies that municipalities can use when designing new or replacing existing systems.

Financing for water technology firms is also important to spur company development. Once again, New York does have existing resources. The Eastern New York Angels provide pre-seed and seed stage financing for firms in the Capital District and there are a number of investment firms in the Hudson and Mohawk Watershed. Programs such as the Innovate NY Funds announced last year provide venture capital firms incentive to invest in New York based companies and the new proposed Innovation network will create a $50MM venture capital fund for seed stage companies. This will complement the existing small business investment fund for established companies run by Empire State Development. While these resources exist, there is an ongoing challenge that these investors may not have experience in the water sector. An organization that could facilitate conversation between existing water technology investors, such as XPV and existing New York focused sources of investment funds would encourage more water technology investment.

Most important to the success of developing a water cluster is engaging people with expertise and entrepreneurial vision. Again, in Ontario, a significant number of executives at new water start-ups had prior experience working in larger water companies. The Hudson and Mohawk are home to significant players in the water space, along with companies such as Sabre and IBM, Xylem and GE Power & Water are headquartered near the watershed. SABIC, a plastic company also has a manufacturing presence and development shop in the Capital District and filtration leader Pall is based in New York. The large number of executives and researchers involved in water technology would suggest an incredible base of knowledge in water technology. Finding a way to help individuals pursue entrepreneurial activities would better leverage this capacity.

For entrepreneurs, having a specific lifestyle is also important. This includes support for their work which New York can provide through and an extensive variety of incubators. It also however includes a high quality of life. Our next project will examine how water can be used to encourage a better quality of life for residents of the region, including entrepreneurs.

A final note on building a New York water ecosystem is the geographic location of the state in comparison to other existing water clusters. Buffalo boarders the Province of Ontario and is a Great Lakes City like Milwaukee, while Albany is only a three hour drive from Boston. The central location of New York's water resources suggests that the creation of a water ecosystem should not be done in isolation but, rather, should incorporate existing efforts outside of the political boundaries. This will allow a more rapid, efficient development of a New York water ecosystem.

Given that New York has a strong existing network of water companies, significant research and development capabilities that are focused on water, emerging water technology demands, a base technology commercialization capacity and a base of investors, creating a New York water technology business ecosystem warrants further investigation and action. **This includes developing a water technology inventory, gauging existing industry support and bringing stakeholders together to develop a strategic vision and work plan.**

The initial step taken by existing water clusters has been the development of a water technology business asset inventory. This inventory, or map, is designed to identify all of the existing stakeholders in the water technology space. Included in this exercise are existing water companies, both established and start-up, water service providers, firms and groups that support water businesses and start-ups such as legal and accounting, funding organizations and investors and water research and education programs. Additionally, some inventories, such as the one performed by SWIM, have reviewed the existing state of water intellectual property around water within their respective region.

Moving concurrently with the development of a water inventory, efforts need to be made to engage existing water businesses and begin a conversation about water technology business development. As noted above, the success of a water hub depends on having industry support for the initiative. Initial dialogue with various water business stakeholders will help build a more accurate inventory and will also provide feedback on interest within the industry to pursue improved networking and sector

collaboration. If both the inventory and industry buy-in are sufficient, the next step is to bring the stakeholders together.

A major finding of the existing water clusters is that while each region had an existing significant water technology sector, there was little communication between and among the companies. For that reason, many of the clusters hosted an event to jumpstart the conversation around building a water technology community. These symposiums or conferences are designed to create an initial network among water technology firms and the program usually identifies both how existing clusters operate as well as defining next steps and barriers for building water technology businesses.

Having established support for a water ecosystem, an organizational steering committee is needed to maintain momentum and ensure that the work plan is established and completed. This will include everything from securing funding to actually implementing programing for each of the parts of the ecosystem.

Water as an Economic Catalyst

Shipping, boating and fishing are all examples of these types of businesses and are some of the most historic economic uses of the Hudson and Mohawk Rivers. Henry Hudson, the person who the Hudson River is named after, was searching for a better commercial route to Asia when he is credited with the European discovery of the river. The Erie Canal served as a major economic artery to move freight and people between the settled east coast and the expanding western frontier. “River drives” in the upper Hudson watershed remained the most widely used way to transport timber from the Adirondacks until the 1950s.

Today water as a catalyst continues to be a major economic driver in the Hudson and Mohawk Watershed. One part of the broader project that sponsored this report specifically explored how the Port of Albany, with its significantly expanded freight shipping, can be made more sustainable. The New York State Canal system is expecting more than 100,000 tons of fright shipped through New York’s waterways this year. That’s up from 10,000 tons per year only several years ago. In the Schoharie Creek, the New York Power Authority’s Blenheim-Gilboa Pumped Storage plant has over 1,100 megawatts of water based electrical generation capacity that provides low-cost power to municipalities and business across New York State.

Perhaps the largest use of the Hudson/Mohawk water resources as an economic development catalyst comes in the form of tourism and recreation. This report begins a conversation on how water tourism can drive economic development and recommends further study. Tourism provides significant economic activity in the Hudson and Mohawk Watershed. From the estimated annual $14.6MM in direct spending associated with visits to the new Walkway Over the Hudson to the annual $3MM economic impact from the various rowing regattas hosted by the Saratoga Rowing Association to the estimated annual $378MM economic impact of tourism on the New York State Canal system, people enjoy spending time on and near the water in the Hudson and Mohawk Watersheds.

Expanding both tourism and recreational activities in the watershed impacts economic develop in two ways. The first is to pull revenues into the region from non-local visitors. These expenditures are then used to spur further development within the region in the form of purchased services and wages. The second way water activities impact economic development is to supplement the quality of life for local citizens and in doing so, help encourage more water-use businesses to locate in the region and more entrepreneurs to start water technology (or other) companies.

In the Mohawk Valley, tourism provides over $1.34 billion in annual visitor spending to the local economy and is the third largest generator of employment. In the Upper Hudson/Capital District tourism provides $2.1 billion annually in revenue while supporting 3,500 business and 15,000 direct jobs. In the Hudson Valley, spending by visitors to the region runs about $3 billion annually and employs some 55,000 direct jobs. Water plays an important role in these tourism activities. Certainly, it supports business and attractions that are classified as water-use, such as the breweries along the Mohawk Valley, golf courses at places such as Turning Stone Casino or more basically in providing basic restrooms and facilities to attractions throughout the region.

More importantly, water is a critical catalyst for many tourism activities. Beyond its role in watershed scenic attractions (Walkway Park), sport (rowing) and personal boating (Canal System), other examples include of water recreation include Tubing down the Esopus, riding the Lil' Diamond III tour boat in Herkimer and skiing the slopes of Gore Mountain (which uses water from the Hudson for snowmaking) to name a few.

An initial review of water tourism within the Hudson/Mohawk Watershed suggests that water-tourism firms must contend with many of the same environmental issues and business climate barriers that both water-use and water-technology firms face.

Given their dependence on clean, usable water, a significant barrier to growth is ongoing water quality degradation. As discussed in our initial resource review, throughout the Hudson and Mohawk Watersheds, water quality issues limit the use of the resource. A ban on eating many types of fish from the lower Hudson due to contamination for example likely limits the number of companies involved in providing fishing supplies, lodging and food to anglers. A similar situation exists in parts of the Mohawk River and lakes in the Adirondacks. Even if poor water quality is no longer an issue in some parts of the watershed, legacy perceptions—similar to those discussed in the initial review—remain. People may have a perception that a body of water is of poor quality and limit their use of it, even if poor water quality is no longer an issue.

Another large environmental issue faced by water-tourism companies is climate change. Just as climate change may attract water-use businesses to the region over the long-term, it also may serve as an impetus for out-of-region boaters, anglers and other water recreation users to visit the Hudson/Mohawk Watersheds. However, just as there ultimately is limited carrying-capacity for water-use companies in the watershed, there is a finite limit on the number of anglers that can use a lake, boats that can be moored and people that can fit on a ski slope without significantly reducing the quality of the experience.

It's not just additional people that may hinder enjoyment of the water resources, climate change will also affect tourism experiences. Larger, more intense rainstorms create flooding. Over the past few years, the Erie Canal has been closed multiple times due to floods. This not only limits the amount of money boaters spend at businesses along the Canal but also means added clean-up costs for those businesses, such as restaurants and hotels, along the canal. As noted in the water-use section, reevaluating flood plains as a result of recent floods also creates new limits on the lands that can be developed into tourism business sites and increases complexity of waterfront revitalization projects. Finally, one additional recognized consequence from climate change to the watershed is more limited winter recreation activities. With models predicting more mild winters, the watershed may see a decrease in the availability of winter activities that use water, such as ski slopes or snowmobile trails. This is of particular concern not just in attracting out-of-watershed revenue from visitors but also in the way it impacts the quality of life for local entrepreneurs. Availability of winter activities has already been recognized, for example, as regional weakness by the Mohawk Valley Regional Economic Development Plan process.

From a business climate perspective, New York's generally unfavorable business environment hinders not just large water-use companies from moving here but also discourages the establishment of smaller water-tourism (and other sector) companies. Some of the negative rating of New York's business climate is often attributed to stringent environmental regulations. The Mighty Water Task Force noted that increased invasive species regulation, limited dredging and barriers to brownfield redevelopment (remediation and reuse of previously developed and possibly contaminated sites) all hinder development of new businesses that use the Hudson and Mohawk Rivers. Environmental regulation therefore creates a paradox, in that for some areas of the watershed more is likely needed, while a different system is needed in other areas to better encourage economic development while still protecting water quality.

Another major issue that water-tourism businesses face is dealing with New York's home-rule governance structure and the significant level of multi-municipality oversight it creates. Just as with water use companies—if not more so—firms wishing to create businesses around water recreation and use often have a myriad of local, state and federal agencies that they need to work with to implement water based projects. With the Hudson and Mohawk Rivers serving as the political boundaries for many counties, villages and towns, this creates an even larger number of political jurisdictions. On a practical level, this includes everything from the number of agencies (and time) that is needed to approve building permits to the number of police jurisdictions with authority to enforce water activities.

The multitude of municipalities and historical focus on local economic development efforts (as opposed to a regional approach) also has created a system where there is little incentive for communities to work together. One community we learned of, for example, maintains a public marina where boats can dock, however boaters, once docked, will cross the bridge into the next village to purchase needed items. This provides no additional revenue for the marina community who bears the maintenance costs. The traditional approach to home-rule independence means cooperative agreements or shared-service agreements are not considered as default approaches, but rather unique occurrences.

Since communities often undertake local waterfront redevelopment plans independent of other localities in the region, there are questions of over-supply of services such as boat marinas. While increasing overall use of the river and canal system helps address this issue, expanding without consideration of the overall demand limits the immediate potential of waterfront development projects and may limit the profitability of existing private marinas and service providers.

Local efforts may additionally be so diffuse in nature, that they don't serve as effective economic development tools. This is particularly an issue when localities seek to implement a development approach that doesn't match the existing environment. Just as some areas of the Hudson/Mohawk watershed are not well suited for certain types of water-use companies, some areas of the watershed will not be able to provide support for water-tourism activities. For example, certain types of existing infrastructure, such as the Thruway, ports, railroads or water-catalyst firms that have water-side sites may limit where marinas can be located both technically and aesthetically.

Given that water-tourism firms are often small businesses they also face many similar challenges as water technology firms. In many ways, our conversations suggest that just as existing water-technology companies have relatively weak connections with little overall industry coordination (creating an opportunity for cluster development), the water-tourism industry, particularly along the Hudson and Mohawk Rivers, could improve coordination efforts and establish a better water-tourism ecosystem.

The lessons learned from the existing water-technology clusters provide some guidance on how to begin a water-tourism focus. This first step would be a more in-depth evaluation of the types of water-tourism that exist in the watershed and overall market opportunities around water-tourism. Given that the rivers and canals are such a driving force throughout the watershed, they should serve as the foundation of this evaluation. It appears from the initial research that while some efforts have been made to quantify the economic impact of water recreation, specifically boating, to the Canal system, little analysis has been done on the total potential economic capacity of water tourism along the Hudson and Mohawk Rivers. The most recent report attempting to quantify economic development from tourists in the canal system, undertaken by Mower & Associates in 2008, suggests that out of state parties spent $756 per trip along the Canal System. For comparison, on the Rideau Canal System in Canada, non-regional boaters spent an average of $2,396 per boat per trip in 2011—more than three times as much when evaluated in comparison with New York canals. While these numbers cannot likely be directly compared because of different methodologies, it is clear that more insight is needed about Canal System users.

Additional knowledge is important to understand how users spend money along the Canal. However, it is also important to understand how to add additional value to a canal system users' trip and in doing so, obtain additional revenue. This "voice-of-customer" approach means not just surveying Canal users about the money they spent on a trip but also what they would have spent money on if it was available and what additional services would make the trip more enjoyable. This analysis includes examining groups of users that may not have utilized the Canal in the past to understand the barriers that need to be removed to encourage increased user numbers. Some specific conversations from the interviews suggested that small boats and day trips were a non-traditional area for user expansion, while issues

such as lack of hotel room locations near the Canal system and lack of fuel availability were significant "pain-points" or areas of discontent for users.

Having a comprehensive understanding of the market is critical for an overall marketing effort by the region. The 2007 Mower report notes that total Canal System visitors dropped by 40% between 2002 (the last year the state provided a large marketing campaign) and 2007. While additional work is needed to determine causation of Canal System marketing to overall visitor number, it is likely that spending on marketing would increase Canal traffic. Of course, one of the challenges of developing a system-wide marketing effort and water-tourism ecosystem within the Hudson Mohawk Watershed and New York State in general is the very diverse nature of the water-tourism sector and sheer size of the Canal System. While the Rideau Canal system is 126 miles long, the NYS Canal System is over 524 miles long. This means a local water-front arts festival in Newburgh has very little connection to the water-front restaurant in Little Falls or the crew regatta on the canal in Pittsford. While all certainly would benefit from an overall increase in the number of people using the river and canal, building a strong network between the groups would likely be difficult and provide limited immediate value.

One solution to this challenge might be the establishment of several smaller regional marketing efforts. This is a model used by the Grand Union Canal in the United Kingdom where regional groups focus on strategic planning for a small part of the canal. While the overall canal is over 200 miles long, the region of Leicestershire put together a strategic plan focused on the 23 mile portion of canal that runs through the community. This approach of a regional plan would seem to address the myopic approach of individual locality planning but still provide enough tangibility for individual businesses, organizations and governments to become vested in the process. In general stakeholders are more likely to be involved when they can see a more direct impact on their specific situation. A limited regional planning approach also seems to fit well with the existing Regional Economic Development Council model.

Understanding the customer is helpful to drive increases in overall demand for water-tourism companies, but it is also important to understand the barriers faced by water-tourism firms attempting to grow. Again, the Mighty Waters Task Force has started this process but further engagement of business owners throughout the watershed would provide a more nuanced and specific set of challenges. This barrier analysis, and more importantly identification of possible solutions, is a key next-step to identify issues that need to be addressed. For example, one suggestion provided during our conversations was a highly placed ombudsman who could help business owners navigate the issue of significant bureaucracy and slow response by the multiple agencies noted above. Such an approach—having a person with enough authority to push through internal barriers—is actually a best practice that many large firms are attempting as they seek to be more innovative.

One interesting trend along the Canal System has been the growing number of day trips and festival related events. Mower & Associates notes that direct sales revenues throughout the Canal System increased by 60% between 2002 and 2006 mostly due to increases in revenues from festivals and event-related visitors. These day-trips are examples of one way that the Hudson/Mohawk Watershed can use water recreation to enhance the quality of life in the region. While Canal tourism is beneficial when the Canal is actually open, ensuring long-term stable economic growth requires a more diverse local

economy. In order to grow the number of entrepreneurs in the region or create a more welcoming community for water-use firms, the quality of life needs to be desirable. Improving water quality, encouraging additional water access and creating more vibrant communities are ways to encourage this development and should become the focus of economic development activities, rather than the more limited priority they are currently receiving.

While building a water-tourism ecosystem requires significant long-term focus, particularly around water quality issues and regulation, climate change adaptation and business climate improvements, there are steps that can be taken immediately.

Moving forward, water-tourism needs to become a focus in both the environmental and economic development community. A champion (or champions) is need to highlight the focus on water-tourism ecosystems. This could include a subset of business owners and officials within the Regional Economic Development Council system, Chambers of Commerce from watershed communities, or elected officials. Congressman Tonko, for example, has provided significant emphasis on watershed businesses with the Mighty Waters Task Force. These champions should lead the development of regional specific plans around water-front access, water-front development and water-tourism encouragement.

In order to better understand ways to improve the water-tourism and water-catalyst ecosystem in the Mohawk/Hudson Watershed, the next immediate steps should include a more comprehensive analysis of existing successful canal systems such as the Rideau and Grand Canal. This will provide a fuller understanding of existing successful best practices while also providing a more nuanced comprehension of the specific context that solutions to encourage water-catalysts in the Hudson/Mohawk need to consider.

An initial marketing plan should be established that considers the potential market size of visitors to the watershed for water based recreation and tourism. This initial study should include voice of customer interviews with current Canal System and recreational users as well as a survey of existing water-tourism businesses to identify existing challenges to business growth and success.