To what extent does a flood disaster affect the 'value' and use of industrial properties within a floodplain: Case study of the lower Pawtuxet River basin in central Rhode Island

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Thesis
2011
Center for Environmental Studies
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THIS THESIS HAS BEEN SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR A BACHELOR OF ARTS IN ENVIRONMENTAL STUDIES AT BROWN UNIVERSITY

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Executive Summary:

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On March 29th, 2010, dark clouds hovered above New England, heavy with rain. The storm broke and Rhode Island was drenched with 8.8 inches of rain in two days[1]. The Pawtuxet River in central Rhode Island crested at 20 feet, more than six feet above its previous historic high[2]. The Pawtuxet River has flooded nineteen times since 1993 alone, causing damage along the lower region several times. Why then, were significantly damaged properties rebuilt instead of being returned to open space and wetlands, which can better absorb floodwaters and heavy rains than impervious surfaces?

Currently, Pawtuxet River quality is improving after 200 years of industrial and commercial use. Three Resource Conservation and Recovery Act (RCRA) sites and nine Brownfields sites are located within the lower Pawtuxet River. These properties are in various stages of cleanup and use[3]. Some properties are active, with hazardous materials still stored on-site.

My thesis focuses on the following question: To what extent does a flood disaster affect the 'value' and use of industrial properties within a floodplain? I use digital mapping to describe risks associated with industrial properties' proximity to residential areas, release and storage of hazardous materials and trend of property values over time. This will allow me to rank relative risk of these properties to the surrounding communities; giving Warwick, Cranston and similarly situated municipalities' options in addressing risks from flood disasters and industrial properties. , I examine the extent to which the risks associated with industrial properties located in the flood plain affect their assessed value. By charting assessed property value as a function of distance from the Pawtuxet River, I show that river-front properties are more highly valued than properties of increasing distance from the river. Yet, these more highly valued properties are more vulnerable to flooding and thus pose a higher risk to the community and governments that provide services to them. By accounting for risk in the value of a property, one can also include other benefits besides the traditional notions of the "highest and best use" of the land[4].

There are 12 properties included in my case study. I found that the assessed value of the 12 properties is both artificially high and low. It is low because the assessed value by Warwick and Cranston does not include risk of contamination and cost of services for cleanup and emergency response. Warwick and Cranston assess properties at nearly the same rate per acre, without accounting for on-site risks and vulnerability to flooding. The assessed value is artificially high because the properties closest to the Pawtuxet River have higher assessed values than properties farther away from the River.

Finally, I offer recommendations on actions to improve the flood storage capacity along the Pawtuxet River and reduce risk of contamination from industrial property spreading. Some of these recommendations are: Acquire vacant and abandoned properties and properties that have suffered greater than two repetitive losses from major floods and return them to open space, Reduce impervious cover along the banks of the Pawtuxet River and the floodplain by creating tax incentives and Attach value to risk; properties with risk of contamination spreading beyond their boundaries should have a low value and a higher tax burden to reflect the hazard they impose on the community.

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[1] "Historic Flooding of the Pawtuxet River," Pawtuxet River Authority and Watershed Council, http://www.pawtuxet.org/news.php, accessed March 20, 2011
[2] Ibid.
[3] "Cleanups in My Community," United States Environmental Protection Agency, http://iaspub.epa.gov/Cleanups/index.jsp?CleanupProgram=Brownfields, accessed March 20, 2011
[4] "Monitoring Land & Housing Markets," *National Center for Housing and the Environment*, accessed December 29, 2010.

CHAPTER ONE:

Introduction

Figure 1[5]

On March 29th, 2010, dark clouds hovered above New England, heavy with rain. The storm broke and Rhode Island was drenched with 8.8 inches of rain in two days[6]. The spring storm, coupled with snowmelt and saturated soils from a previous storm only two weeks earlier, led to the worst flooding in the state in over one hundred years. The Pawtuxet River in central Rhode Island crested at 20 feet, more than six feet above its previous historic high[7]. Statewide, more than $100 million in federal disaster aid has been given since March 2010[8]. Many

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[5] Figure 1. Flooding in West Warwick, March 2010. The Providence *Journal.*
[6] "Historic Flooding of the Pawtuxet River," Pawtuxet River Authority and Watershed Council, http://www.pawtuxet.org/news.php, accessed March 20, 2011
[7] Ibid.
[8] "RI to Receive $13M in Federal Flood Help," Providence *Journal*, http://newsblog.projo.com/2010/09/ri-to-receive-13-million-in-fe.html, accessed March 20, 2011

businesses, such as the Warwick Mall, were shut down for months; homes were deemed unsafe and residents could not return[9]. In assessing the damage to these properties in a floodplain, one must ask why and how these properties could be built in such a "risky" area. The Pawtuxet River has flooded nineteen times since 1993 alone, causing damage along the lower region several times. Why then, were significantly damaged properties rebuilt instead of being returned to open space and wetlands, which can better absorb floodwaters and heavy rains than impervious surfaces? Federal disaster money does not include restrictions on rebuilding in a floodplain, but does offer homeowners a "buyout" from the government[10].

The Pawtuxet River Valley is in central Rhode Island. The lower portion of the river divides the municipalities of Warwick and Cranston; feeding directly into Narragansett Bay, and is the largest watershed located entirely within the state[11]. The River is particularly vulnerable to flooding. Indeed, 14.7% of Cranston's land area lies within the Pawtuxet River floodplain[12]. Much of the valley is low-elevation and historic wetland buffers against flooding have been filled or developed. Engineered channels, armored shorelines and dams along the banks of the Pawtuxet River have replaced the naturally occurring "free ecosystem services" provided by wetlands. Additionally, commercial, industrial and residential development along the River has further reduced available pervious surfaces and area for the water to be absorbed.

Currently, Pawtuxet River quality is improving after 200 years of industrial and commercial use. In 2008, the main stem of the River (from the confluence of the North & South

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[9] "Northeast floods wipe out homes, dreams," *MSNBC, http://www.msnbc.msn.com/id/36085345/, accessed December 29, 2010*

[10] "Ongoing Challenges Facing the NFIP," Testimony before the Committee on Banking, Housing and Urban Affairs, U.S. Government Accountability Office, accessed February 28, 2011

[11] Rhode Island Rivers Council, http://www.ririvers.org/wsp/Watersheds/PawtuxetRiverWatershed.htm, accessed 9/27/10

[12] "Cranston embarks on hazard-mitigation plan for disaster assistance," Providence *Journal*, http://www.projo.com/ri/cranston/content/CRANSTON_HAZARD_MITIGATION_PLAN_09-13-10_DFJS_v26.1e58904.html, accessed March 20, 2011

branches at Riverpoint) were removed from the Rhode Island State list of impaired waters for low levels of dissolved oxygen[13]. However, water quality and human uses are still threatened by other contaminants such as phosphorous, cadmium, fecal coliforum and mercury. Thus, the main stem of the River, which runs eleven miles from Riverpoint in West Warwick to Narragansett Bay, does not meet the Clean Water Act's fishable or swimmable standards; meaning it is not safe to swim or fish in the river[14]. In addition, three Resource Conservation and Recovery Act (RCRA) sites and nine Brownfields sites are located within the lower Pawtuxet River. These properties are in various stages of cleanup and use[15]. Some properties are active, with hazardous materials still stored on-site. Other properties, known as Brownfields, are "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant[16]." Some properties still in use reported to the Toxic Release Inventory due to the annual release of several organic and inorganic compounds that are hazardous to human health and the environment. For example, Safety-Kleen Systems Inc is a company located on the banks of the Pawtuxet River in Cranston. In 2009 alone, 286 pounds of trichloroethylene, a known carcinogen, was released[17]. Many Brownfields are listed due to contamination from illegal dumping of industrial waste and leaking of underground storage tanks[18].

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[13] "State of Rhode Island List of Impaired Waters," http://www.dem.ri.gov/pubs/303d/303d08.pdf, accessed December 29, 2010
[14] Ibid.
[15] "Cleanups in My Community," United States Environmental Protection Agency, http://iaspub.epa.gov/Cleanups/index.jsp?CleanupProgram=Brownfields, accessed March 20, 2011
[16] "Brownfields," United States Environmental Protection Agency, http://www.epa.gov/oswer/cimc/whatsthis.htm#brownfields, accessed March 20, 2011
[17] "Detailed Facility Report,"

[18] "Cleanups in My Community," United States Environmental Protection Agency, http://iaspub.epa.gov/Cleanups/index.jsp?CleanupProgram=Brownfields, accessed March 20, 2011

Furthermore, the Pawtuxet Valley faces impacts from climate change and sea-level rise. Climate change is one of the defining issues of the twenty-first century; its impacts will be felt on a global scale. Indeed, these impacts can already be observed on a local scale. Rhode Island faces many uncertainties throughout the next several decades due to the risks posed from climate change and other disaster scenarios. Average temperatures in Rhode Island and the Northeast have already risen 1.5ºF since 1970.[19] Sea level is expected to rise by at least 10 inches by the end of the century, with as much as two feet of sea level rise possible[20]. This significant increase would enhance the frequency of coastal flooding and subsequently, property damage and erosion. Under a high-emissions scenario (in which overall emissions to the atmosphere are not significantly reduced), 100-year storms and flooding scenarios could occur once every nine years instead. In a low-emissions scenario, 100-year storms would still occur five times as frequently, once every 21 years[21]. Communities will be faced with a changing shoreline due to erosion and inundation of low-lying areas. This will put a huge burden on local infrastructure and coastal communities. More frequent storms, coupled with sea-level rise will have numerous impacts on the ability of Warwick, Cranston and other coastal communities to protect public health, safety and welfare.

These identified risks, in combination with projected changes in frequency and intensity of storms and flood events, raise several central questions about how state and municipal governments should manage these risks along the Pawtuxet River. My thesis focuses on the following question: To what extent does a flood disaster affect the 'value' and use of industrial

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[19] "Confronting Climate Change in the US Northeast," http://www.climatechoices.org/assets/documents/climatechoices/rhode-island_necia.pdf, accessed December 21, 2010.
[20] Ibid.
[21] Ibid.

properties within a floodplain? This is the main question that I ask throughout my thesis; and I examine parts of it in further detail. I use digital mapping to describe risks associated with industrial properties' proximity to residential areas, release and storage of hazardous materials and trend of property values over time. This will allow me to rank relative risk of these properties to the surrounding communities; giving Warwick, Cranston and similarly situated municipalities options in addressing risks from flood disasters and industrial properties. For instance, to what extent could Warwick and Cranston reconsider their physical and social relationships to the River to better protect their citizens and infrastructure from increased flooding? Primary concerns for municipal governments include how to successfully assure the physical, economic and environmental health of the present community, while also ensuring these needs for future generations.

These policies also should encompass a clear definition of risk. Risk, simply, is the probability of an undesirable event occurring within a certain time frame. For Warwick and Cranston, the risk can be described as the cost of emergency and disaster response, the number of people affected under different scenarios (such as flooding or sea level rise), the number and/or value of properties that could be inundated and the amount of hazardous materials stored on industrial properties. The risks along this industrial river are complicated because there are many historic mills and EPA-designated RCRA & Brownfields sites that use and/or continue to contain hazardous and toxic materials. Thus, there are several overlapping layers of governmental jurisdiction, complicating action and slowing effective responses to disasters. Flooding along the River can potentially cause these sites to be inundated, and the hazardous materials to be transported overland and downstream where they can affect vulnerable and sensitive receptors such as schools and residential neighborhoods.

Within this context, I examine the extent to which the risks associated with industrial properties located in the flood plain affect their assessed value. I address the sensitivity of property value to risk using property value as a way to consider whether risk is accurately reflected by municipal tax assessments and/or access to insurance. Is the value of these industrial properties properly reflected in their assessed value given the risk of flooding and impacts beyond their property boundaries? Are the costs associated with municipal services required to respond to risks presented by these properties adequately represented in the assessed value of the property? Municipal costs of service are an important factor to consider when viewing the benefits of different types of property value and land use. By charting assessed property value as a function of distance from the Pawtuxet River, I show that river-front properties are more highly valued than properties of increasing distance from the river. Yet, these more highly valued properties are more vulnerable to flooding and thus pose a higher risk to the community and governments that provide services to them. By accounting for risk in the value of a property, one can also include other benefits besides the traditional notions of the "highest and best use" of the land[22]. Other benefits include ecosystem services such as absorption and storage of water from flooding and storm surges and increased public access to the Pawtuxet River[23]. For ecosystem services, people must be convinced that the land is best returned to its previous or "natural" state. In effect, municipal policies need to create a demand for these services, by creating value associated with the property and its services, instead of merely assessing its marketable and buildable value[24].

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[22] "Monitoring Land & Housing Markets," *National Center for Housing and the Environment*, accessed December 29, 2010.
[23] "Ecosystem Services," *Ecological Society of America*, accessed December 29, 2010
[24] "Ecosystem Services: Foundations for a new rural-urban compact," Pablo Gutman, accessed December 23, 2010.

My thesis is divided into several sections. In the next section, I lay out the key principles associated with the risk/value analysis, by discussing previous literature on the subject. I will then present the Pawtuxet River as a case study for municipalities to gain tools and a better understanding of how they can better protect their citizens from risk and conceptualize value. This section will include a review of the history of the Pawtuxet Valley region. This will put in context the industrial legacy along the river, and the current burden that Warwick and Cranston face. I also discuss alternative strategies for redevelopment or "undevelopment" along the River, by using smart growth principles and the creation of a greenway corridor that absorbs floodwater and provides public access. Finally, I conclude with a summary of my key findings, and review my hypothesis that property value is disconnected from risk and offer recommendations on how Warwick, Cranston and other similar communities could attempt to address risks presented by undervalued industrial riparian properties.

CHAPTER TWO:

Literature Review

Figure 2[25]

This section reviews relevant literature and reports relating to the National Flood Insurance Program, property value as a function of proximity to riparian corridors and the cost of community services. This section will provide context for the case study of properties along the Pawtuxet River. It looks specifically at the first part of my question: the notion of value and how this relates to open space.

[25] Figure 2. Historic Pontiac Mills, Warwick. Photo from author.

Property Value:

The value of land is based on the value of the services it can support, or its "highest and best use." Land was traditionally valued by societies for its cultivation potential or its proximity to a desirable feature, such as the mouth of a river. Land was seen as property, holdings that increased in worth based on one's labor or "sweat equity." John Locke was an English philosopher who first constructed this idea in the late 1600s. Locke wrote, "Whatsoever, then, he removes out of the state that Nature hath provided and left it in, he hath mixed his labour with it, and joined to it something that is his own, and thereby makes it his property. It being by him removed from the common state Nature placed it in, it hath by this labour something annexed to it that excludes the common right of other men[26]." By improving the land, one earned the title to the land and the right to exclude others from it. Locke's view on land and labor is an early concept of capitalism and the idea of adding value to a product simply by improving upon its natural condition. The concept of land improvement repeated in America, as the fertile and seeming available land made for a new relationship with the land. European colonialists "bounded" the land after arriving in New England, creating a new ecological relationship with the land. They demarcated forests and meadows, ending the Native American tradition of using the land as a public commons. As William Cronon, an environmental historian, explains, land once held for the public good changed to private control to provide profit. "Initial divisions of town lands, with their functional classifications of woodlot and meadow and cornfield, bore a superficial resemblance to Indian usufruct rights, since they seemed to define land in terms of how it was to be used. Once transferred into private hands, however, most such lands became

[26] Locke, John. "Of Property." *Two Treatises on Government. The Laws of Nature and Nature's God*. Web. 15 May 2011. <http://www.lonang.com/exlibris/locke/loc-205.htm>.

abstract parcels whose legal definition bore no inherent relation to their use…to the abstraction of legal boundaries was added the abstraction of price, a measurement of property's value assessed on a unitary scale.[27]" The English settlers viewed land as a commodity that could be owned and sold, a different concept from the Native Americans, who believed that the community instead was stewards of the land. Land became marketable, and had a value based on its productive potential. New England settlers redefined the local relationship with the land. Instead of valuing land for its bounty of food that it provided, land became valued for the market value of the food. As Cronon notes, "It was the attachment of property in land to a marketplace, and the accumulation of its value in a society with institutionalized ways of recognizing abstract wealth…that committed the English in New England to an expanding economy that was ecologically transformative.[28]" Land was a commodity, and the resources it provided could be further separated into products that could be sold.

The Industrial Revolution in the 19th century further transformed the relationship between nature and man. Water too, became a commodity that could be privatized and sold. Thus, a price on water also created value on the land surrounding it. Banks of rivers became quite valuable for early mills, such as Slater Mill in Pawtucket, Rhode Island. Founded in the early 1790s, it is the nation's first textile mill and redefined a community's relationship with land and water. The water was a commodity and the land surrounding it became very valuable[29]. The interests of private mill owners were prioritized over those of the community as a whole. Water law was

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[27] Cronon, William. *Changes in the Land: Indians, Colonists, and the Ecology of New England*. New York: Hill and Wang, 2003.
[28] Ibid.
[29] Steinberg, Theodore. *Down to Earth: Nature's Role in American History*. Oxford: Oxford UP, 2002.

changed to support privately owned industrial activity[30]. Industrialization forever changed society's relationship with the land. Development occurred along the banks of rivers to support industrial activity, and the concept of land value continued to justify growth of private holdings instead of public commons. This is a theme repeated today, as many modern industrial properties along the Pawtuxet River are located on the site of former mills.

Beginning in the 19th-20th centuries with the rise of the environmental movement, land has been valued for its other uses and services, like water filtration, aesthetics and recreation. These non-market goods (meaning they don't have an easily identifiable dollar figure attached to them) create value for preservation and conservation of land. The value of land as a marketable good is attributed to the availability of surrounding land, and as development squeezes remaining land, its value only increases, as does the value and cost of preserving open space land. "As the supply of open space within metropolitan regions decreases, its value and efforts to preserve that value will increase.[31]" The benefit of open space land rises with its value as well. Open space provides many economic and environmental benefits, such as providing habitat to wildlife, filtering air and water and allowing for recreational uses[32]. The value open space brings to the community can be viewed as a "public good." Public goods are non-rival and non-excludable goods, meaning that they cannot be diminished based on the number of users and people cannot be excluded from them; public parks are public goods[33]. It is difficult to arrive at a dollar value for open space or public good because they are not produced in a traditional market economy,

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[30] Fitts, Frederic P. "Water Rights in Rhode Island, 1790-1840: The Commodification of the Landscpae." *Rhode Island History* 61 (Summer 2003): 27-35. Print.
[31] Faushold, Charles J. & Lilieholm, Robert J. 1996. "The Economic Value of Open Space: A Review and Synthesis," Lincoln Institute of Land Policy, accessed February 28, 2011
[32] Ibid.
[33] Ibid.

which is typically how we arrive at a value for goods and services. There are several methods of measuring value of land through indirect means.

Fiscal impact analysis is one method that is used by local governments and organizations to measure the revenue-expenditure ratio of preserving open space relative to the ratios of residential, commercial or industrial development. Since 1970, communities have gradually learned that new development does not always pay for itself. The costs of providing services and infrastructure (sewer lines, fire stations) may be more than the economic benefits received from additional property tax revenue. Governments, especially local ones, use cost of community services studies to analyze the benefits of new residential, commercial or industrial development. These studies are conducted by:

- Estimating the population growth from development;
- Translating this population into public services costs (construction of new schools, or extending sewer and water lines);
- Projecting the revenues from growth;
- Comparing the costs of development to the revenues.[34]

The American Farmland Trust published a report in 2010 listing revenue-expenditure ratios for different types of land use in towns across the country.[35] There were four towns in Rhode Island identified: Hopkinton, Little Compton, Portsmouth and West Greenwich. Their revenue-expenditure ratios are reproduced below:

[34] Ibid.
[35] "Fact Sheet: Cost of Community Service Studies," American Farmland Trust: 2010, accessed February 28, 2011

Community:	Residential	Commercial & Industrial	Working & Open Land
Hopkinton	1:1.08	1:0.31	1:0.31
Little Compton	1:1.05	1:0.56	1:0.37
Portsmouth	1:1.16	1:0.27	1:0.39
West Greenwich	1:1.46	1:0.40	1:0.46

These ratios show that for every one dollar in revenue generated by growth, the community spends more than a dollar on residential services and less than a dollar for the other two types of land use. For example, Hopkinton spends $1.08 on residential services for every dollar it produces, and only $.031 on industrial land or open land. The four Rhode Island communities had similar ratios compared to the northeastern average. One can immediately see that residential development is the least beneficial type of land use, while using land for open space or industrial purposes produce similar ratios and benefits. Open space land does not generate much revenue from property taxes, but it needs fewer services than other types of land use.

Fiscal impact analysis does have its drawbacks; it shouldn't be the only tool used by communities to debate the merits of development. Despite the burden on services, development is often necessary for economic growth. The cost of community services study is a useful way for local governments to see that not all development is created equal and that open space provides economic relief to communities. However, the cost of community services does not include the larger costs of cleanup or mitigation efforts related to flooding disasters. For Warwick and Cranston, approving development in a floodplain means that the municipalities must be prepared for emergency response or the damage of public infrastructure that later must be repaired and paid for. The benefits of open space for flood mitigation and its lower cost of services demonstrates the challenge of quantifying land value; and that development in a floodplain is not always worth the additional property tax revenue.

Communities have also found value in open space by examining the costs of inaction. In Johnson County, Kansas, the county spent $858,000 on riparian greenways for flooding controls and storm water management. This preventative action later saved over $170 million[36] on engineering costs for construction of storm water management defenses, such as levees and dams.[37] Likewise in Massachusetts, the Army Corps of Engineers, working with state and local governments, purchased or acquired 8,500 acres of wetlands in the Charles River basin for flood storage.[38] The total cost of the wetlands was 15.5 million, while engineering would have been $155 million.[39] The value of the wetlands in the Charles River basin could be further broken down, with each acre of wetland having a present value of $88,000 for flood prevention, $44,000 for pollution reduction and $266,000 for water supply. Furthermore, open space and wetlands can be calculated based on its replacement value. The cost of replacing the natural ability of wetlands to store floodwaters is $440 per acre-foot of water (an acre-foot is the amount of water in one acre at a depth of one foot, which is roughly 326,000 gallons).[40]

A second way of determining value of open space is the willingness of people to pay for such space or the services it provides. Willingness to pay for a good or service and the measurement of the consumer surplus (the maximum amount above the market price someone is willing to pay) are two methods that estimate the value of non-market goods. Two relevant questions for the determination of the value of open space for flood storage are: "what would homeowners or other property owners be willing to pay to return surrounding developed land to

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[36] In 2011 dollars
[37] Sandborn, Calvin. 1996. Green Space and Growth: Conserving Natural Areas in B.C. communities. B.C. Commission on Resources and Environment, Victoria B.C., accessed January 14, 2011
[38] Faushold, Charles J. & Lilieholm, Robert J. 1996. "The Economic Value of Open Space: A Review and Synthesis," Lincoln Institute of Land Policy, accessed February 28, 2011
[39] In 2011 dollars
[40] Ibid, in 2011 dollars

open space for flood mitigation? What price would homeowners be willing to sell at to leave the floodplain?" For Warwick and Cranston, several homes have suffered repetitive losses due to flooding within the last ten years (as will be discussed later in the case study). By determining what homeowners would be willing to pay to move out of the floodplain, a value can be established for returning land to an undeveloped state or preserving remaining wetlands for absorption of water during a flood event.

In summation, open space has many different ways to be valued. Fiscal impact analysis allows a municipal government or community organization to viscerally identify the costs of development for different land uses. Calculating the natural value of open space and its functions is another important method. These types of analyses are a valuable tool for municipalities in determining whether to keep open space open, or apply the principle of "highest and best use."

Other literature has found that proximity to riparian corridors and stream restoration projects have a significant effect on surrounding residential property values. In one study based on a riparian corridor in northeast Tucson, sale prices of homes increased by 6% when the home was located within .1 miles of a corridor, 3.5% within .3 miles and 2.5% within .5 miles.[41] Declining distance to corridors increased the value of vacant land by 10% to 27%. Another study found that urban stream restoration projects that reduced flood damage and restored fish habitat increased property values by 3% to 13% of the mean property price.[42] This study was based on seven urban stream restoration projects located in three California counties.

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[41] Colby, B. and Wishart, S. 2002, Quantifying the Influence of Desert Riparian Areas on Residential Property Values. *The Appraisal Journal* 70(3): 304-308, accessed January 13, 2011

[42] Streiner, C.F. and J. Loomies. 1995. Estimating the Benefits of Urban Stream Restoration Using the Hedonic Price Method. *Rivers* 5(4): 267-78, accessed January 13, 2011

In Portland, Oregon, a study examined the effect of riparian corridors on the value of single-family homes using the hedonic price method. The hedonic price method attempts to find the value of a non-marketable good (stream restoration) using the price of a good that is traded on the market (home sale prices). The results found that the percentage of parks and trails within one half mile of a property has a positive effect on the sale price of a home.[43] However, streams within one half mile of a property decreased the sale value. This result was consistent with earlier research that found ownership of the stream determined a positive or negative effect on the value of nearby properties. Publicly owned stream corridors increased property values, while privately owned streams decreased the value. The study area in Portland has a majority of privately owned land, explaining the decrease in value. However, sale prices still reflected the quality of habitat on the property. Properties with natural resource value had a higher sale price. The study also found that the amount of quality habitat that maximizes the sale price of a home is over two and a half times less than the average habitat cover actually on the property. Thus, municipal programs to encourage restoration of riparian habitat and ecological functioning may not always be in the best interest of private landowners. Government programs and policies aimed at restoring riparian corridors and preserving open space must work with private landowners to ensure that the landowners have a proper incentive to preserve open space and its natural benefits.

Other studies have researched the effect of big-box stores such as Wal-Mart and Target and Superfund sites on residential property values. One study looked at the correlation between Wal-Mart locations and residential property value; other big-box stores were also compared.

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[43] Netusil, Noelwah. 2006. Economic Valuation of Riparian Corridors and Upland Wildlife Habitat in an Urban Watershed. *Journal of Contemporary Water Research and Education* 134: 39-45, accessed January 8, 2011

Homes near big-box stores spend a longer time on the market and sale prices are lower.[44] According to the Environmental Protection Agency, Superfund sites reduce property value between 2 to 8%.[45] However, this assumes that all Superfund sites have the same effect on property value. One study used 74 National Priority List sites in 13 U.S. counties to test this idea of negative association between Superfund sites and property value. The study used the hedonic price method to calculate sale prices of homes in order to estimate the value of cleaning up Superfund sites. Superfund sites do not always have a negative effect on housing prices; indeed, NPL sites were even an attraction in certain cases. This is similar to a study published by the EPA on the value of Brownfields once they have been assessed or cleaned up. Residential property values increased 2%-3% after assessment or cleanup; overall property values within a one-mile radius can increase by $0.5 million to $1.5 million. [46]Thus, residential property values increase when proximate to riparian corridors but not to big-box stores and other large commercial development. This is an important distinction for communities to consider when planning for corridors or other zoning issues.

The National Flood Insurance Program:

The National Flood Insurance Program is a federal program administered by FEMA that provides insurance to homes and businesses in a floodplain. The NFIP is responsible for mapping the different floodplain zones and offers incentives to local governments to encourage

[44] Johnson, Daniel K.N. 2009 Working Paper. The NWIMBY Effect (No Wal-mart in my backyard): Big Box Stores and Residential Property Values. Colorado College Dept. of Economics, accessed January 13, 2011
[45] Kiel, Katherine & Williams, Michael. 2005. The Impact of Superfund Sites on Local Property Values: Are All Sites the Same? College of the Holy Cross Dept. of Economics Working Paper, accessed January 13, 2011
[46] "The EPA Brownfields Program," EPA: January 2011, accessed March 21, 2011

floodplain management requirements. The NFIP has recently undergone map modernization efforts to more accurately identify the risks in each community. Flood insurance is a federal program that pays fees to private insurers to sell flood policies. A true private market failed to develop because of the "catastrophic nature of flooding and the difficulty of adequately predicting flood risks[47];" as such insurance companies were averse to bearing the risks of insurance. This market failure led to the National Flood Insurance Act of 1968, which was designed to "provide policyholders with some insurance coverage for flood damage, as an alternative to disaster assistance and try to reduce the escalating costs of repairing flood damage.[48]" NFIP can borrow from the Treasury to cover claims, a statutory authority that effectively places the burden of risk on the federal government.

The NFIP faces a problem in covering repetitive loss properties, in which a property has suffered from more than two flood events within the last ten years. Repetitive loss properties are only 1% of all properties covered by the NFIP, but represent 25-30% of all claims.[49] Furthermore, the NFIP is grandfathering properties in high-risk areas that have a previous policy at a lower rate from a different flood zone. This is done to encourage participation in the program, yet participation is already required for properties in high-risk flood zones. Congress has previously established subsidies for insurance premiums to help keep the program and the cost of insurance affordable. However, these subsidies distort the market, and these subsidies allow some property owners to only pay 35-40% of the true risk premium. All this has led to the NFIP being in dire financial struggles. As of October 2007, the program owed $17.5 billion to

[47] "Ongoing Challenges Facing the NFIP," Testimony before the Committee on Banking, Housing and Urban Affairs, U.S. Government Accountability Office, accessed February 28, 2011
[48] Ibid.
[49] Ibid.

the U.S. Treasury. This debt was mostly incurred from paying out claims from the 2005 hurricane season.

Despite this burden, the program is not designed to collect capital for the long-term payout of claims. Due to the subsidized rates, the program does not have enough capital to cover unforeseen catastrophic events. Repetitive loss claims also create year-to-year budget problems. The NFIP currently receives about $2 billion per year in premiums, but has a debt of $17.5 billion. As of September 2007, 70,000 repetitive loss properties nationwide are covered by the NFIP. The government has decided to further reduce its income from premiums by grandfathering properties into a higher risk area and maintaining the lower rates. This supposedly encourages retention in the program, but it is instead an unsustainable practice that only further erodes the ability of the federal government to effectively respond to flood disasters and compensate property owners. These subsidized properties, with reduced rates, remain eligible for the NFIP unless there has been "substantial damage" for a flood event and 50% of the market value is lost or if there has been "substantial improvement," in which the market value is increased by 50%.

As previously discussed, the value of residential properties increases relative to a riparian corridor; this trend also exists for properties in a floodplain. A Congressional Budget Office report from 2007 examined the value of subsidized properties, 10,000 non-randomized properties from V-flood zones (coastal zones subject to wave action) around the country were used.[50] The report found that properties covered by the NFIP were more valuable than non-covered properties. This is due to the value attached to coastal land; the land is generally worth more than

[50] "Value of Properties in the NFIP," Congressional Budget Office: 2007, accessed February 27, 2011

the improvements on it. Coastal land is valued by developers and property owners for its aesthetic qualities and recreational uses. 40% of the subsidized properties in the study are worth more than $500,000, with 12% worth more than $1 million. For properties defined as inland, only 12% are worth $500,000 and 3% worth more than $1 million. The median value of owner-occupied houses nationally is $160,000; subsidized properties in the study have a value between $220,000 and $400,000. The study distinguishes between owner-occupied houses and rental properties because rental properties on the coast are often worth more and can distort the figures. The study also includes non-residential properties, which make up 5.6% of policies in the NFIP. The CBO calculated the assessed value of land versus the assessed value of improvements for subsidized and non-subsidized properties. The subsidized coastal properties have the highest average land value and total value. Subsidies can partially raise land values because they are distorting the risk of flooding on the property and thus distorting the incentive to build and live there.

Summary:

The value of land is based on the value of the services it can support, or its "highest and best use." The benefit of open space land rises with its value as well. Open space provides many economic and environmental benefits, such as providing habitat to wildlife, filtering air and water and allowing for recreational uses[51]. Fiscal impact analysis is one method that is used by local governments and organizations to measure the revenue-expenditure ratio of preserving open space relative to the ratios of residential, commercial or industrial development.

[51] Ibid.

Communities have also found value in open space by examining the costs of inaction. Furthermore, open space and wetlands can be calculated based on its replacement value. The cost of replacing the natural ability of wetlands to store floodwaters is $440 per acre-foot of water (an acre-foot is the amount of water in one acre at a depth of one foot, which is roughly 326,000 gallons).[52] Other literature has found that proximity to riparian corridors and stream restoration projects have a significant effect on surrounding residential property values. Residential property values increase when proximate to riparian corridors but not to big-box stores and other large commercial development.

The National Flood Insurance Program is a federal program administered by FEMA that provides insurance to homes and businesses in a floodplain. Flood insurance is a federal program that pays fees to private insurers to sell flood policies. A true private market failed to develop because of the "catastrophic nature of flooding and the difficulty of adequately predicting flood risks[53];" as such insurance companies were averse to bearing the risks of insurance. The NFIP faces a problem in covering repetitive loss properties, in which a property has suffered from more than two flood events within the last ten years. Repetitive loss properties are only 1% of all properties covered by the NFIP, but represent 25-30% of all claims.[54] The value of a residential properties increases relative to a riparian corridor; this trend also exists for properties in a floodplain. A Congressional Budget Office report from 2007 examined the value of subsidized

[52] Ibid, in 2011 dollars
[53] "Ongoing Challenges Facing the NFIP," Testimony before the Committee on Banking, Housing and Urban Affairs, U.S. Government Accountability Office, accessed February 28, 2011
[54] Ibid.

properties; the report found that properties covered by the NFIP were more valuable than non-covered properties[55].

[55] "Value of Properties in the NFIP," Congressional Budget Office: 2007, accessed February 27, 2011

CHAPTER THREE:

Case Study

Figure 3[56]

This section discusses flooding along the Pawtuxet River and specific properties that present a risk to the municipalities of Warwick and Cranston. I examine the second part of my thesis question, how flooding disasters affect the use of industrial properties. I begin this section with a discussion of the Rhode Island State Hazard Mitigation Plan and the Warwick and Cranston Hazard Mitigation Plans. All three plans identify hazards in their community plus their

[56] Emergency Response teams in Warwick.

relative vulnerability to disasters. However, these plans do not acknowledge the risks on properties to other properties or populations. I also use GIS maps to show the count of various types of land use under 20ft of elevation, the same level the Pawtuxet River crested at in March 2010.

Flooding is the most common natural disaster in Rhode Island, as well as the United States. Flooding annually causes $5 billion in property damage nationwide.[57] Flooding is particularly dangerous because of dense settlement in floodplains and coastal areas. In Rhode Island, flooding is usually caused by spring snowmelt that saturates the soil, followed by heavy rains and the constraints of the built environment and impervious surfaces. A flood as defined by the NFIP is "a general & temporary condition of partial or complete inundation of two or more areas of normally dry land area or of two or more properties from overflow of inland or tidal waters; unusual and rapid accumulation or runoff of surface waters from any sources, or a mudflow.[58]" A floodplain is often hard to distinguish without a flood to delineate its boundaries. A floodplain is a natural flood control system, it allows for the absorption of water and its percolation back into the groundwater system. Dams, levees, and armored shorelines sever a river from the floodplain and the natural benefits are then lost or reduced. Impervious surfaces restrict the ability of water drain into the ground, and force water and any pollutants suspended in the water into creeks and rivers[59].

Rhode Island is very flood-prone, and has been active in determining the risk of flooding. Flooding risk is based on the percent annual chance of flooding; a 100-year flood has a 1%

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[57] Rhode Island State Hazard Mitigation Plan," RI Emergency Management Agency: 2008, accessed February 28, 2011
[58] Ibid.
[59] Konrad, C. P. "Effects of Urban Development on Floods." *USGS Publications*. US Geological Survey. Web. 17 May 2011. <http://pubs.usgs.gov/fs/fs07603/>.

chance of happening annually, while a 500-year flood has a 0.2% annual chance. However, this does not mean a 100-year flood only occurs once every 100 years. They generally occur more frequently, and the 100-year designation is used by FEMA to determine flood insurance rates under the National Flood Insurance Program and the necessity of floodplain management. For buildings in a special flood hazard area, there is a 26% chance of flooding over the course of a 30-year mortgage[60]. Properties can suffer "repetitive losses" in which the property has more than one partial loss within ten years. In Cranston, between 6-10 properties have had repetitive losses, and 10-17 properties in Warwick have as well.[61] The probability of repetitive losses is exacerbated due to the amount of impervious cover in the communities. As development increases, water will have fewer places to go and will continue to damage properties in floodplains. In Cranston, 19% of the City is an impervious surface, while 24% of Warwick is impervious[62]. Indeed, flood frequency will only increase if development further restricts the ability of water to be absorbed and recharge groundwater reservoirs.

In the RI Hazard Mitigation Plan published in 2008, RI EMA scored the State's vulnerability to flood events. This vulnerability score was assessed using scores from two hypothetical flooding events. The score is calculated by evaluating several different types of data. "The hazard score in a region is a function of the geography and natural recurrence of disasters over time in a given area. Thus, hazard scores are inherent to a county and theoretically cannot be lowered through mitigation or intervention. The hazard score is comprised of:

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[60] "National Flood Insurance Program: Program Description," Federal Emergency Management Agency, accessed May 15, 2011
[61] Ibid.
[62] Zhou, Yuyu & Wang, Y.Q. 2007. Assessment of Impervious Surface Area in Rhode Island," *Northeastern Naturalist* 14(4): 643-650, accessed April 12, 2011

-Frequency score: a 100-year flood has a score of 3;

-Area Impact score: how much geographic area is affected;

-Intensity score: level of intensity; a base flood elevation of 20' has a score of 3 (moderate-heavy flooding).[63]

These three scores are multiplied together for the aggregate hazard score.

The vulnerability score factors in populations, environmental resources and "critical facilities" that are at risk from hazards. The score measures the amount of resources, population or facilities in a given area. The score reflects the natural and built environment, as well as demographics. The RI EMA plan uses four criteria to assess vulnerability: critical facilities, populations at risk, environmental resources/threats and economic values.

Critical facilities include public infrastructure, utilities, schools, hospitals, fire stations, and water treatment plants. Damage to these facilities during a disaster can greatly restrict the government's ability to respond and can compound the magnitude of the disaster. The vulnerability score for critical facilities is the vulnerability score multiplied by the importance factor. The type score estimates value of a facility or population to exposure.

Occupancy:	**Category:**
Fire, Police, Medical Facilities	IV
Emergency Shelters	IV
Environmental CERCLA sites	III
Major Industrial sites	III
Schools	III
Other public utilities	II
Other structures	II

[63] Rhode Island State Hazard Mitigation Plan," RI Emergency Management Agency: 2008, accessed February 28, 2011

Occupancy Category:	Importance Factor
I	.85
II	1
III	1.2
III	1.3

Once the scores are known, they are added together to evaluate the overall score for each exposure. Other factors in the vulnerability score are: the number of sites, property value (higher value leads to a higher score), percent of population and population density (people/square mile).

Environmental resources include the presence of rare species, scenic vistas and protected areas. Direct and indirect costs are also calculated. Indirect costs include: accidental spills of fuels, sewage and industrial waste, household chemicals, distribution of debris and other contaminants[64]. To calculate risk, the resilience of the environment needs to be assessed—the soil type, hydrology and vegetative cover all factor into this resilience. However, the most important factor in resiliency related to flooding is water absorption. Impervious cover reduces the rate and effectiveness of absorption. Also, the spread of pollution and hazardous waste during flooding adversely affects water quality by entering groundwater systems and then contaminates the drinking water supply and the environment. Environmental vulnerability as calculated by RIEMA, reflects two things: "fragility and/or potential of an environmental resource to be damaged by a natural hazard, and the potential of a secondary impact of a natural hazard creating damage to an environmentally fragile ecosystem.[65]" This scenario is further discussed below.

[64] Ibid.
[65] Ibid.

The combined vulnerability score calculates the effects of hazards on the vulnerability of a given region (Combined Score= Hazard score * Vulnerability score). The resulting score provides a basis for understanding distribution of risk. Cranston has an overall flood risk score of 360, and Warwick has a score of 684. Flood scores are determined by projecting two events, a 100-year flood and a 500-year flood. The Plan concludes, "No Rhode Island community is completely safe from the threat of flooding;" all 39 towns in Rhode Island are "flood prone" according to the RI HMP.

The Rhode Island Hazard Mitigation Plan examines the Pawtuxet River in slightly more detail, but notes that data does not exist on where there is repeated urban flooding. The Plan lists the Pawtuxet River as a specific area of past flooding, but does not conclude that mitigation should or needs to occur there; it simply notes: "Cranston and Warwick areas, due to its shallow depths from sediment buildup, frequent flood occur…leads to lack of water storage, also because much of the shoreline and adjacent wetlands have been filled for development.[66]"

The Plan does however; note the total acreage of each community in a flood hazard area (known as A or V zones, with A being a 100-year flood zone and V being coastal areas at risk of wave action). Cranston has 8.25% of its 18,860 total acres designated as flood hazard area, for a total of 1,541 acres. Warwick has 3,923 acres (16.51%) of a total 23,760 acres in a flood hazard zone. The Plan also lists the number and type of critical facilities in special flood hazard zones statewide. I also calculated these figures for Warwick and Cranston, using facilities under 20ft elevation as the cutoff, as this was the peak crest of the Pawtuxet River in March 2010.

[66] Ibid.

Warwick and Cranston use similar risk scoring methodology in their Hazard Mitigation Plans. Warwick's plan was last updated in 2005. Cranston's Plan was recently updated in a draft version published in August 2010. According to the Cranston Plan, the March 2010 flood was the largest ever on the main channel of the Pawtuxet River. At its peak, the River was flowing at a rate of 10,400 cfs.[67] Cranston participates in the NFIP, with 562 policies. Of these, 56 are non-residential. 366 of the properties are within an A-flood zone. Since 1978, 472 claims have been filed, with $8,572,758 paid in damages. Thirty-three of these 562 properties are listed as repetitive loss properties. There have been 19 floods since March of 1993 alone. Cranston recognizes the risk flooding generates upon its citizens, and has been thorough in assessing its own vulnerabilities. Cranston's risk assessment has six categories:

- Facilities inventory,
- Hazard mitigation mapping,
- Fiscal impact analysis,
- Population impact analysis,
- Level of risk determination, and
- Vulnerability of future structures.

The Plan shows that 14.7% of Cranston's 18,507 acres (a different amount from the RI EMA Plan) are in a 500-year floodplain. Total value of damages to improvements (i.e. buildings) on these properties is $555,428,000, with 28.3% ($156,955,900) of these potential damages in the main branch of the Pawtuxet River floodplain.[68] The City conducted this analysis using the same database this author did, and both arrived at the same conclusion: the City Tax Assessors

[67] "Hazard Mitigation Plan," City of Cranston: August 2010 Draft, accessed March 21 2011
[68] Ibid.

database lacks information on market value, which could be used to find a more accurate reflection of the value of these properties. The Plan also identifies 14 pumping stations within the 500-year floodplain, of which 8 of these are under 20ft of elevation.[69] When flooding occurs at a pumping station, sewage can backup because the sheer amount of water overwhelms the system. The 14 pumping stations have $62,227,000 in total potential property damages if flooded. The potential damages in a flood disaster are immense; and the impact on the City is enormous. The City generates approximately 75% of its revenue from property taxes, with 24% of that from commercial and industrial properties.[70] If these properties are flooded and deemed a total loss, the City loses a significant and irreplaceable source of revenue and must find ways to raise alternative sources of revenue, at the same time as undergoing remediation of these properties. This is central to understanding whether tax assessment accurately reflects risk of loss to the City or community from flood damage to industrial properties. Some of these industrial properties carry hazardous materials, are in low-elevation areas and therefore have high risk attached to them. However, the risk is detached from value because the property's tax burden is based on improvements, not the risk they carry[71]. This distorts the cost of services to these properties in a flood disaster. The properties have high risk but do not generate enough tax revenue to enable the City or State to respond effectively. In the event of a flood disaster, these properties must undergo remediation and assessed for potential spread of pollutants, placing the burden on the City, not the property owner.

Warwick has a similar methodology in determining its risk and calculating potential property damage claims from a disaster. Warwick has calculated the risk categories for each

[69] RIGIS database
[70] "Hazard Mitigation Plan," City of Cranston: August 2010 Draft, accessed March 21 2011
[71] Cheit, Ross. Personal interview. 11 Mar. 2011.

flood zone, and the amount of land within category. VE (coastal) zones have the highest vulnerability score of 5, and 681 acres of City land are in this zone.[72] The other zones and acreage are:

FEMA Flood Zone	Acreage	Square Miles	Percent
AE Zones	2,410	3.76	10.5
VE Zones	681	1.06	3.0
X500 Zones	3,835	5.99	16.7
X Zone	15,731	24.57	68.5
A Zone	288	.449	1.25

Warwick has also listed CERCLIS sites within the city, but this list is based on outdated RIGIS data from the 1990s. Currently, Warwick has four properties that are RCRA or Brownfields sites[73]. Warwick calculated the number of structures, the type, average replacement value and total damage potential for 8,4 and 2-foot floods. For an 8 ft. flood, 50 non-residential structures, with an average replacement value of $350,000, are at risk of loss with a total damage potential of $8,575,000. Warwick's plan does not consider the risk of industrial properties to another property during a flooding disaster, as does Cranston's. However, neither Plan offers actions to remedy the issue. Both fail to comprehensively identify properties that are the riskiest to the town.

I identify several industrial properties that Warwick and Cranston should consider because of their risk of contamination and on-site storage of hazardous materials that pose a hazard to surrounding properties. I have chosen 12 properties to examine in closer detail as part of identifying the risks to Warwick and Cranston. I chose these properties because they all carry

[72] "Warwick Hazard Mitigation Strategy," City of Warwick: April 2005, accessed March 21, 2011
[73] "Cleanups in My Community," EPA, http://iaspub.epa.gov/apex/cimc/f?p=255:63:7912366124123842, accessed May 17, 2011

a risk to the environment and local populations. These are also at varying distances from the Pawtuxet River, which is a strong indicator of their assessed value. I discuss why their assessed values are inaccurate and a dangerous indicator of value for emergency planning and development purposes. One industrial site is currently active, others are inactive but are still listed on the EPA "Cleanups in My Community" website. These properties were often used for the manufacturing of inorganic chemicals and petrochemicals. Other properties are vacant lots with dumping of hazardous waste or contamination spread from nearby industrial properties. These are known as Brownfields, and have the potential for redevelopment after cleanup and remediation[74]. These properties show active, inactive and indirect sources of contamination and illustrate the different levels of risk Warwick and Cranston face. I later offer recommendations to Warwick and Cranston for action on these and similar sites.

Rhode Island Technical Plating – 50 Libera Street, Cranston

RI Technical Plating is a former facility used for metal plating. It has been unoccupied since 2001, when the company defaulted on its bank loans and has been held in receivership since that time.[75] The EPA completed cleanup in October 2001. Mariposa Holdings LLC has owned the 1.32-acre property since December 2002. The property was used for jewelry manufacturing from 1971 to 1984. From 1984 to 2001, RITP used the site for industrial metal plating, including hard chromium and nickel. The site topography is mostly flat, with surface and

[74] [74] "Brownfields," United States Environmental Protection Agency, http://www.epa.gov/oswer/cimc/whatsthis.htm#brownfields, accessed March 20, 2011
[75] "After Action Report for the RI Technical Plating Removal Site, Cranston RI," EPA 2001, accessed April 12, 2011

groundwater running east towards Randall Pond, which has excessive nutrient loading and low oxygen levels during the summer[76].

Assessment of the property for contamination began in March of 1991. The EPA tested the groundwater and soil for evidence of contamination. The groundwater was found to have elevated levels of: chromium (9.62 mg/L), hexavalent chromium (3.3 mg/L), trichloroethylene (200mg/L), and tetrachloroethylene (8.1 mg/L).[77] Elevated levels of chromium (2,270 ppm) and copper (379 ppm) were found in the soil as well[78]. Contamination in the soil was likely due to air venting from the plating room causing contamination on the roof of the building and runoff during a rainstorm. The Cranston Fire Department also found storage of hazardous materials in metal drums: 600 lbs of copper cyanide; 3,000 lbs of sulfuric acid; 2,000 lbs of nitric acid; 2,000 lbs of potassium cyanide and 200 lbs of sodium cyanide. The EPA fined Technical Plating for failing to comply with the Clean Air Act and hazardous waste laws and storing waste without a permit. In July 2001, EPA started cleanup of the site and decontaminated and removed the metal vats of waste. Cleanup was complete in October 2001, costing $308,257. In October 2010 the Site Plan Review Committee in Cranston had a meeting to approve the use of the property and building for an automotive service center. However, the Committee first needs determination from the RI Department of Environmental Management before it can proceed because DEM holds jurisdiction over on-site activities[79].

[76] Ibid.
[77] Ibid.
[78] Ibid.
[79] Ibid.

The 2009 assessed value of the property was $536,000.[80] The land was $164,600 and the improvements were valued at was $372,000. The parcel is 2.72 miles from the Pawtuxet River, although it is adjacent to Randall Pond. It is at an elevation of 78 feet, so is not in a high-risk area of flooding. The risk attributed to this property is based on the levels of contamination found on-site. These chemicals impact the ecological health and groundwater quality of Randall Pond. The City wants to put the parcel to use, but it should find alternative locations before choosing 50 Libera Street. This property poses a hazard to the community, and further cleanup will be required before it can be active once again. The potential for reuse keeps the property value high, despite the site history. If Cranston wants to use the property again, it should ensure that revenue generated from an automotive center justifies the costs of further cleanup.

West Russe Realty – 20-26 West Russe Street, Cranston

In August 2009, a public notice was issued to surrounding properties detailing the recently completed Site Investigation on 20-26 West Russe Street.[81] The soil and groundwater on the property was tested for elevated levels of metals, polynuclear aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH). The soil samples contained concentrations above the RIDEM Residential and Industrial/Commercial standards for metals, TPH and semi-volatile organic compounds. There were no concentrations above RIDEM GB groundwater standards. The letter further proposed several remedial actions:

- Excavation of soils that exceed GB standards

[80] Cranston Tax Assessors' Database, visionappraisal.com
[81] "Public notice: site investigations," August 14, 2009, accessed April 12, 2011

- Placement of a two-foot vegetated cap with clean fill
- Development of a Soil Management Plan to protect workers during cleanup
- Placement of Environmental Land Use Restriction (ELUR) on the site which prohibits future use of the land for residential development
- Monitoring of groundwater

In a February 2011 letter from RIDEM to the property manager, the Department noted that the excavation of total petroleum hydrocarbons contaminated soils was not completed.[82] This was due to a perceived danger in the slope stability by the cleanup contractors (RIDEM oversaw and approved cleanup, but SAGE Environmental Inc. was responsible for the actual cleanup). The Department disagreed that slop stability was an issue and stated that excavation should commence. The letter asked the manager of West Russe Realty LLC to offer alternative remedial strategies by March 2011 to continue cleanup of the contaminated soils.

According to the Cranston Tax Assessors' database, this property had no improvements on and the land was assessed at only $83,200. The property abuts Spectacle Pond to the west and all groundwater flows into the pond, which is also surrounded by homes and other businesses. The property is in the active process of cleanup, and no other uses are currently planned for it. RIDEM has been proactive in reducing the hazards on-site and preventing future exposure. The assessed value speaks to its lack of potential for reuse and the spoiled content of the land.

[82] Letter from RIDEM to Mr. David Weisberg, Manager West Russe Realty, February 10, 2011, accessed April 12, 2011

Ciba-Geigy – 180 Mill Street, Cranston

Ciba-Geigy, located at 180 Mill St in Cranston, is a former chemical manufacturing facility, operating there until May 1986.[83] The facility opened in 1930, manufacturing chemicals as Alrose Chemical Company. The Geigy Chemical Company bought the property in 1954 and merged with Ciba Corporation in 1970. The facility made agricultural products, plastics additives, pharmaceuticals and bacteriostats. During 56 years of manufacturing, the site has experienced several severe floods and storms, from the 1938 hurricane to the 2010 floods. The industrial manufacturing plant at Ciba-Geigy has resulted in degradation of the Pawtuxet River and potential contamination of the property. In June 1989 Ciba-Geigy was ordered by the EPA to undergo a RCRA Corrective Action study.[84] This study involves assessing the site for risks and presenting corrective measures to mitigate these risks. The Ciba-Geigy property was found to have releases of hazardous materials. In 1995, over 2,225 tons of contaminated sediment were excavated and removed from the River, replaced by clean sand. In November 2002, remaining sediment was sampled by Ciba-Geigy as was required by the EPA and RIDEM.

The sampling found that traces of volatile and semi-volatile compounds had been reduced in the ten years since the last sampling.[85] However, concentrations of some metals (copper, lead, zinc) increased. Overall though, Ciba-Geigy was satisfied with the results and concluded:

> With no new contaminant sources to the Pawtuxet River from the former Ciba facility or from other nearby areas, Ciba includes that river processes will continue to function as a natural cleanup tool and sediment contaminant concentrations will continue to improve over time. Ciba therefore recommends

[83] "Sediment Sampling Report for the Pawtuxet River, former Ciba-Geigy Facility," Ciba Specialty Chemical Corporation: May 2003, accessed March 21, 2011
[84] Ibid.
[85] Ibid.

> that no future monitoring of sediment contaminant concentrations in the Pawtuxet River should be necessary. [86]

Ciba-Geigy has undergone several measures to ensure that spread of contamination is limited. An earlier report from 1996 noted: "contaminated groundwater is present only within the facility boundary;[87]" with a pump and treat system reducing the spread of the contaminated groundwater outside the property boundary into the river or drinking wells.

A Risk Assessment from December 1994 created different exposure models and risk scenarios. The risk scenarios projected the hazard index for cancers and non-cancers for a canoeist along the River, a raccoon, heron and fish. For a canoeist, the total hazard index was .002 and the total lifetime incremental cancer risk was $2x10^{-7}$. Neither the index nor the cancer risk exceeds the EPA target range (although some levels of exposure are within it). The assessment for the "protection of human health and the environment" is based on the health risks associated with recreation and the ability of corrective measures to reduce long-term exposure to ecological receptors.

Ciba-Geigy, RIDEM and EPA have been proactive in pursing strategies to prevent the spread of contamination remaining from Ciba's 56 years of manufacturing. This is an example of effective cooperation and coordination among federal and state agencies and a private business. However, the EPA's Corrective Actions report neglects to consider the possible spread of contamination and pollutants from large natural disasters, e.g. flooding. The 1996 report summarizes that "unacceptable threats to human health from actual exposure to the remaining contamination are not plausible based on current uses of the site." This fails to address the factor

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[86] Ibid.
[87] "Basis for Human Exposures Controlled Determination," EPA: September 1996, accessed March 21,2011

of an external catastrophic event that removes barriers to spreading and protective controls. This property and its cleanup is an example of the failure of governments to address events that are seemingly uncertain (yet flooding is a nearly annual event along the River) and do not have contingency plans for these events. This exposes a larger failure in the capacity of governments when assessing the potential damage and risks from hazardous materials or planning for larger scale disasters.

The optimism from the relatively low levels of contamination after cleanup led to proposed development of the site for 61 homes.[88] However, the developer withdrew his plans in 1999 after high arsenic levels were found. Arsenic was found in concentrations as high as 15 ppm, far exceeding the RIDEM Residential standard of 1.7 ppm.

Cranston assessed the property at a value over $3 million in 2009. This is based mostly on the improvements ($2.5 million).[89] This is quite extraordinary considering the elevation of the property is 20 feet and is only 232 feet from the River. Flooding is almost certainly an annual occurrence for Ciba-Geigy. Much has been done to mitigate risks to human exposure by replacing contaminated soil and disposing of waste, but this should not create such a high value for the property. It is in a high-risk flood zone, and has serious environmental hazards associated with it. The land is valued for its potential, such as building 61 homes on it. However, this property is not adequate for development, as evidenced by the high levels of arsenic. Sites at higher elevations in a floodplain with a reduced risk of flooding that have contamination should still not be considered for development. Indeed, Ciba-Geigy has left a legacy in the floodplain

[88] "Developer scraps plan for houses on Ciba land," The Providence *Journal*, March 22, 1999, accessed April 12, 2011
[89] Cranston Tax Assessors' Database, visionappraisal.com

that is of an artificially high value and this does not represent the true risk on the property, or how this impacts surrounding owners.

Safety-Kleen Systems, Inc - 167 Mill St, Cranston

Safety-Kleen is an active facility next to Ciba-Geigy. The 4.01 acre property is bordered to the South by the Pawtuxet River, with a small amount of vacant land that is used as a buffer between the River and the site. The current owner is Safety-Kleen Systems Inc, headquartered in Plano, Texas. Safety-Kleen purchased the property from One Hundred Sixty Seven Mill Street LLP in December 2007 for $1,865,000.[90] A textile mill began to use the site in 1810. That mill operated until 1870, when it was destroyed in a fire and replaced by another mill.[91] In 1895, the Turkey Red Dyeing Company used the property, and later shared it with the Whittle Dye Works by 1901. Various businesses used the site through the 1930s and 1940s, until the Atlantic Tubing Company bought the property in 1944 and operated there until 1982. As owners of the property, Atlantic Tubing rented out portions of the site to other manufacturers, including those involved in chemicals, plastic products, wood finishing, industrial equipment cleaning and the storage, treatment and disposal of hazardous waste.

In August 1990, while still owned by Atlantic Tubing the property was listed as a CERCLIS site and given low priority status in March 1991. In November 1992, the site was listed as a RCRA hazardous site and handler of hazardous waste. In September 2001 the property was assessed for groundwater contamination and human exposure and both were found to be

[90] Cranston Tax Assessors' Database, visionappraisal.com
[91] "Site History," Phase I Environmental Assessment, Woodward & Curran Inc: April 2008, accessed April 12, 2011

"under control." More recently in June 2009, soil around the property was tested as part of a Phase I Environmental Assessment. 16 volatile organic compounds were tested, and two of those consistently had concentrations higher than the approved levels. Tetrachloroethylene and trichloroethylene were both present in the soil at levels that exceeded the Residential Direct Exposure Criteria, GA Leachability Criteria and GB Leachability Criteria.[92] GA water is approved for drinking by RIDEM, while GB is not potable, but allowed for recreational use. The Pawtuxet River is classified as a GB river. A remedial action work plan was finalized in December 2010 and approved in November 2010 for a short-term response action to excavate soil contaminated with VOCs, polychlorinated byphenyls and "light non-aqueous phase liquids;" completion is targeted for June 2011. The remedial actions will place an impermeable cap over soils around the source of the contamination, a leaking underground storage tank (LUST); this will prevent concentrations greater than the Industrial/Commercial Direct Exposure Criteria and GB Leachability Criteria. Safety-Kleen currently submits quarterly soil and groundwater results to RIDEM for verification that these levels are not being exceeded. However, more contaminated sediment may soon be exposed and can potentially impact recreational activities along the River. The Pawtuxet Falls Dam is being considered for removal, and this will expose an additional six feet of the riverbank around the property. RIDEM asked Safety-Kleen in February 2011 to test the exposed soils for further contamination.

Safety-Kleen is the only active property among those chosen for the case study. It is also only 17 ft above sea level and less than 200 feet from the Pawtuxet River. Safety-Kleen, in conjunction with Ciba-Geigy, represents the biggest risk of all the properties. It is assessed at over $1 million. The building is worth almost twice as much as the land, $674,900 to $379,400.

[92] Ibid.

The property is extremely risky and an artificially high value that ignored risks of spreading contamination threatens the community. The value of the property for Cranston is based on the assessment of its production. The assessed rate in essence, should be higher to reflect costs of service to the community for cleanup of contamination. As flooding continues along the River, the property will require assistance in cleanup and mitigation efforts so that it may continue to operate. This is a nasty cycle that ignores history and only increases the costs to the municipal and federal governments. The risk associated with this property is great and poses a threat to surrounding properties. A high value that doesn't incorporate risk only increases the burden on the rest of the community.

For the remaining properties, I was unable to find records of the sources of their contamination and their history. These properties are listed on the EPA and RIDEM websites with assessment histories, but no more records were available. I have listed available data on the chart at the beginning of this section. I to include them because they offer an important example of the difficulty in making information accessible to the public, and the danger in failing to create records of the risk of these sites relating to disaster scenarios. They also offer a look at the trend in assessed value based on increasing distance from the river.

Cranston/Gemcraft Inc – 0 Perkins Ave, Cranston

This property is listed on the Cranston assessor's website as being jointly owned by the City and Gemcraft Inc. The parcel is 0.1 acres, and has no improvements on it. The assessed value was $4,600 in 2009. The City of Cranston asked the EPA for funding to examine the property for its potential use as a public greenway along the River. $870 was given. The EPA

assessed the property in September 2007 and found evidence of solid waste dumping. Potential contaminants included: corrosive materials, petroleum, waste oils with PCBs, semi-volatile organic compounds and heavy metals.[93] The City is aware of the contaminants on the property, but has not done a full soil and groundwater testing analysis yet. This property is only 15 feet in elevation, and less than 300 feet from the river. The City wants to use the property as a public area and for open space, but is restricted by the contamination thus far. However, the City understands the value of keeping this land undeveloped. The property will be less expensive (and thus have a lower cost of service) to cleanup because it will need to meet less stringent criteria because there will not be any development on-site.

S.O.T.E.S – 0 Fifth Avenue, Cranston

S.O.T.E.S is a local non-profit group comprised of Cranston citizens who want to donate the parcel to the city. Other sites registered for the release of hazardous materials surround the property. It is unknown if contamination has occurred on the property. The assessment of the property began in April 2008, and was completed in June of that year. The parcel has no improved value, and has a land value of $18,600. It is unclear if the property has already been transferred to the City, or if they would even be willing to accept the site. It is located on Fifth Avenue, which is a street that runs parallel to the river and is at a low elevation, only 27 feet above sea level.

[93] "Brownfields Property Progress Profile," Cleanups in my Community, EPA, accessed April 12, 2011

Fort Barton Holdings, Inc – 33 Graystone St, Warwick

This is the only property in Warwick. It is a one acre parcel that was the site of primary smelting and refining of nonferrous metals (except aluminum and copper). The site was assessed beginning in October 1987, and cleanup was completed in December 2009. The land value is $227,600, and is at 57 feet elevation. This is a good example of a property that is high enough in elevation to not be considered a flood risk, and its assessed value reflects that. However, the assessed value does not reflect risk on site. Although cleanup did occur on the property, there is insufficient data as to the types and amount of contaminants found on-site.

Cranston/Mill Development Co. – 0 Riverbank Rd, Cranston

This property is listed as being owned jointly by the City of Cranston and Mill Development Co. It is very small, only 0.05 acres, and has a value of $400. The property has undergone Phase I Assessment in September 2005, and Phase II Assessment began in September 2007. It is not known what contamination there is on-site or if dumping of hazardous materials occurred there.

Ralph Shuster Metals, Inc. – 12 Walter St, Cranston

This property is a former metal recycling facility. A Phase I Preliminary Assessment occurred in January 2007, and was completed in March 2007. The land was assessed at

$358,200, and the improvements at $31,300. The property is about two miles from the river, and at an elevation of 60 feet. However, it is next to Spectacle Pond, and the ground at the facility slopes down toward the Pond. It is not known what contamination occurred on the site, and cleanup has not been completed.

Technic Inc - 56 Spectacle St, Cranston

This property is listed simply for "historical use." It is a vacant parcel with a land value of $52,500. This property is also located about 2.5 miles from the River, adjacent to Spectacle Pond. It is a small piece of property, only 0.19 acres. The value of the property is lower because of the small parcel size, and does not necessarily reflect the distance from the river. It is next to a water body, and this may artificially enhance its value. Cleanup is planned for the property between October 2010 and September 2011.

Time Plating, Inc – 30 Libera St, Cranston

This property was originally developed and occupied in 1970 by Spenco, Inc. for jewelry manufacturing. The site was converted to Time Plating in 1981 for metals plating. Part of the property is undeveloped and wooded and is next to Randall Pond. The land is valued at $185,800 for 0.91 acres, while the on-site improvements are valued at $139,500. The land is worth more than the improvements upon it, which shows that the City values properties for their distance to bodies of water, not necessarily their flooding risk or hazard risk. The Property is at 73 feet in elevation, and several miles from the river, so flooding is not a risk. However, the property is

still valued because of its proximity to a water body. Cranston does not asses properties based on risk, but rather how close they are to natural amenities.

Pawtuxet River Authority – 0 Libea St, Cranston

This is a former Cranston-owned sewer easement that connects to Randall Pond. It is not known what on-site contamination occurred, if any, but it is listed as a Brownfields. The land value is listed at $81,300. There was a Preliminary Phase I Assessment in January 2007, and this was completed in March 2007. It is not clear what exactly is being assessed for cleanup.

GIS:

I present several maps that identify industrial properties within the Pawtuxet River floodplain. I also identify other types of land uses (i.e., residential or public infrastructure) located lower than 20 feet in elevation. I chose 20 feet in elevation because this is the level the Pawtuxet River crusted at in March 2010. Overall, there are 218 residential properties, 58 commercial and industrial properties and nine public infrastructure properties in the floodplain. The maps also include properties that are along the coast of Narragansett Bay. The properties, while not within the Pawtuxet River floodplain, are still vulnerable from storm surges and sea-level rise due to climate change. The maps show that many properties of different land uses are located near each other. For example, Safety-Kleen and Ciba-Geigy neighbor a cluster of residential properties that have suffered repetitive losses from flooding. The GIS maps were assembled using data from RIGIS in ArcGIS. The maps are important because they can spatially

identify the location of risks and the distance between the industrial properties and other types of land uses. This is important for municipalities when planning to increase vegetative buffers between contaminated sites and the River, or contaminated sites and residential properties.

Discussion:

These 12 sites present varying levels of risk to Warwick and Cranston. I chose these properties because they all carry a risk to the environment and local populations. These are also at varying distances from the Pawtuxet River, which is a strong indicator of their assessed value. Safety-Kleen is the only active site among the 12, and presents the most direct risk to the communities. The other historical properties that are still being monitored for soil and groundwater quality (e.g., Ciba-Geigy) also present risk for spreading contamination. The remaining Brownfields sites that have evidence of contamination present lower levels of risk but are still important to consider because the land is still available for remediation and "reuse" as open space.

A chart summarizing their assessed value and on-site risks is provided on the next page. I also show the assessed values of the properties graphed as a function of distance from the River. This is important because it shows that the value of the industrial properties declines as they get farther away from the River. This is the opposite of what I expected, because assessed value by the municipalities should reflect the cost of service of emergency response and vulnerability of properties in a floodplain. When the assessed value of the properties is graphed on a per acre basis, one can see that most properties are assessed at similar rates. This is also a different result than I expected, because I thought that the properties would be assessed on their levels of risk

and elevation in the floodplain. This shows that there is a disconnect between what value the properties are assessed at, and what value they should be assessed by Warwick and Cranston. I recommend changes to this assessment structure in the next section.

Hazardous Properties and their Associated Values in Warwick and Cranston, RI

Name	Address	Town	Appraised Land Value	Appraised Building Value	Net Assessed Value	Use	Parcel Size (acres)	Land Value/acre	Net Value/acre	Distance from the River (ft.)	Elevation (ft.)	Brownfields/ RCRA	Hazards	Cleanup
Safety-Kleen Systems Inc.	167 Mill St	Cranston	$379,400	$674,900	$1,054,300	In use	4.01	$94,613.47	$262,917.71	197	17	RCRA	Petrochemical, paint, coating, other misc. manufacturing; waste management and remediation services; testing laboritories; hazardous waste treatment and disposal; solid waste collection; secondary smelting, refining and alloying of nonferrous metal	Assessed 1992, complete 09/2007
Ciba-Geigy Corp.	180 Mill St	Cranston	$551,000	$2,458,400	$3,009,400	Vacant since 1986	8.04	$68,532.34	$374,303.48	232	20	RCRA	Inorganic chemical, petrochemical, medicinal and botanical manufacturing	Assessed 1988, cleanup complete 05/2002
Cranston/Gemcraft Inc.	0 Perkins Ave	Cranston	$4,600	$0	$4,600	Vacant	0.1	$46,000.00	$46,000.00	297	15	Brownfields	Evidence of solid waste dumping, potential contaminants include: corrosive materials, petroleum, waste oils with PCBs, semi-volatile organic compounds and heavy metals; Evaluated for development as a public river walk and park area	Assessed 09/2007
SOTES	0 Fifth Ave	Cranston	$18,600	$0	$18,600	Vacant	0.14	$132,857.14	$132,857.14	316	27	Brownfields	S.O.T.E.S is a local non-profit that wants to donate parcel to city, several surrounding properties are registered for release of hazardous materials, dumping may have occurred at site	Assessed 04/2008, completed 06/2008
Fort Barton Holdings Inc.	33 Graystone St	Warwick	$227,600	$615,700	$843,300	Vacant	0.93	$244,731.18	$906,774.19	1,908	57	RCRA	Primary smelting and refining of nonferrous metals (except copper and aluminum)	Assessed 10/1987; Cleanup complete 12/2009
Cranston/Mill Development Co	0 Riverbank Road	Cranston	$400	$0	$400	Vacant	0.05	$8,000.00	$8,000.00	6,440	61	Brownfields		Assessed Phase I 09/2005; Phase II Assessment 09/2007 (not completed)
Ralph Shuster Metals Inc.	12 Walker St	Cranston	$358,200	$31,300	$389,500	Not in use	3.17	$112,996.85	$122,870.66	10,785	60	Brownfields	Formerly occupied by a brewing company before being converted to a metals recycling facility in 1940-50	Phase I Preliminary Assessment 01/2007, completed 03/2007
Technic Inc	56 Spectacle St	Cranston	$52,500	$0	$52,500	Vacant	0.19	$276,315.79	$276,315.79	11,516	$50.00	RI Brownfields	Historical Use	Response Action Planned between 10/20010 and 9/2011
West Russe Realty LLC	55 Spectacle St	Cranston	$83,200	$0	$83,200	Vacant	2.41	$34,522.82	$34,522.82	12,520	49	RI Brownfields	Historical Use	Response Action Planned between 10/20010 and 9/2011
RI Technical Plating Inc.	50 Libera St	Cranston	$164,600	$372,000	$536,600	Vacant for 3 years as of 4/8/05	0.77	$213,766.23	$696,883.12	14,393	78	Brownfields	Former hazardous waste site, cleaned 1998	Completed 1998
Time Plating, Inc.	30 Libera St	Cranston	$105,800	$139,500	$325,300	Not in use	0.91	$204,175.82	$357,472.53	14,612	72	Brownfields	Developed and occupied in 1970 by Spenco, Inc for jewelry manufacturing. Converted to Time Plating, Inc in 1981 for metals plating; part of parcel undeveloped and wooded	Phase I Preliminary Assessment 01/2007, completed 03/2007
Pawtuxet River Authority	0 Libera St	Cranston	$81,300	$0	$81,300	Vacant	0.05	$1,626,000.00	$1,626,000.00	14,612	73	Brownfields	Former City-owned sewer easement	Phase I Preliminary Assessment 01/2007, completed 03/2007

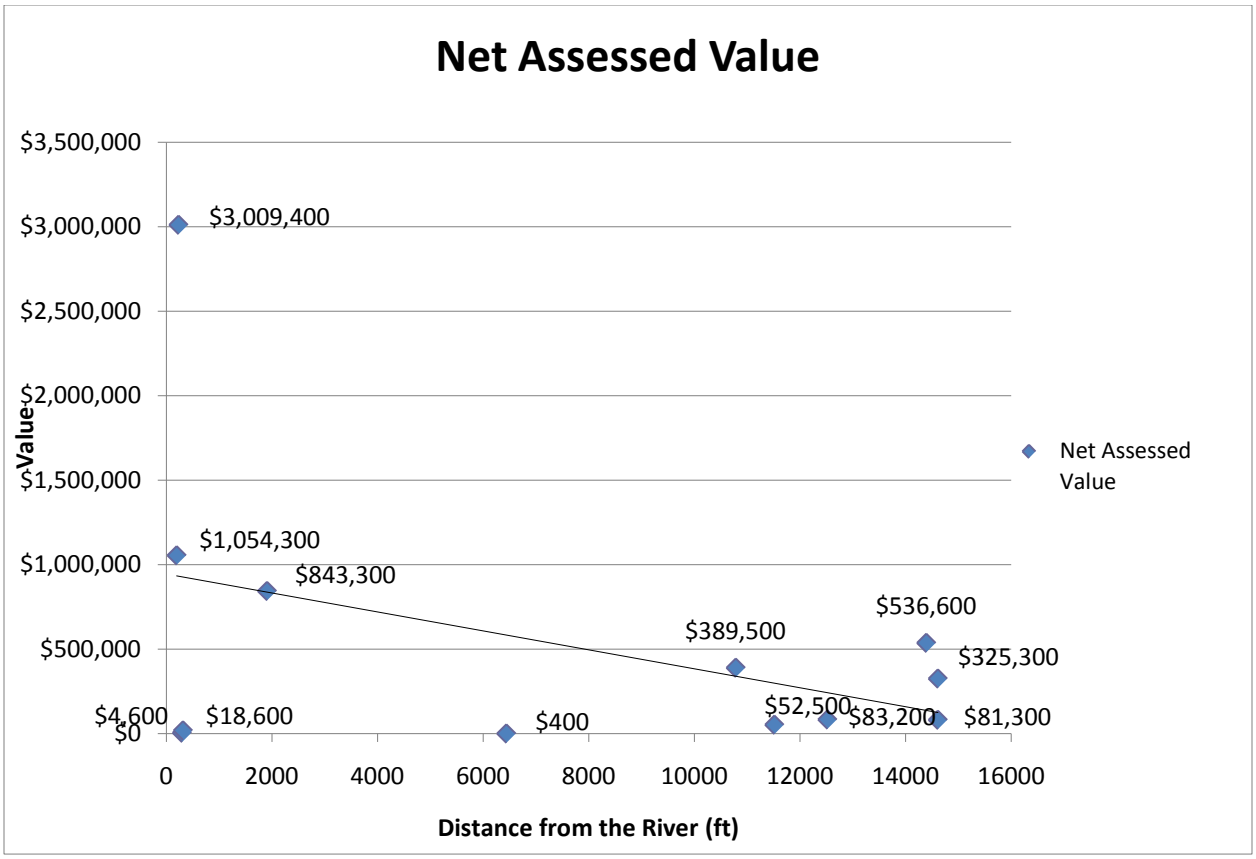

Figure 4. This chart shows the Net Value of the properties. There is a total decline in the assessed value of the properties as distance from the river increases.

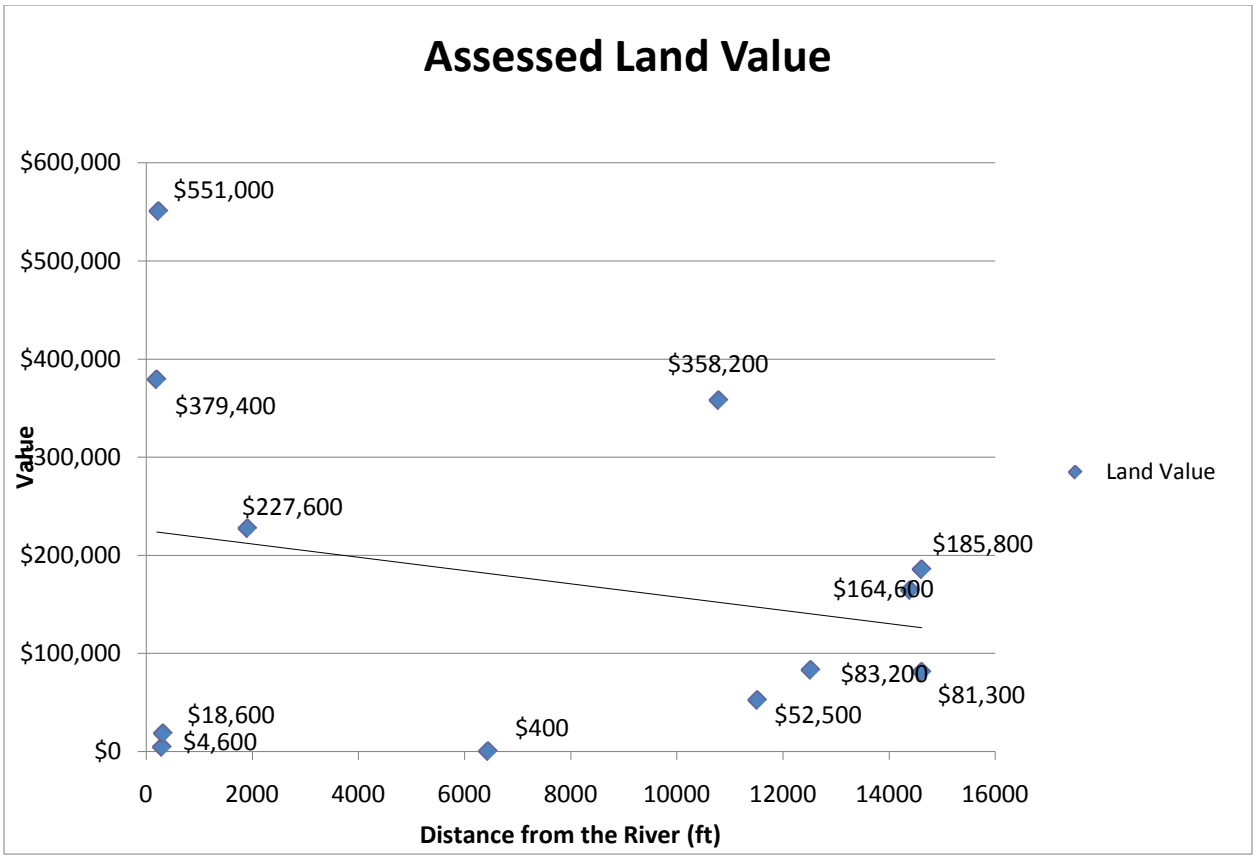

Figure 5. This chart shows the Assessed Land Value of each property. There is a decline in the assessed value of the land as the property gets farther from the river.

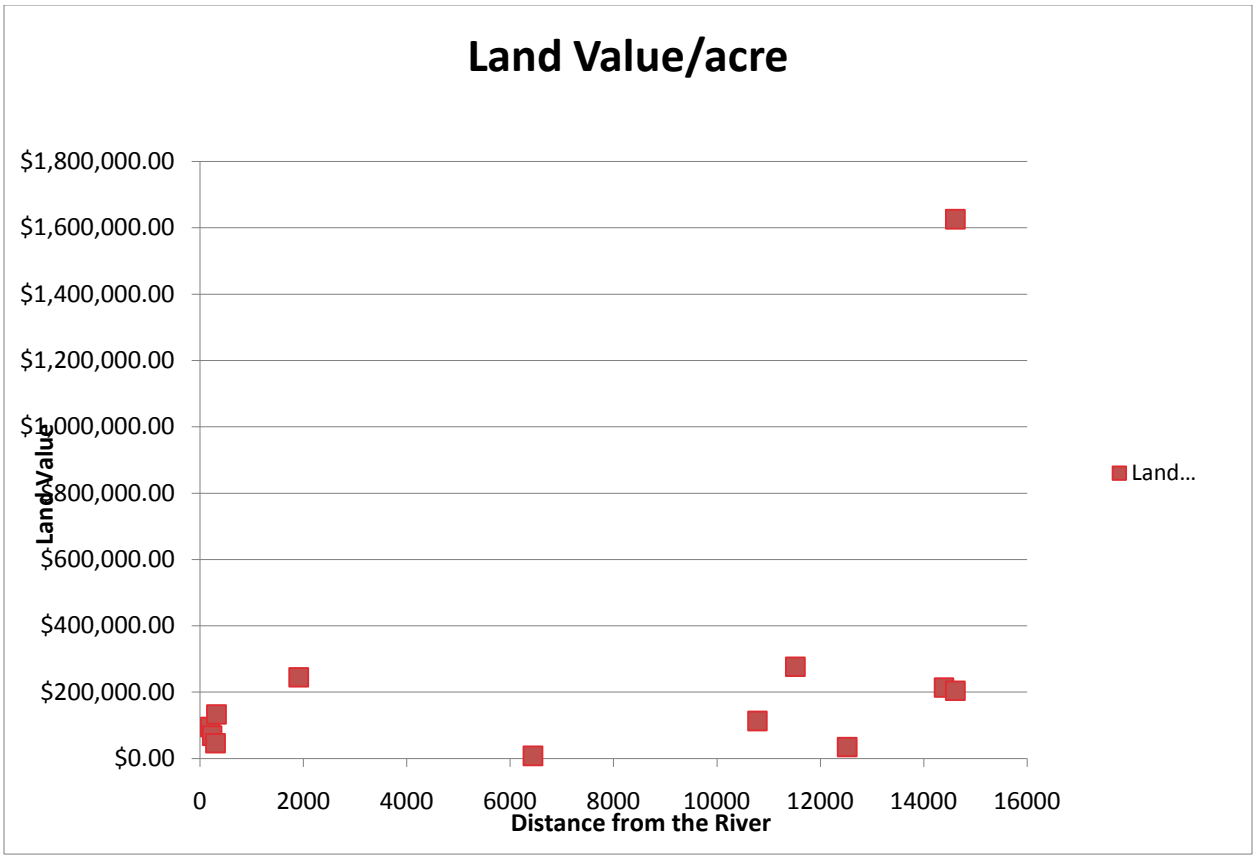

Figure 6. This chart shows the assessed value of each parcel on a per acre basis. This chart shows that most properties are assessed at similar rates. However, the rates fail to account for risk of on-site hazards and the frequency of flooding on the property.

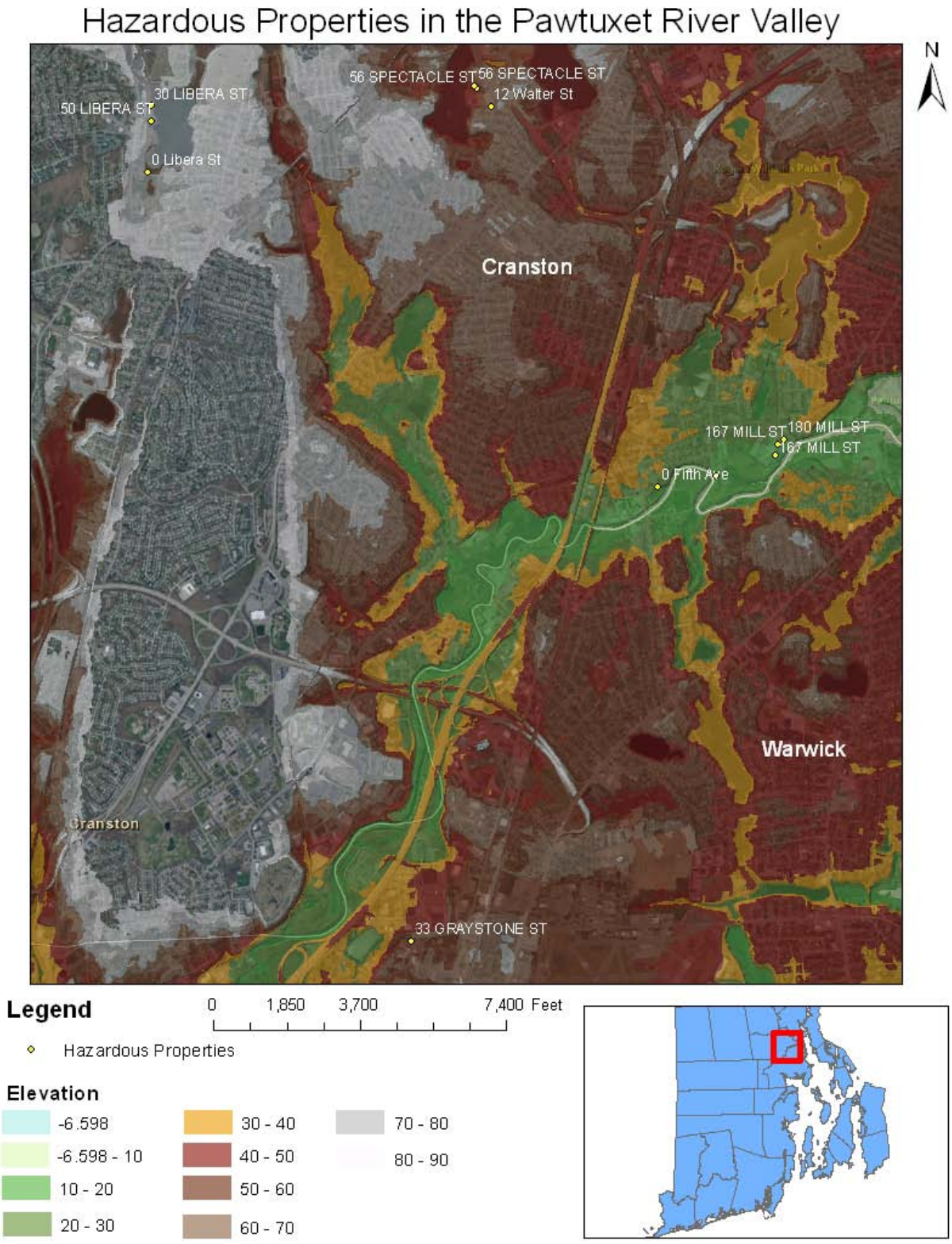

Figure 7. This map shows the 12 properties in the case study. They are labeled by address. The elevation profile of the Pawtuxet River is also shown.

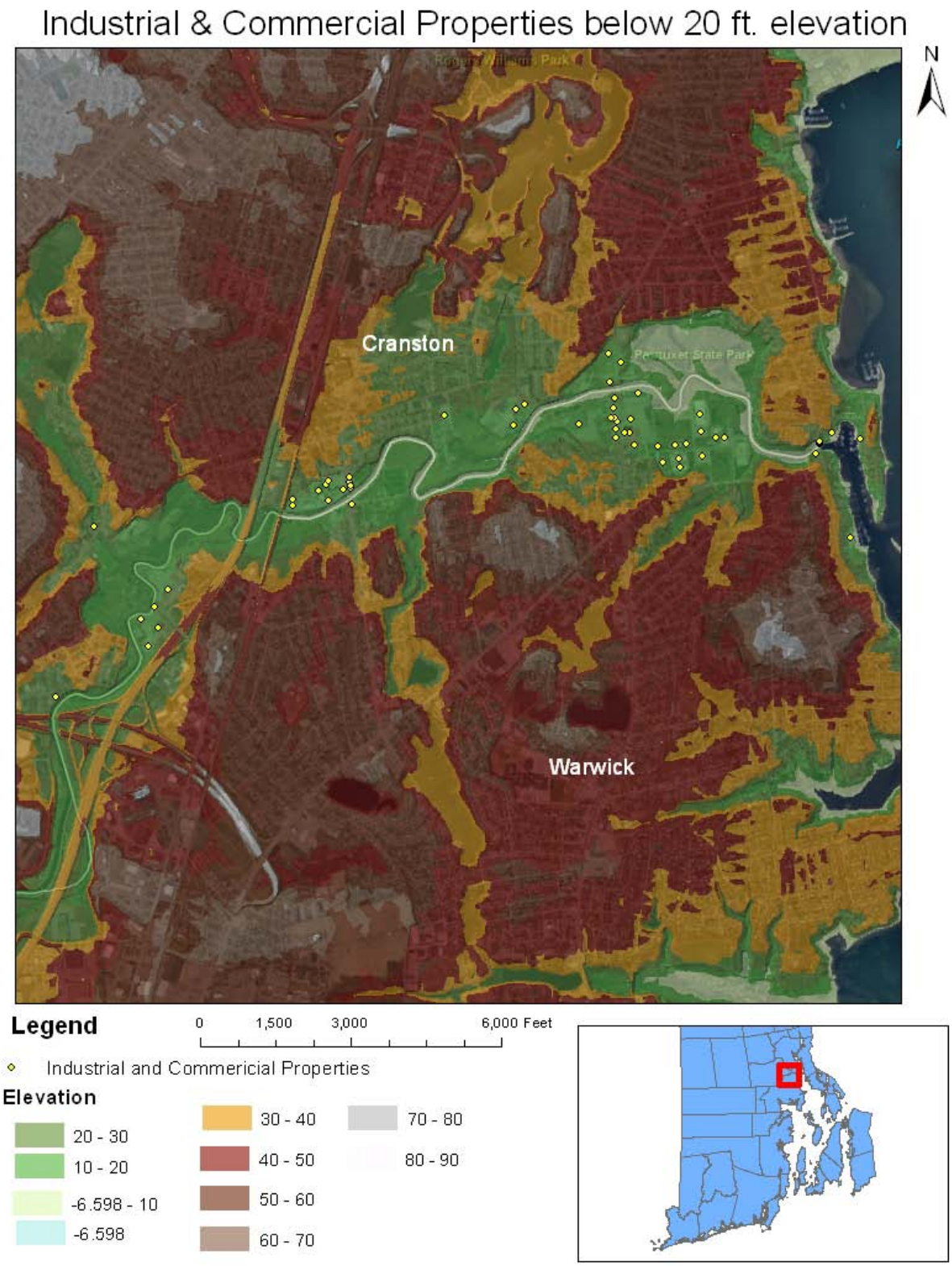

Figure 8. This maps shows the total number of industrial and commercial properties. There are 58 total below 20 ft. in elevation.

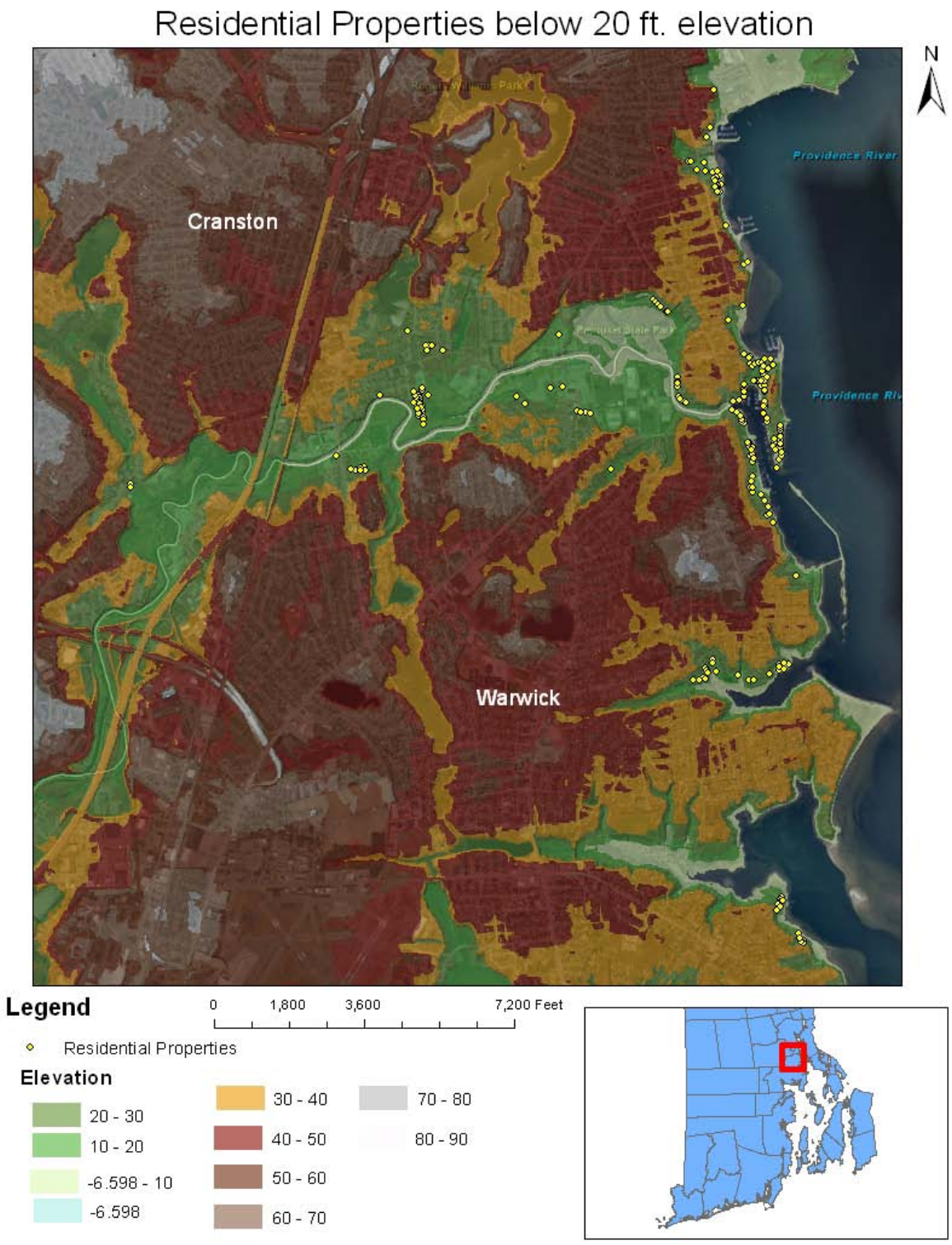

Figure 9. This map shows all residential properties below 20 ft. in elevation. There are 218 in total. Some are clustered near other types of property and others are along the coast, vulnerable to sea-level rise.

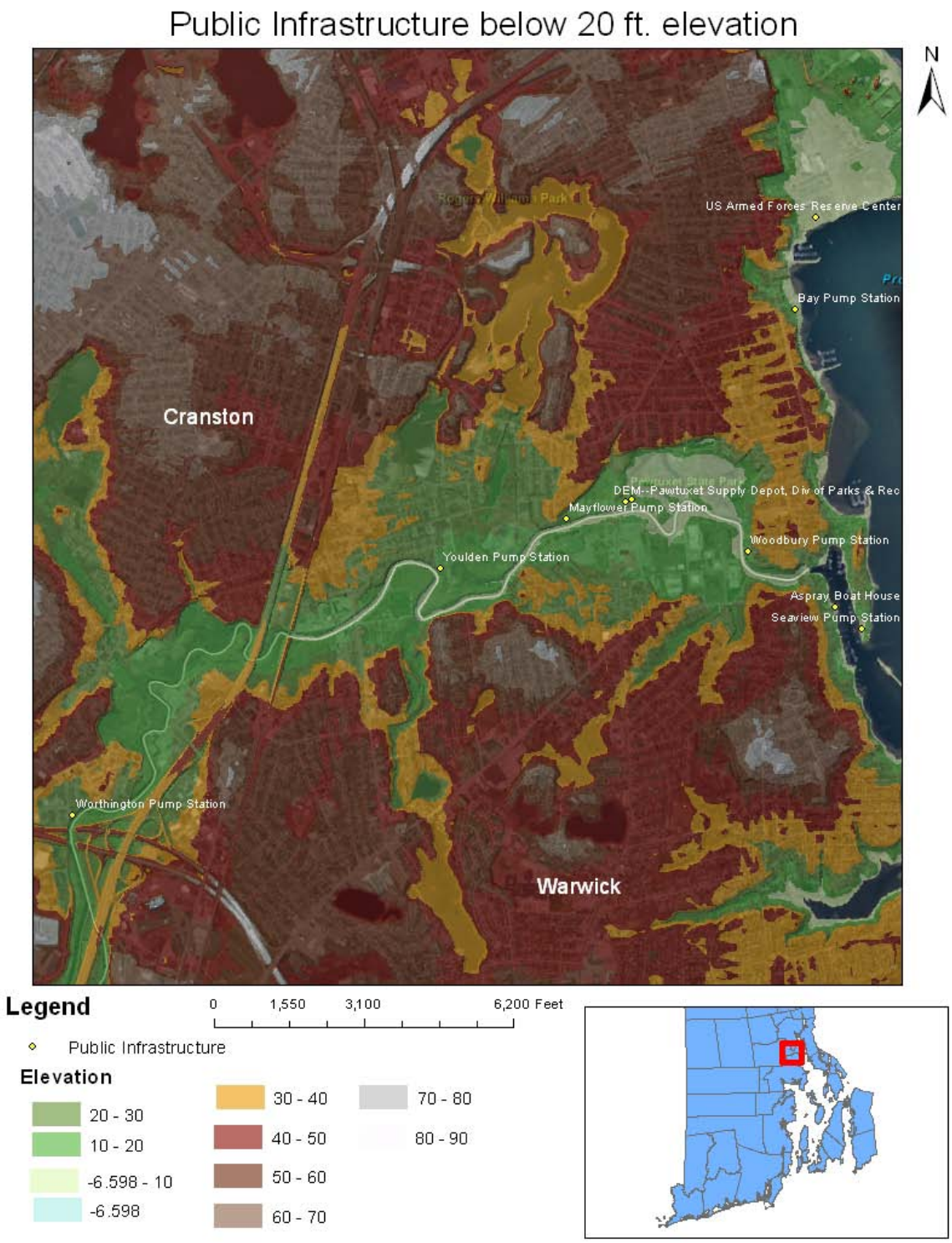

Figure 10. This map shows public infrastructure below 20 ft. in elevation. There are nine total. These are sites that could be severely damaged in a flood, and reduce Warwick and Cranston's ability to respond in an emergency. Many of the sites are pumping stations that can back up and overflow during a flood.

CHAPTER FOUR:

Conclusion & Recommendations:

Figure 11[94]

Key Findings:

I set out to answer the question "to what extent does a flood disaster affect the value and use of industrial properties within a floodplain." I have discussed the different ways in which land can be valued, and how Cranston and Warwick value contaminated industrial and riparian properties in their communities. I gauged the risk of on-site contamination and the risk of spreading contamination from industrial properties. I present several key findings:

[94] Pawtuxet Falls Dam. Photo from author.

- There have been 19 floods since March of 1993 alone.
- In Cranston, between 6-10 properties are repetitive losses, and 10-17 properties in Warwick are as well[95].
- In Cranston, 19% of the City is an impervious surface, while 24% of Warwick is impervious[96].
- Cranston has 8.25% of its 18,860 total acres designated as flood hazard area, for a total of 1,541 acres. Warwick has 3,923 acres (16.51%) of a total 23,760 acres in a flood hazard zone[97].
- Cranston participates in the NFIP, with 562 policies. Of these, 56 are non-residential. 366 of the properties are within an A-flood zone. Since 1978, 472 claims have been filed, with $8,572,758 paid in damages. Thirty-three of these 562 properties are listed as repetitive loss properties[98].
- The assessed value of the 12 properties is both artificially high and low. It is low because the assessed value by Warwick and Cranston does not include risk of contamination and cost of services for cleanup and emergency response. Warwick and Cranston assess properties at nearly the same rate per acre, without accounting for on-site risks and vulnerability to flooding. The assessed value is artificially high because the properties closest to the Pawtuxet River have higher assessed values than properties farther away from the River.

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[95] Ibid.
[96] Zhou, Yuyu & Wang, Y.Q. 2007. Assessment of Impervious Surface Area in Rhode Island," *Northeastern Naturalist* 14(4): 643-650, accessed April 12, 2011
[97] Rhode Island State Hazard Mitigation Plan," RI Emergency Management Agency: 2008, accessed February 28, 2011
[98] "Hazard Mitigation Plan," City of Cranston: August 2010 Draft, accessed March 21 2011

The 12 properties discussed in the case study present varying levels of risk to Warwick and Cranston. Both municipalities have Hazard Mitigation Plans that score their vulnerability and the level of hazards in their communities[99]. Neither discusses the disaster of flooding as it relates to hazardous materials stored or leaked in a floodplain. The contamination of these properties is part of Warwick and Cranston's industrial legacy, and indeed it is a legacy repeated across the United States. As a result, these small municipalities lack the resources to effectively respond to natural disasters without the aid of the federal government.

Yet, the federal government faces its own problems in keeping the NFIP solvent. The program faces several problems in reducing its debt and increasing its ability to pay out claims. According to the Government Accounting Office, a non-partisan research service, updating premiums to better reflect actual risk of flooding on a property would possibly reduce voluntary participation in the program or would result in insuring people who only pay the minimum premium (i.e., the amount equal to the outstanding mortgage balance)[100]. If this occurs, taxpayers would be responsible for covering a larger share of the claims. A similar debate is undergoing in Cranston over the equity of homeowners from the March 2010 floods receiving lower property tax assessments while unable to live in their homes[101]. This forces other Cranston taxpayers to cover a larger share of the community tax burden. The NFIP has been proactive in updating its flood maps and redrawing flood hazard zones, but has dragged its feet on charging premiums that reflect the actual risk.

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[99] Ibid.
[100] "Ongoing Challenges Facing the NFIP," Testimony before the Committee on Banking, Housing and Urban Affairs, U.S. Government Accountability Office, accessed February 28, 2011
[101] Howell, John. "Flood Victims Stay Focused." *Cranston Herald*. 13 Jan. 2011. Web. 17 May 2011. <http://www.cranstononline.com/view/full_story_news/11002803/article-Flood-victims-stay-focused?instance=home_news_right>.

Part of this problem is the failure of a private insurance market to develop. One reason a private flood insurance market never formed was the “uncertainty” of flooding. However, there have been 19 floods along the Pawtuxet River in the past 18 years; a rate of roughly one per year. Private companies have been unwilling to bear the burden of risk not due to the uncertainty of flooding, but the certainty of flooding. Annual flooding and payout of claims for property damage leads to an unsustainable business model. Therefore the federal government has stepped in to provide guarantees for coverage to homeowners and business owners in a floodplain.

However, private markets can also fail to allocate resources efficiently and can produce negative externalities. Externalities are consequences that are not borne solely by the entity that produces them. The federal government bears the burden of risk in effectively ensuring homes and businesses against flooding. The industrial properties created pollution and hazardous waste, which was historically discharged directly into the Pawtuxet River and groundwater supply. Now the citizens of Warwick and Cranston are being asked to bear the burden of risk by sharing a floodplain with these hazardous properties. However, Warwick and Cranston are not totally innocent in this history. Both have sanctioned development within the floodplain and have undertaken expensive remedies, such as dams and armored shorelines, to prevent flooding that still fail. These engineered solutions only push the water somewhere else. During a flood, it does not immediately disappear but must still be stored somewhere until it can percolate back into the groundwater recharge system or flow into Narragansett Bay.

Recommendations:

I now offer several recommendations to Warwick and Cranston that will better prepare them for flooding disasters, as well as improve their overall relationship to the river. These recommendations are focused towards policies that Warwick and Cranston can pursue to mitigate flooding and reduce negative environmental externalities. Some though, are focused towards the federal government and the need to amend the role of the National Flood Insurance Program.

- Cleanup any remaining contamination on properties and periodically test soil and groundwater for greater than allowable concentrations of hazardous compounds and materials.
- Acquire vacant and abandoned properties and properties that have suffered greater than two repetitive losses from major floods and return them to open space. As discussed previously, the value of open space is not in the revenue it generates, but the costs it doesn't require and the natural services it provides.
- Reduce impervious cover along the banks of the Pawtuxet River and the floodplain by creating tax incentives. Tax incentives would help reduce cover by placing a value on open space for the communities. This will allow for more vegetative cover that can be used as a buffer between properties and the water and allows for immediate absorption of floodwaters.
- Attach value to risk; properties with risk of contamination spreading beyond their boundaries should have a low value and a higher tax burden to reflect the hazard they impose on the community.

- End subsidies of flood insurance policies in the NFIP; properties have artificial value when not paying full price for the risks they face and externalize to everyone else. In addition, premiums should be increased to prepare the NFIP for future flooding disasters and give the Program the ability to cover losses.
- Tax open space at a lower rate than improved parcels, because this provides an incentive for property owners to keep their land undeveloped, and rewards them for having a lower cost of service to the municipality.

Some of these recommendations are already being realized. As discussed earlier, RIDEM currently monitors several historical industrial properties such as Ciba-Geigy and RI Technical Plating for soil and groundwater quality[102]. This implicitly acknowledges that risks still exist on-site and may spread off-site in the future. Additionally, there is a bill currently being considered in the 112th Congress to reform the National Flood Insurance Program[103]. The bill would restrict development in floodplains, reduce subsidies and increase insurance premiums[104]. The legislation also creates incentives for private insurers to participate, which will increase prices. Mapping of floodplains will be changed to create "risk-based insurance" that discourage development near hazardous areas. It is unclear how repetitive loss properties would be treated, if they would lose coverage or the property forced to be condemned. The Bill is currently

[102] "Sediment Sampling Report for the Pawtuxet River, former Ciba-Geigy Facility," Ciba Specialty Chemical Corporation: May 2003, accessed March 21, 2011
[103] Flood Insurance Reform Act of 2011, H.R. 1309, 112th Cong. Print.
[104] Mianecki, Julie. "House Panel Passes Bill on Government Flood Insurance Program." *Los Angeles Times.* 14 May 2011. Web. 17 May 2011. <http://www.latimes.com/news/nationworld/nation/la-na-louisiana-flooding-20110514,0,601374.story>.

pending in the House Committee on Financial Services, with no clear timetable for full approval in the House or Senate[105].

Cranston and Warwick have also looked to reform their assessment policies for properties within a floodplain. However, the City Councils want to provide tax abatements for properties flooded in March 2010, so that residents do not have to pay taxes while they are unable to live in their homes[106]. The Mayor of Warwick, Scott Avedisian, supports this proposal because it reflects the "lost use" of the property. However, Mayor Allen Fung of Cranston has vetoed the measure from his Council because he believes it places an inequitable burden on the rest of the Cranston community and unfair to those who were not affected by the flooding. Both communities have responded in different ways to the flooding disaster in March 2010, and want to help those that were affected by the flooding. However, as I have made clear, assessing the value of properties vulnerable to repeated flooding is not effective. It further reduces revenue to the municipalities and their ability to provide services for cleanup and emergency response. A more absolute way of reducing future losses from flooding is increasing the amount of open space and wetlands adjacent to the Pawtuxet River. This type of land use has low cost of service to the community; absorbs floodwaters and provide buffers between industrial properties, the River and other types of property.

Currently, the Pawtuxet River is planned for ecological restoration. The Pawtuxet Falls Dam at the mouth of the River is slated for removal to lower the water surface elevation, connect

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[105] Flood Insurance Reform Act of 2011, H.R. 1309, 112th Cong. (2011).
[106] Howell, John. "Flood Victims Stay Focused." *Cranston Herald*. 13 Jan. 2011. Web. 17 May 2011. <http://www.cranstononline.com/view/full_story_news/11002803/article-Flood-victims-stay-focused?instance=home_news_right>.

the River to Narragansett Bay, and improve fish migration[107]. Lowering the water surface elevation will reduce the severity of flooding along the River. It is important to note that it will not reduce the frequency of flooding along the River, but only its severity for low-elevation properties. Removing the Dam will also improve water quality by increasing the velocity of flow and decreasing the water temperature[108]. This will decrease growth of algae and bacteria. Removing the Dam will also help restore the natural functions of wetlands, so that floodwaters can be more readily absorbed. The project to remove the Dam is being co-managed by a team of governmental agencies on the State and Federal level, such as the EPA and RI Department of Environmental Management. It is also supported from non-governmental organizations like the Pawtuxet River Authority and Narragansett Bay Estuary Program. There is no definite date on when the Dam will be removed. However, the concert of action between different levels of governmental and non-governmental agencies shows that restoring natural ecological functioning is a priority. Removing the Dam will help reduce the impact of flooding, and provide relief for properties that are inundated by the Pawtuxet River's nearly annual flood events.

Conclusion:

Water prefers to sit in low-lying areas, and does not much care what sorts of buildings or human activities are compromised by its presence. It is up to us as a society to prevent this conflict between the water and our property. In March 2010, residential properties and industrial properties were impacted from the disastrous flooding event. Warwick and Cranston applied for

[107] "Pawtuxet River Restoration Project: Application to Alter," Pawtuxet River Authority, June 2010, accessed May 17, 2011.
[108] Ibid.

disaster aid and received over a hundred million dollars in grants from the state and federal governments[109]. This only fixes the problem from March 2010. There will be another flood event, and the communities will face many of the same scenarios as before: people are forced out of their homes, businesses close and the federal government has to step in and literally bailout the community.

This paper has focused on industrial properties, and the inherent risks they provide with their current and former activities. Yet, much has and should be written on the impacts to homeowner as well. Much of the news coverage of the 2010 floods have focused on homeowners, and how they are victims to nature. But as I have proposed and hopefully proven, no one is completely innocent; Warwick and Cranston have not been able to completely mitigate hazards they slowly created. The Pawtuxet River Valley has been settled in some fashion for thousands of years, with industrialization and the economies of scale it provides only representing a small slice of that. Industrialization and its legacy of pollution and contamination will continue to be part of the lower Pawtuxet River Valley for several more generations at least, even as the River washes through. The River will hopefully outlast us, despite our best attempts to alter and impede its path. It is the least we can do to ensure the River is at least healthy as it flows out into the Bay. Giving it space to flood is just as important to its health as is removing pollutants from the water and maintaining fish runs.

[109] "RI to Receive $13M in Federal Flood Help," Providence *Journal*, http://newsblog.projo.com/2010/09/ri-to-receive-13-million-in-fe.html, accessed March 20, 2011

Acknowledgments:

I would like to sincerely thank my advisor, Caroline Karp for guiding me through the long process of producing this thesis. I can't imagine working without her help and guidance. I would also like to thank the other faculty and staff of the Center for Environmental Studies for helping me learns about my place as a global citizen through the lens of the environment.

I would also like to thank the Rhode Island Department of Environment Management, and the great staff there who pointed me in the right direction several times as I researched and assembled material for my thesis.

Finally, I would like to thank my friends and family for supporting me during my time at Brown, and helping me grow in numerous ways.