Improving Public Access to the Nashua River in Lancaster, MA

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Abstract

Town-owned land along the Nashua River in Lancaster, Massachusetts requires some work in order to reinvigorate public access and utilization. Our group worked with volunteers and town officials to accomplish a series of specific goals to address this situation. Top priorities included: a boundary survey of the Cook Conservation Area; an accurate map of the existing trail system; and an investigation into the history of land use in the parcel. This report details how we accomplished all of these goals through repeated visits to the area using GPS equipment and GIS software, gathering and interpreting primary and secondary source materials, and conducting interviews with significant participants in the movement to restore the river's ecosystem.

Acknowledgements

We offer our sincerest thanks to Professor David Spanagel for his guidance and support throughout the course of this project. We would also like to thank Tom Christopher, Bill Flynn, Marion Stoddart, Susan Munyon, Peter Farmer, Noreen Piazza, Professor Suzanne Le Page, and Professor John Hall for their invaluable contributions to this project. In addition, we are grateful for the support and assistance provided by the following organizations: the Lancaster Friends of the Nashua River, the Lancaster Conservation Commission, and the Lancaster Historical Commission.

1.0 Introduction

The history of the Town of Lancaster, Massachusetts is inextricably linked to its most precious natural resources, the Nashua River. The area that Lancaster occupies today was originally inhabited by the Nashaway people, a group of Algonquian Indians. The Nashua River takes its name from the Nashaway, which means "river with the pebbled bottom" [NRWA 2013b]. At the heart of the town, the North and South branches of the Nashua River converge before flowing northward towards the Merrimack. The town of Lancaster was officially incorporated in 1653 as "Lancaster on the Nashua" and is the oldest town in Worcester County. Intervales (broad fertile valleys that are carved out by rivers over thousands of years) combined with seasonal fish runs make this area highly attractive to human settlement [Massachusetts Historical Commission 1984, 1-2]. Aside from providing sustenance, the river also brought aesthetic pleasures and recreational opportunities to the residents of Lancaster. Although the Nashua River played a crucial role in the lives of early settlers, the residents of Lancaster have not always been attached to this beautiful landmark.

The industrial revolution transformed the primary uses and overall health of the river significantly. During the 19th century, towns upstream such as Fitchburg and Leominster became booming industrial centers for the manufacture of paper, plastics and textiles, while Lancaster held onto its rural and agrarian roots. According to the custom of the time, these mills dumped their wastewater (including sewage) directly into the Nashua and its tributaries. As a result of over a century of unrestricted industrial discharges, the Nashua River was ranked as one of the most polluted rivers in the United States in the early 1960's [Nashua River Watershed Association 2012b]. In the public's eye, the river gradually faded into obscurity, and its formerly pristine waters, teeming with fish, were now lifeless and foul. The memory and reality of a

vibrant Nashua might have been forgotten forever, were it not for the combined effort of multiple stakeholders in the region, all aroused by the extraordinary leadership of one local woman, Marion Stoddart. In the late 1960's, Mrs. Stoddart mobilized citizens, local businesses, and politicians to help cleanup and restore the Nashua River

Many organizations carry on the mantle of Mrs. Stoddart by working to protect the Nashua River. The Lancaster Friends of the Nashua River (hereafter LFNR) is one such organization. Since their group's establishment in 2010, members of this local affiliate of the Nashua River Watershed Association (hereafter NRWA--the Groton-headquartered group that Marion Stoddart founded in 1969) have been committed to reintroducing the community to this underappreciated natural treasure. Fortunately, the town of Lancaster owns a large swath of land along the North Branch of the Nashua River which is designated as conservation land. The area is heavily forested and a prime location for hiking, fishing, and other recreational activities. As of 2012, however, it was highly underutilized due to obstructed accessibility and a lack of publicly prominent maps and guides to the terrain.

In an effort to enhance and increase public access to the Nashua River, the Lancaster Friends of the Nashua River requested the assistance of our IQP group. We were asked to focus on the Cook Conservation Area, which is one of several parcels along the river. Our primary goals for this project include: (1) perform a boundary survey of the Cook Conservation Area; (2) map out the various trails in the area and; (3) investigate and document the history of land use in the parcel. The various components of this project are intended to help visitors to appreciate the beauty of the Nashua River and to support the town of Lancaster's ability to preserve and improve the health and vitality of its river corridor, while expanding the river's recreational opportunities for citizens.

2.0 Background

This portion of the report frames the project in a historical context to better illustrate its significance. Different subsections chronicle the history of the Town of Lancaster, the Nashua River, and the restoration effort. Another subsection also provides contemporary technical information regarding the impact of pollution on waterways. Furthermore, this background provides an overview of the area that this project focused on and a discussion of the outstanding issues.

2.1 Town of Lancaster

Lancaster was once called "Nashaway," meaning the meeting of waters. The land is fertile with dispersed forests and ponds. In the decade after the founding of Massachusetts Bay Colony in 1630, the English pushed west to seek trade with the native people. According to Heather Maurer Lennon, Thomas King of Watertown, in 1642, was invited to settle here by the Nashaway sachem Sholan, which started the history of English people living among the Nashaway [Lennon 2001, 7].

Ravaged by diseases, the Nashaway tribe at this time found its members in militant fights with other native tribes. Meanwhile, the English grew their settlements here. In 1653, John Prescott with nine families, petitioned the Massachusetts General Court for the right to incorporate. On May 18 of the same year, Lancaster, became the "mothertown" for most of what is today Worcester County.

In the first thirty years after Lancaster was founded, the area was still considered by the European settlers as unsafe. An inevitable clash of cultures occurred and violence erupted here. In 1675, when King Philip's war broke out, the town was pillaged and burned by the natives. It was not until 1681 that resettlement and rebuilding began. According to Abijah Perkins Marvin:

> *From 1708 the increase was quite rapid, since we find, from the table of garrisons, on a preceding page, that in 1711, there were in the town, eighty-three families, one hundred and eleven men inhabitants, and four hundred and fifty-eight souls. This gives very nearly five and one-half souls to a family, and shows the increase to have been, if the data were correct, about one hundred in three years. This result is not improbable or surprising. No person was killed by the Indians, in this town, after 1707 except an Indian boy. There was comparative safety here, and the people from the lower towns flocked into this beautiful section in large numbers* [Marvin 1879].

By 1701, Lancaster's territory had increased to 112 square miles, about 290 square kilometers. The town at that time included what is today Leominster, Sterling, parts of the two Boylstons and Clinton.

In the 19th century, the United States was expanding rapidly, having grown from a narrow fringe of eastern states to a continent-wide nation of 76 million. As part of this trend, rural New England lost much of its population to the cities and to the west. Another loss was incurred when Clinton, Lancaster's last "daughter town," broke away in 1850. In 1900, the town was typical of rural America, where 60 percent of the population lived in communities of less than 2,500 or on farms. The neat cottages and quaint farmhouses, coupled with the stately elms, rolling hills, and broad fields, made Lancaster a tourist destination in a time when "the trees alone" were thought to be worth a trip. The Lancaster house drew guests each summer, and rooms in local farmhouses were rented by summer boarders [Lennon 2005, 7].

Life in Lancaster was not entirely rural and agricultural in the 19th century. Even before the coming of the Fitchburg Railroad in 1845, traffic through town was heavy, as Lancaster was

positioned at the junction of thoroughfares to western and northern Massachusetts. In 1838, for example, 32 horse-drawn stagecoaches passed through every week, carrying an average of 48 passengers in total. Teamsters hauling freight flowed endlessly; five hotels operated in town at the time. Blacksmiths, wheelwrights, wagon makers, and harness makers found ready employment. Local factories produced leather, brick, tin, and shoe shanks (the supportive structure between the insole and outsole in a boot or shoe). Other local tradesmen engaged in engraving and printing, cabinetmaking, watchmaking, painting, and gunsmithing, as well as making hats, comb, soap and pocketbook. Mid-19th Century Lancaster also had a tannery, brickyards, a tin shop, and cider mills [Lennon 2001, 7].

In the 20th century, however, the appearance of the town began to change. Residential and agricultural uses of the land recovered and displaced the industrial and commercial uses that had prevailed for a time. Many of those earlier industries, such as hat, boot, and printing, migrated to nearby Clinton or else disappeared entirely. Land acquisitions by the wealthy Thayer family turned into prominent estates along Main Street, George Hill, and the Back road. These fine homes signaled a long term trend toward the bucolic identity Lancaster now celebrates in the 21st century."

Because Lancaster is situated near the converging branches of the Nashua River, water has always been a significant part of the town. This become very apparent when a hard winter, an early thaw, and torrential rain produced the flood of 1936 and left its mark. The Nashua River flooded, destroying all bridges and isolating Lancaster Center for many days. As the 20th century progressed, the Nashua River began showing the effects of years and years of pollution [Lennon 2005, 8].

2.2 The Nashua River

The Nashua River watershed includes parts of 31 communities in Massachusetts and New Hampshire, with a total drainage area of approximately 538 square miles. The river flows for a total of 56 miles before joining with the Merrimack River at Nashua, NH. The Nashua River and its tributaries have some highly unusual characteristics. The majority of the tributaries that feed the main stem of the Nashua River flow in a southerly direction, while the main stem flows in a northerly direction (refer to Figure 9 in Appendix A) [NRWA 2013a]. The North Nashua River begins in the former industrial center of Fitchburg and flows through Leominster and into Lancaster. The South Nashua River flows from the Wachusett Reservoir in Clinton, which serves as part of the water supply for Boston, before entering Lancaster. The two main branches of the river join in Lancaster to form the main stem which then flows to its terminus in New Hampshire. The town of Lancaster contains more river miles of the Nashua River than any other town in the watershed.

Over the years, the use of the Nashua River has been subject to the competing interests of landowners, mill owners, and citizens. These competing interests have had a tremendous impact on the overall health of the river from the time the Nashua River Valley was first settled in the early 17th century up to the present. This situation is not unique to the Nashua River. In fact, many rivers throughout New England share in the region's environmental legacies of agricultural and industrial development.

Early European settlers possessed a certain reverence for the rivers of New England. They depended on these rivers for sustenance, just as the Native Americans inhabitants had for thousands of years. Farmers used the river to irrigate their fields and the fertile floodplains were ideal for growing and harvesting hay for livestock [Steinberg 1991, 27]. The annual spawning

runs of anadromous (fish that spend most of their life in salt water, but return to fresh water to spawn) fish species provided an abundant and reliable source of food for early settlers. In the Nashua River, shad and salmon were particularly plentiful [Marvin 1879, 33]. The reverence that the inhabitants had in the rivers is reflected in the common law practices carried over from England. The natural-flow rule, which states that "water flows and ought to flow, as it had customarily flowed," was the guiding principle in these times [Steinberg 1991, 141]. This law sanctioned the use of water for domestic purposes and for agriculture so long as it did interfere with another individual's rights and property [Steinberg 1991, 142]. The advent of the industrial revolution in the 19th century caused profound changes to the relationship between individuals and the rivers of New England and to the overall health of rivers like the Nashua.

Prior to the industrial revolution, sawmills, gristmills, and fulling mills played an integral role in the agricultural economy. However, these mills paled in comparison to the scale and purpose of their industrial successors. These early mills were open to the public and helped provide food, clothing, and shelter to the early settlers. They also required significantly less water than industrial mills as they were only operated seasonally [Steinberg 1991, 28]. As industrial mills sprung up along the various waterways of New England, these mills created conflicts between mills and riparian (situated on the banks of a river) landowners. These mills required significant milldams to provide water power and the impoundments they created often flooded low–lying areas upstream. Traditionally, riparian landowners were granted protection from this loss of property under common law. In this scenario, landowners were afforded two options: "bring an action for damages and attempt to recover compensation for their flooded land" or "take the law upon themselves and abate the nuisance" [Steinberg 1991, 150]. The latter option posed a serious threat to mill owners as it granted landowners the authority to

disassemble a dam on their own accord. As the industrial revolution progressed in New England, however, new laws were enacted that favored mill owners and economic progress. For example, legislation known as mill acts established a set procedure for compensating landowners for loss of property resulting from the construction of a milldam. Furthermore, these acts firmly established this as "the exclusive remedy for flooding lands" which ensured that mill owners would no longer face the threat of costly litigation [Steinberg 1991, 31].

By the middle of the 19th century, mill owners had won the battle for the rivers of New England. For the next century or so, the river was dominated by industrial interests and the landowners and citizens would come to bear the burden associated with this increased productivity. Aside from the extensive network of dams built in industrial centers like Fitchburg, industries discharged all or most of their process water and sewage directly into the tributaries and streams of the Nashua River. For example, in 1887, the Nashua River received discharges from nine paper mills, four woolen mills, two cotton mills, and the sewage from the entire city, which at time was home to approximately 12,000 people [Massachusetts State Board of Health 1877, 43]. This trend continued into the 20th century and by 1960, the Nashua River had become one of the most polluted rivers in the entire country [NRWA 2012b].

The effects of industrialization severely limited the use of the river. Any recreational opportunities that the river once afforded were lost. Dams constructed downstream at Nashua, N.H. and on the Merrimack River had cut off annual fish runs from reaching the Nashua River [Marvin 1879, 33] and any local fish species had been killed off by pollution. In many places, the aesthetic value of the river was lost too. The raw sewage discharged into the river produced a foul odor and the dye from the paper mills caused it to run various colors [Flynn 2013].

During the political and social turbulence of the 1960's, some local citizens decided to reject the status quo and challenge the powers that had neglected the river for so long. The seeds of the environmental movement had been planted with Rachel Carson's landmark 1962 book *Silent Spring*. Citizen efforts, like the Nashua River Clean-up Committee (NRCC) led by Marion Stoddart, mobilized public concern over environmental issues into support for concrete local actions. The NRCC was successful in reclaiming the river for the people with the help of local business owners and state and federal legislation. NRCC activists pushed for class B status, which meant that the river would suitable for fishing, swimming, and boating [NRWA 2012b; Stoddart 2013]. Wastewater treatment facilities were constructed in cities like Fitchburg to treat the industrial waste and sewage before discharge. Today, the river is protected by the interests of citizens who look to the river for its aesthetic value and recreational opportunities, neither of which were present 50 years ago. The NRWA and its offshoots continue to work to expand recreational opportunities and to implement long term protection programs, like the Nashua River Greenway, to promote river health.

2.3 Impact of Pollution

During the 1960's and 1970's, a number of rivers in the United States reached levels of pollution that deemed the water unusable. During this time, awareness of the damage which pollution causes increased in American society. Along with this increased awareness came a need to clean up the pollution and repair the damage. *Downstream,* written by zoologist John Bardach, provides some insight on the understanding about the impact of large scale pollution on a river in the 1960's.

In small quantities, pollutants may not cause significant problems in a river. The reason a small amount of pollution may not cause problems is due to the fact that a river will dilute any

contaminates as it flows downstream because surface water runoff and other bodies of water will flow into the stream, providing a larger amount clean water. Even bacteria harmful to humans present in sewage can be diluted in a river of natural conditions to a point that the bacteria will die and the water will be safe to drink. Dissolved oxygen can also be depleted due to bacteria, but the oxygen can be replenished as the water flows downstream [Bardach 1964, 203].

Although a river can recover easily from a small amount of contaminants, a river may not be able to naturally recover when subjected to a larger scale of pollution. A large factory dumping its waste into a river differs greatly from naturally occurring contaminates found in the environment. As more pollutants are added to a river, the effects are felt a greater distance downstream because more water is needed to dilute the contaminants. Chemical waste dumped into a river in large quantities will spread through a long distance of the river. Fish that pass through an area contaminated with chemicals will breath in the chemicals which can harm the organs of the fish or cause the fish to suffocate. Plants living in the area can also absorb toxins from the river and die. Organic materials can also cause trouble for a river in large quantities. When sewage is discharged into a river, the decomposing material absorbs dissolved oxygen from the river in order to break down. In high concentrations, the sewage will leave little oxygen for fish to breathe and in turn the fish may suffocate or be forced to avoid the area, while other organisms that can live in the polluted environment, such as certain types of algae, begin to populate the area. What remains from this pollution is algae covered, non-potable water with smells that come with decomposition [Bardach 1964, 201-204].

A polluted river also affects those living in the area around the river. If fish were dying off or migrating away, there would not be an opportunity to fish, and if some fish did remain, they could be tainted and unsafe to eat. The effect the polluted water has on plant life could also

pose problems for farmers with crops in the area. Beyond this, a polluted river may give off an unpleasant scent and be unsafe for recreational use by those who live nearby. The effects of dumping hazardous materials into a river were not always understood as well as it is today. The problem of pollution may have not been as prominent during a time before large factories were present in such numbers as they were in the mid to late 20th century.

The Nashua River is a prime example of a river that was polluted by industrial waste to a point which exceeded social, environmental, and political tolerance. In fact, it was even named one of the ten most polluted rivers in the United States [NRWA 2012b]. Due to the size of this watershed and the many towns it includes, the pollution of this river has the potential for negatively influencing the lives of inhabitants of the area (Commonwealth of Massachusetts 2007, 4). The portion of the Nashua River running through Lancaster Massachusetts experienced an unfair share of the pollution. Records from the 1930's show little pollution originating in Lancaster, however a considerable amount of dumping occurring in the towns of Fitchburg and Leominster, which both lie upstream from Lancaster [W.P.A. State Planning Project 1936]. The pollution from these towns ran downstream and through Lancaster.

2.4 Cleanup Effort

As American society developed better understandings of results and dangers of pollution, individuals, organizations, and even the United States government made stronger efforts to keep rivers clean and to clean up ones that had been polluted. The first major federal law to be passed regarding water pollution was the Federal Water Pollution Control Act of 1948 (FWPCA hereafter). This act helped make way for future laws. However in its original form, the regulation rights provided to the US government by the FWPCA were limited. In 1970, the United States Environmental Protection Agency (EPA hereafter) was formed by President Nixon

and Congress. The job of the EPA was (and is) to set forth guidelines regulations to improve the condition of the environment and to prevent poor conditions from occurring. Several other laws were passed in the 1970s, which reflect increased movement and continued public resolve to clean up the problems caused by pollution. In 1972, to increase the effectiveness of the FWPCA, the US government amended the law in response to "increased awareness and concern for controlling water pollution" [Environmental Protection Agency 2012]. The amended FWPCA became more commonly known as the Clean Water Act. The Clean Water Act prevents dumping pollutants into navigable waters unless a permitted is obtained, provided funding wore waste water treatment, allowed the EPA to set standards for pollution, and provided several other solutions for the problem of pollution [EPA 2012].

When it came to the cleanup of the Nashua River, many individuals worked in organizations to bring about a change in the condition of the river. Marion Stoddart is one of these individuals. A citizen of Groton Massachusetts, Mrs. Stoddart observed the Nashua River, highly polluted by local mills that dumped their waste directly into the river. Since water was scarcer where she grew up near Reno, Nevada, Marion may have had more respect for the importance and the opportunity of such a huge water source. She made it life goal to clean up the river. Back in the 1960's, Mrs. Stoddart formed the Nashua River Clean-up Committee. She and those who joined her worked through communities and the government to improve the condition of the river [NRWA 2012a]. They pushed for mill and business owners along with government officials to get involved with the cleanup effort. They also pushed for the passage of the Clean Water Act. For all her work, the United Nations included Mrs. Stoddart in its Global 500 Roll of Honor in 1987 [NRWA 2012d].

Another individual that played a major role in the river cleanup was Bill Flynn. Having grown up in Fitchburg, Mr. Flynn learned to accept the river in its polluted condition. Mr. Flynn said "when you're too close to something, you don't realize what's going on," [Flynn 2013]. Mr. Flynn was elected as mayor of Fitchburg, Massachusetts in 1968. Once in office, the young mayor was approached by Marion Stoddart who urged him to work towards cleaning up the river. Mr. Flynn saw both environmental and economic gain from the cleanup and as a white water canoeist he liked rivers and naturally gravitated towards the repair of a river [Flynn 2013]. Bill Flynn worked with Mrs. Stoddart to clean up the river. Mr. Flynn took advantage of the controversy by seeking Federal subsidies to support the replacement of Fitchburg's decrepit 63-year old water treatment plant. The results were welcomed by stakeholders on all sides: the city had a brand new plant; environmentally concerned citizens saw improved water quality for the river; and taxpayers appreciated tremendous savings in the form of 85% reimbursement for the total costs. But that was not all. After the plant was complete, Flynn recalls Stoddart inquiring where the ramp was to get closer to the river. She wanted people to be able to enjoy the river once it was cleaned up [Flynn 2013].

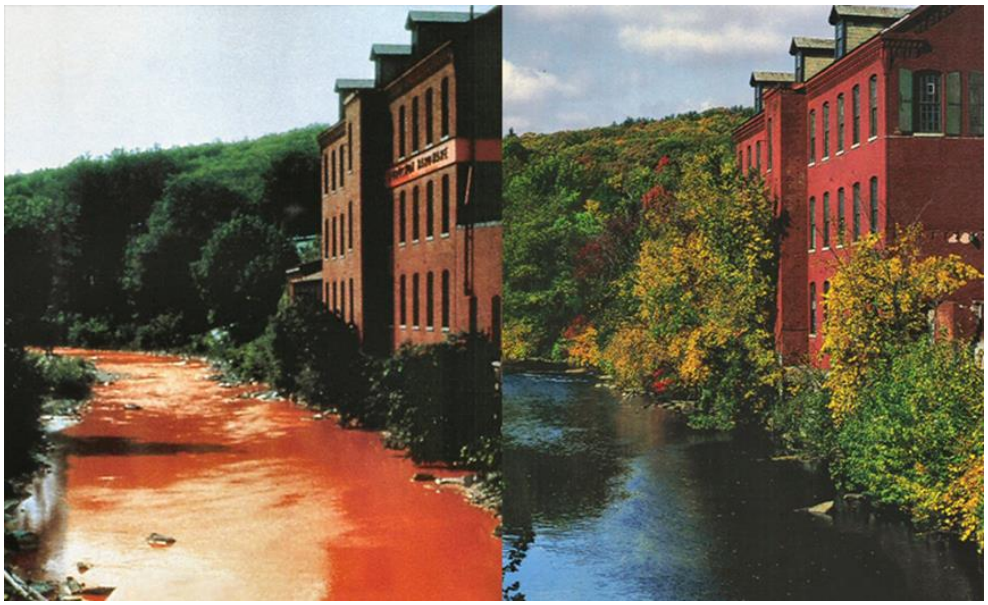

Figure 1: The Nashua River flowing red in the 1960's and clear in the 1980's [NRWA 2013c]

Today, organizations, such as the Nashua River Watershed Association continue to work towards the improvement of the river. The NRWA has monthly water quality records from different locations along the river from the year 2006 to the present time. Although the health of the Nashua River has greatly improved since the days it flowed different colors, and is now a pleasant sight to observe, it has not completely recovered. The levels of E. coli recorded at many sites are above the set standard for what is considered suitable for swimming and the level even exceeds what is considered suitable for boating at certain times of the year [NRWA 2012d].

Beyond keeping records of water quality along the Nashua River, the NRWA oversees many other functions in its efforts to improve the river. Volunteer members and a few paid staff raise awareness and educate people about the importance of the Nashua River and its watershed. The NRWA also provides information on recreational opportunities that the river provides, so more people can be involved and understand what the river has to offer [NRWA 2012c].

The Lancaster Friends of the Nashua River was formed in 2010 to carry forward with the next steps of a rehabilitation process that had been begun by Marion Stoddart. The members of

the LFNR do their part by focusing on improving the part of the river that runs through Lancaster.

2.5 Town-Owned Parcels

This IQP concentrated on an area in Lancaster comprised of several contiguous town-owned parcels of conservation land. The individual parcels are designated as Cook Conservation Area, Chickering Conservation Land, Lancaster State Forest, and Chapman-Goodale Conservation Land. Figure 10 in Appendix A shows a map of the area with the individual parcels outlined. These parcels are adjacent to the northern bank of the North Nashua River between Route 70 and Interstate I-190. The entire area is accessible via the Cook Conservation Area, which borders Route 70 (Lunenburg Rd), and these parcels are often collectively referred to as the Cook Conservation Area for this reason. The Lancaster Conservation Commission is responsible for all of the parcels.

All of the parcels share a common boundary with Central Mass Sand & Gravel property to the North. The company uses this property as a gravel pit and they have been clearing forest and expanding to the borders of the conservation land in recent years [Christopher 2013]. This threat of encroachment has necessitated the need for a boundary survey and it was among the more urgent reasons why the LFNR asked our group to survey the Cooks parcel specifically.

Cooks has been a popular hiking destination for many years. However, it was shut down for several years beginning in 1992 as a result of frequent allegations of illegal activity [Christopher 2013]. Today, there is a small parking area off of Route 70 marked by a sign for the Cook Conservation Area. The area is sought out by hikers and nature lovers, but it is rather inconspicuous and uninviting to those not familiar with the area. The trails themselves are not

marked, but they are well-traveled and clearly visible. In the hope of improving public access to the area and to the Nashua River, the LFNR asked our group to map all of the preexisting trails in the area. The LFNR also requested that our group research the land use history of the Cook Conservation Area. There are visible remains of what appears to have been a mill on the property and none of the members are certain of its original purpose. Photos of the remains in question (Figures 2 and 3) were taken on a preliminary visit to the area.

Figure 2: Stone foundation (Cook Conservation Area)

Figure 3: Remains of a milldam and spillway (Cook Conservation Area)

3.0 Methodology

This section describes the various approaches and techniques the group employed to accomplish the primary objectives of the project. With the exception of the prerequisite work for the project (Section 3.1), the subsections correspond to each of the individual objectives.

3.1 Orientation and Preliminary Meetings

Prior to the official start of the project (B term 2013), representatives from the project group attended the Lancaster Friends of the Nashua River's regularly scheduled monthly meeting on Wednesday October 17, 2012. The organization outlined their respective goals for the project and provided the contact information for individuals and organizations that could be of assistance. Thomas J. Christopher would serve as our contact for the organization for the duration of the project. The organization recommended that our project group also meet with the Lancaster Conservation Commission since they are officially responsible for the Cook Conservation Area and neighboring parcels. Representatives from the project group attended the meeting of the Lancaster Conservation Commission on Tuesday October 30, 2012. Thomas J. Christopher and Professor Spanagel were also present at the meeting. Mr. Christopher outlined the primary goals of the project for the five members of the Conservation Commission. The committee members expressed enthusiasm for the project and provided additional background information on the Cook Conservation Area.

3.2 Surveying the Cook Conservation Area

Before beginning the survey of the Cook Conservation Area, the group came across a couple boundary pins while mapping the trails in the area. The group discovered that these pins

were previously marked with orange tape. The locations of these pins were noted for the future when the group returned to perform the survey.

The group requested assistance in surveying the Cook Conservation Area from Professor John Hall from WPI. As a WPI faculty member who regularly teaches surveying, Professor Hall gave us access to the necessary equipment, walked the group through how to use the equipment and the preparation work that was needed, and he even joined the group on the two half-day trips to the Cook Conservation Area to perform the survey work.

To begin our investigation of the property boundary, the group obtained a copy of the deed for the Cook Conservation Area. The group initially contacted the office for the board of assessors in Lancaster to obtain the deed for the Cook Conservation Area. However, the group was able to locate the deed online in the Worcester District Registry of Deeds. A facsimile of this particular deed is presented in Appendix C: Surveying Data. Using the deed, a scale outline of the area was formed with the distances of line segments labeled (see Figure 4). The azimuth at each angle was also labeled.

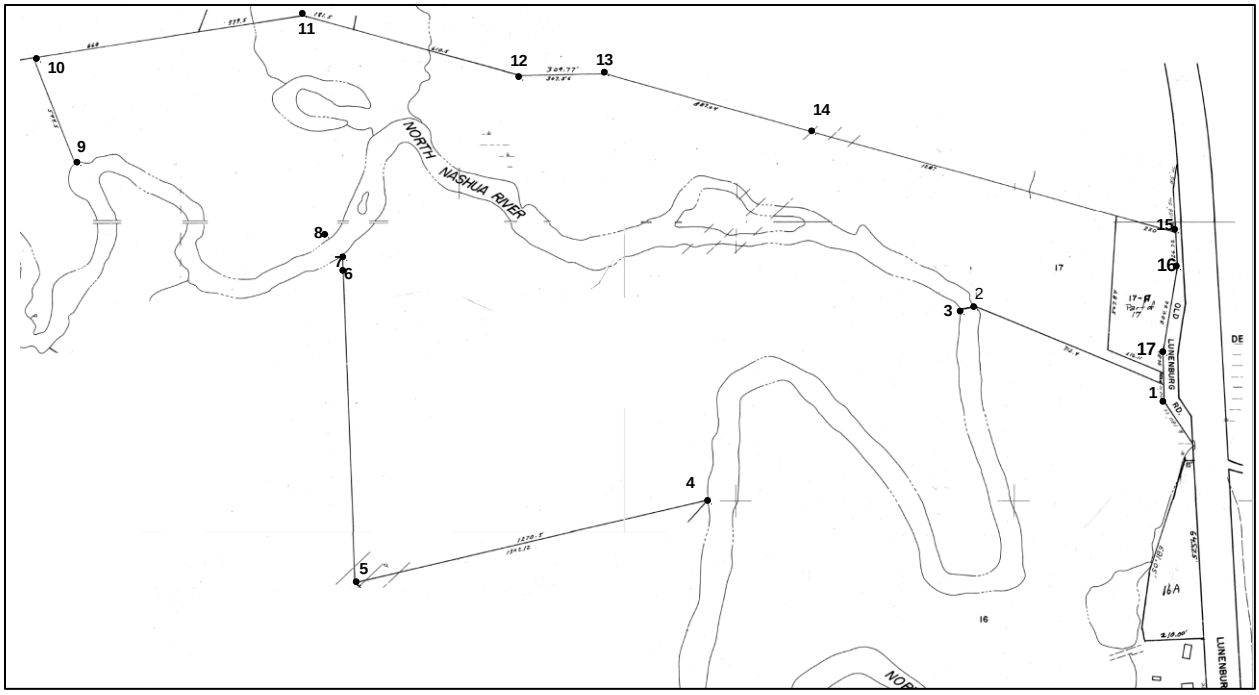

Figure 4: Assessor's map of Cook Conservation Area with numbered corners

Table 1: Direction and distance between numbered points labeled in Figure 4

Points	Direction	Distance (ft)
1-2	N 53° 40' W	712.14
2-3	S 88° 45'	99
3-4	Follow West Bank	2592.68
4-5	N 89° W	1303.5
5-6	N 9° E	1032.9
6-7	N 41.5° W	—
7-8	N 41.5° W	76.65
8-9	Follow West Bank	1000.56
9-10	N 16° W	544.5
10-11	S 83° 45' E	984.06
11-12	S 57° 36' E	792
12-13	S 87° 45' E	307.56
13-14	S 62° E	987.04
14-15	S 59° E	1287
15-16	S 10° 15' W	126.72
16-17	S 20° 15' W	304.26
17-1	S 10° 15' W	141.24

WPI allowed the group to use the GPS surveying equipment owned by the University, a Topcon Hiper Lite Plus model. The equipment is a dual station GPS system. It consists of a base station (that remains stationary at a chosen point) and a rover (that is moved to the boundary points) to record their locations. A data collecting device is used to interact with both units via Bluetooth. The deed lists the boundary points of the Cook Conservation Area in linear order moving along the boundary line in a counter clockwise fashion starting at point 1 labeled in Figure 4. The deed provides specific instructions of distance and direction, so that one may reach each successive pin in terms of how it can be located from the previous pin. This data was placed into a spreadsheet file that was created by Professor Hall. The file used the information provided to determine scaled coordinate points that can be used by the GPS equipment. This is done by first assigning coordinates to the first point provided by the deed. Using the Pythagorean Theorem, the X and Y (east and west) components from the vectors provided by the deed are then calculated. These X and Y components were added to the coordinates of the first point in the vector to calculate the coordinates of next point. The coordinates of each point are calculated in the same order as they are listed in the deed. These coordinate points are a scale representation of the actual coordinates of the pin locations in reference to each other. That is to say, the point of origin that the calculated coordinates are measured from is just an arbitrary point. After recording two pin locations accurately, the GPS system is designed with a function which uses the coordinate points provided to determine the location of the remaining pins. The coordinate points were saved in a file format compatible with the GPS equipment and the file was later uploaded to the GPS equipment.

Once the initial programming of the equipment was complete, the actual survey was performed. The base station was placed in an open area and the location was marked with a

wooden stake. The base station remains stationary and continually record the GPS coordinates of its location and the time of day at which it records the data. The base station also communicates with the rover to help pin point the location of the rover. Using the rover unit, the group then survey three boundary pins they had previously located. Upon successfully logging information from these points, the group used the GPS equipment to attempt to locate the remaining points (these points were going to be surveyed as well; however the group found some difficulty with this step as discussed in section 4.1).

GPS signals may vary throughout a day due to the changing location of satellites used to obtain a signal. In order to reduce inaccuracy caused by this variance, once all the located points were surveyed, the data file containing the time elapsed coordinates of the base station provided by the GPS equipment base station was uploaded to the National Oceanic and Atmospheric Administration's website (NOAA.gov). The website then returned, via e-mail, more accurate coordinates of the base station by comparing the data from the file to the location of the satellites at the time the data was recorded. These coordinates were then added to a Topcon computer program with the data files containing the coordinates of the recorded boundary points and more accurate coordinates were determined for the boundary points. These coordinates were calculated in both GPS Latitude/Longitude and in Massachusetts State Plane Coordinates. The State Plane Coordinate system uses a flat grid with a chosen point of origin which differs depending on the state the system is being used in. This flat, local grid differs from the curved global grid of the Latitude and Longitude system. We have provided the Latitude/Longitude data as it is the data directly produced by the surveying equipment. We have also provided the Massachusetts State Plane Coordinates because the format may prove useful for any surveyors looking at the data.

3.3 Trail Mapping

At the behest of the Lancaster Friends of the Nashua River, the existing trails in the Cook Conservation Area and the neighboring parcels were mapped in an effort to increase the accessibility to the parcels for passive recreational activities. In order to determine the most effective method for mapping the existing trails, the group contacted the Montachusett Regional Planning Commission (hereafter MRPC), which is in provides technical assistance to towns in the region. Jason Stanton, the GIS Director at the MRPC, recommended using a GPS tool in conjunction with GIS Mapping software. In order to determine what resources were available through WPI, a representative from the project group met with Suzanne LePage from the civil and environmental engineering department. Professor LePage outlined the process of mapping the trails using the ESRI ArcGIS software package (available through WPI).

A base map of the Lancaster State Forest area was constructed using ArcGIS software and datalayers from the MassGIS website. A datalayer is a file containing information that is referenced to a specific geographical location. MassGIS provides datalayers related to geological features, natural resources, infrastructure, and political/administrative boundaries for all Massachusetts. The datalayers used to construct the base map were: 1:5,000 Color Ortho Imagery (2005), Protected and Recreational Open Space, MassDEP Hydrography (1:25,000), MassDEP Wetlands (1:12,000), NHESP Certified Vernal Pools, NHESP Potential Vernal Pools, and Contours (1:5,000). This base map would serve as the foundation for one of the required deliverables, a trail map. However, some layers were only useful in a preliminary analysis of the site. These layers aided in the mapping process, but were not included in the final map.

In order to map the trails using GPS technology, the project group visited the area on January 21, 2013, and walked the trails (see Figure 5). A Garmin GPSMAP® 62st handheld

navigator unit was borrowed from an outside source and used to map the trails. We experienced relatively good reception throughout the entire area and the GPS reported a consistent level of accuracy to within 20 feet. As the group walked all of the trails, the GPS unit recorded a trace of wherever we walked and stored it as a GPX file. This file type was not directly compatible with ArcGIS and so it had to be converted. DNRGPS, an open source software program used to transfer data between Garmin handheld GPS receivers and GIS software, was used to convert the GPX file into a compatible format (SHP). In addition to the recording our path, the GPS unit was also used to record the locations of any key points along the trail. In order to correlate the point data with significant landmarks, the latitude and longitude value was recorded down along with a description of the location. Locations of particular interest included areas where trail changed direction and trail junctions. After the point data was collected, it was organized in a spreadsheet using Microsoft Excel (refer to Table 4 in Appendix E). This spreadsheet was converted into a datalayer using ArcGIS. These data are represented as points in ArcGIS and correspond to the points along the trail where a measurement was taken.

Figure 5: Photo of trail mapping process

All of the data collected during the trip were added to the base map. Using all of the available GPS data and the satellite imagery as a reference, the trail was outlined using the drawing feature in ArcGIS. Once all of the trails were outlined, the drawing was converted into a single SHP file and added to the base map. Markers were also added to the base map using the drawing feature in ArcGIS to signify trail junctions.

After the addition of the trail system, the base map still required updating before the final deliverable trail map could be produced. The additional MassGIS datalayers used to construct the final deliverable trail map included the MassDOT Roads and Transmission Lines datalayers. The appropriate labels for elevation, route numbers, and the distance of individual trail segments were added to the map. The location of bridges and the historic Shoe Shank Mill was also noted on the map. A compass rose, map legend, and scale bar were added to the map before exporting the final deliverable trail map. The final product was tested to ensure that it was legible in black and white.

3.4 Historical Research

3.4.1 Preliminary Research

The group scheduled a meeting with a research librarian at the Gordon Library to learn how to more proficiently navigate the resources provided by institution. The research librarian directed the group to several relevant documents in the library's collection and on the internet. Professor Spanagel, our advisor for this project, provided the group with several books with background material for this report.

3.4.2 Land Use in the Cook Conservation Area

The group also visited the Thayer Library in Lancaster to search the local history section for information pertaining to the Cook Conservation Area and the Nashua River. Almost all of the historical accounts of land use in the Cook Conservation Area that the group found were from late 19th Century texts. These texts are public domain and were all available online. Joan Richards, an associate member of the Lancaster Historical Commission, provided the group with all of the information that the organization had on the Cook Conservation Area. These sources contained many conflicting accounts regarding the location of the mill, which made compiling a straightforward narrative history of land use difficult.

The deed for the Cook Conservation Area proved to be an additional valuable source in researching the land use of the property. The deed provided a list of the most recent previous property owners at the time the deed was composed.

3.4.3 Interviews

The group decided to conduct interviews with individuals involved with the Nashua River cleanup to gain a deeper understanding of the work involved in restoring the river. The

LFNR strongly encouraged the group to interview Marion Stoddart. A member of the LFNR contacted Marion and introduced her to the group. She kindly agreed to meet the group at the NRWA headquarters. Prior to the meeting, the group viewed *Work of 1000* (a documentary film about Marion Stoddart's involvement in cleaning up the Nashua River). The group decided to ask questions which inquired what actions allowed Marion to achieve her goal.

The group decided to interview Bill Flynn because of the pivotal role he played in the Nashua River cleanup effort as the mayor of Fitchburg. As member of the LFNR, Mr. Flynn willingly met with the group in the Lancaster Town Hall. The group composed questions to learn more about the details from Mr. Flynn regarding how he dealt with the conflicting interests over the use of the river.

4.0 Results and Discussion

This portion of the report presents the results of our project and discusses the significance of our accomplishments. The last section (4.4) lists the recommendations that our project group generated for the sponsor and also for other organizations involved.

4.1 Surveying

The group located a total of four boundary markers and recorded the coordinates of three of them. The group used the data from the recorded points to calculate the coordinates of the remaining boundary points in both GPS latitude and longitude and in State Plane coordinates. The recorded points were labeled as 12, 13, and 17 (seen on the map in Figure 4, located in Section 3.2). Point 10 was found as well, however we could not get a clean radio signal from the base station and the coordinates for that point could not be recorded.

The task of surveying the Cook Conservation Area required two separate trips which occurred on March 30th and April 6th in 2013. The first attempt resulted in recording two points and locating a third. During this attempt, problems due to user error prevented other points from being located and recorded. Professor Hall contacted the manufacturer and the mistakes were corrected.

During the second attempt at surveying, the location of three markers were measured and recorded. Road Marker 32, along Old Lunenburg Road, was one of the recorded makers. Once the three points were recorded, the localization program in the equipment was run to produce estimated locations of the remaining boundary points. The equipment noted a rather low level of precision estimating to be 80 feet off at some points when calculating boundary locations from the information provided from the deed. We believe that the source of the lack of precision is

the distance between two bounds located close together. These bounds are located at points 12 and 13 on the map in Figure 4 located in section 3.2**.** These points are measured to be 307.56 feet apart according to the deed; however our measurements showed them to be 309.63 feet apart. This is a 2.07 foot discrepancy on distance that was measured with a precision of one 1/100 of a foot. This discrepancy may have reduced the accuracy of the estimated location of remaining boundary points.

The data we collected are represented in Figure 6. The points which we surveyed are marked by X's while the points estimated through localization are marked by dots. The red outline of the Cook Conservation Area shows the boundary data according to the state. Differences between the data we collected and the data held by the state can be seen in this figure. The calculated coordinates of the points depicted in Figure 6 can be found in Appendix C in both Latitude/Longitude and Massachusetts State plane Coordinates.

One boundary point that we searched for was Road Marker 31, which should have been located about 300 feet away from Road Marker 32 along the same road, however this marker was not found. We do not know what happened to the marker; however it is possible that Road Marker 31 was lost or buried during the construction of the current Lunenburg Road.

The property lines on the south side of the river are difficult to measure. The deed makes references to corners of the property, but it does not mention any makers to use as reference to find the corners. In order to survey this portion of the boundary, we suggest locating deeds of the surrounding properties to obtain a more accurate point of reference. The two properties abutting the Cook Conservation Area on the south side of the Nashua River are designated as ones owned by Eugena Gaines and James Sartelle according in the deed.

We also suggest locating the deeds of the portions of land surrounding Cook Conservation Area on the north side of the river. Comparing these deeds to the deed for the Cook Conservation Area may help to resolve all of the discrepancies noted above.

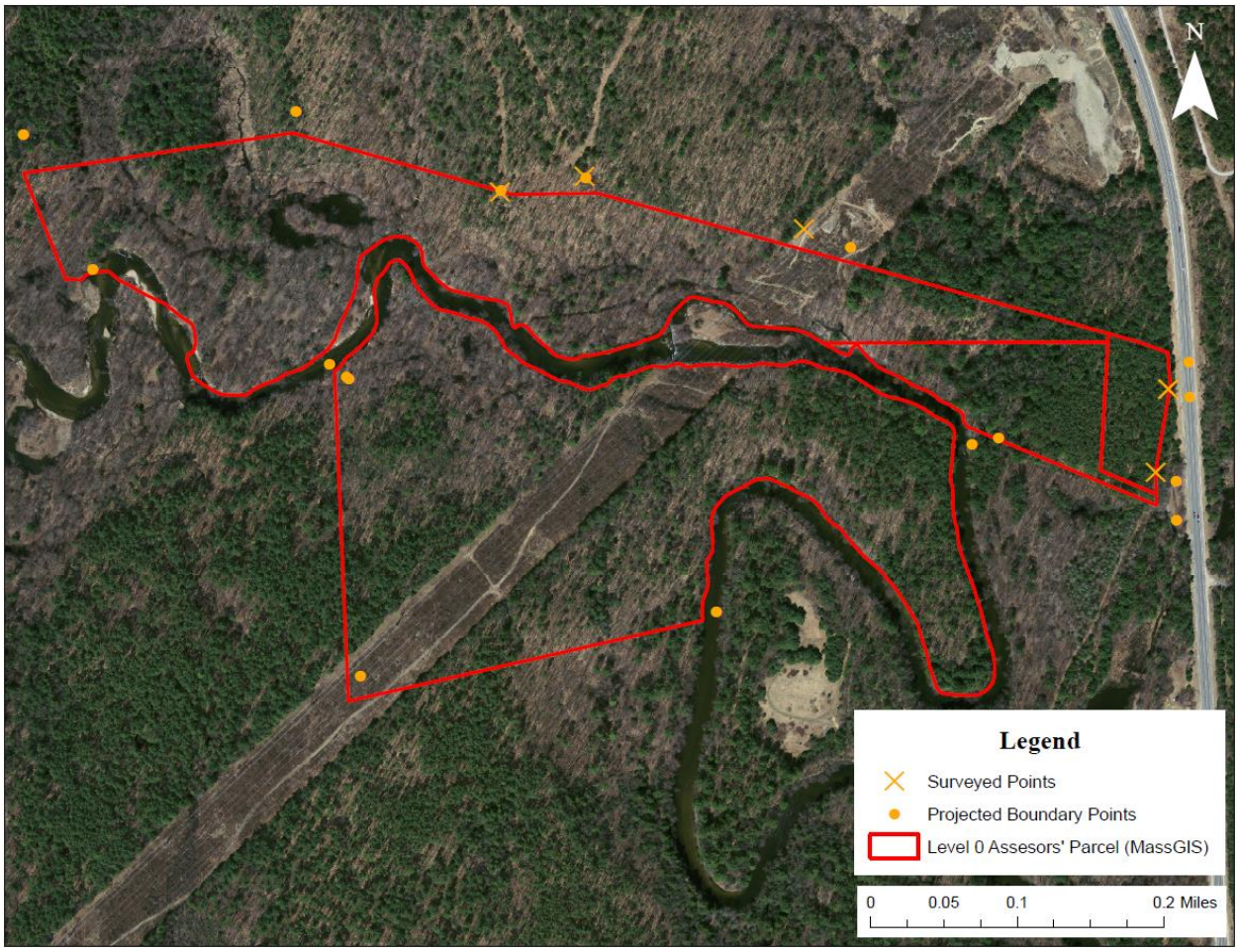

Figure 6: Map of Cook Conservation Area with surveyed points, localized points, and MassGIS boundary data

4.2 Trail Mapping

The trail mapping portion of this project was very successful overall. The group was able to map all of the preexisting trails in the Cook Conservation Area and the adjacent parcels, a total area of nearly 500 acres. The main river trail (2.2 miles) extended from the trailhead off of

Lunenburg Road (Route 70) all the way to Interstate 190 (I-190). This trail continued into Leominster after passing underneath an overpass at I-190, but mapping those trails was beyond the scope of this project. There was a significant trail, approximately 1.6 miles long, which split from the main river trail about 0.8 miles from the trailhead and later rejoined it near I-190. This trail travels through the highlands and appears to be a popular loop trail. However, a large portion of this trail lies outside of the town-owned property. There were also several dead-end trails which appeared to have been cut off by development, primarily by the adjacent gravel pit. The group decided to include these dead-end trails in the map to better orient hikers who are unfamiliar with the area.

We encountered several obstacles while creating the map. One obstacle involved the limitations of Garmin 62st GPS unit. The unit was a vital resource for this project. However, as with any GPS unit, its accuracy was not perfect. The track data could be unreliable in certain instances where the team had back tracked. In these instances, the two paths recorded by the GPS were often not identical. This is understandable as the accuracy of the unit varied throughout the process depending on reception. Nonetheless, as discussed in the methodology, the accuracy generally was within 20 feet, so the tracks were only separated by a short distance. In instances where the track and point data did not match up precisely or where multiple tracks were present, the group outlined the trail using our best judgment. It is important to note that although the trail outline may be off by several feet, the outline itself was not affected by this inaccuracy. In other words, all of the twists and turns are represented on the map.

Another obstacle we encountered involved the availability and accuracy of certain data that would be included in trail map. The transmission line datalayer proved to be inaccurate and difficult to obtain. The transmission lines layer displays the location of power lines, which was

an important feature for the trail map because a stretch of power lines cut through the Cook Conservation Area. Unfortunately, this datalayer was not accessible through the MassGIS website, since it contained information that could be used for malicious purposes. In order to obtain the data, MassGIS required that a special request be sent. A representative from the group contacted MassGIS and the organization provided the requested data promptly. However, the group determined that data for power lines did not match up properly with the actual power lines in Lancaster by comparing it to the Ortho (satellite) Imagery datalayer from MassGIS. To compensate for this discrepancy, the power lines that would appear in the final deliverable trail map were drawn in using the drawing feature in ArcGIS and the satellite imagery as a reference.

The Lancaster Friends of the Nashua River intend to build an information kiosk at the trailhead and parking area of the Cook Conservation Area. This kiosk would display the trail map created by this group (see Figure 7) and offer a brochure with information on the area and a copy of the trail map (Appendix F). The trail map produced by this project was far more detailed than previous endeavors. The only other trail map of the area that the group was able to find was a trail inventory for the Town of Lancaster completed by the Montachusett Regional Planning Commission in 2007. Figure 8 shows the section of the MRPC map that corresponds to the area mapped (Figure 11 in Appendix A shows the complete version of this map with a legend). The MRPC trail inventory establishes the basics of the trail system in the Cook Conservation Area and the neighboring parcels. It shows that a river trail and a loop trail exist in the area. However, it offers no additional information or reference points in the area and is missing many of the trails we marked in our survey. Our map includes all of the preexisting trails in the area. Other helpful additions to the map include elevation contour lines and the distances of the trail segments, which will allow visitors to plan their route ahead of time. The distances and

elevations are arguably the most important additions to the map from a convenience and safety standpoint.

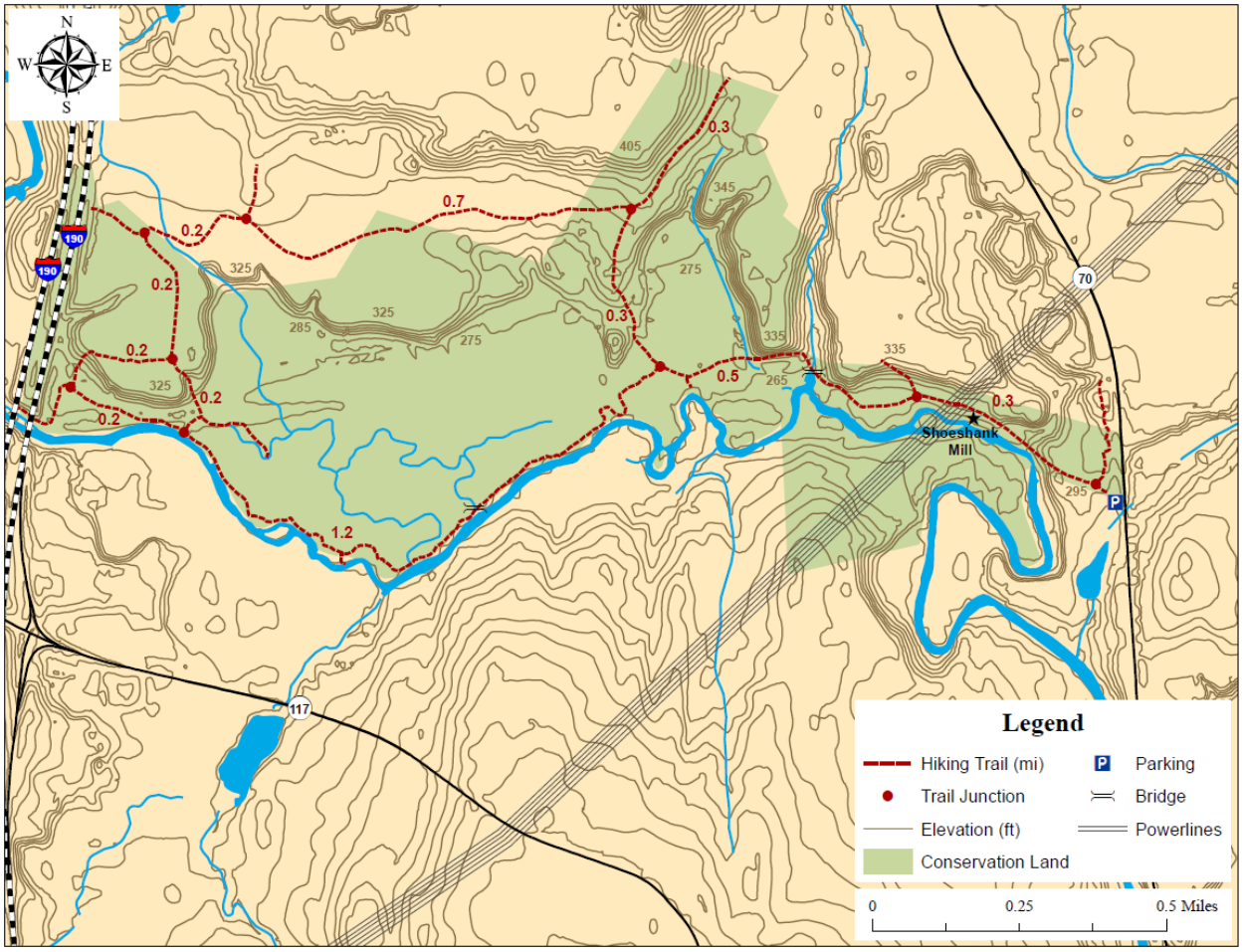

Figure 7: Trail map of the Cook Conservation Area and neighboring parcels

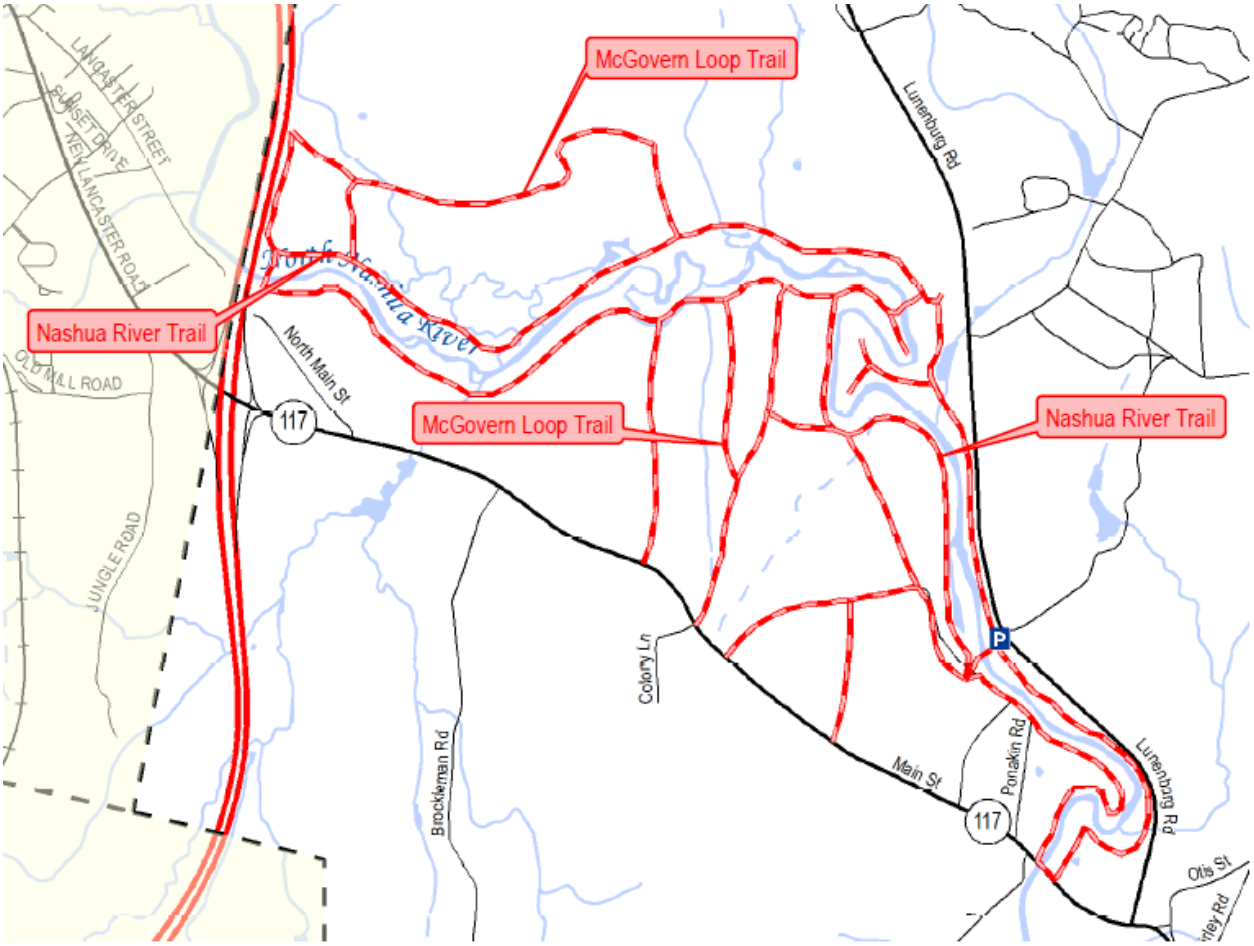

Figure 8: Detail from the MRPC 2007 Trail Inventory for Lancaster, MA

4.3 Historical Research

4.3.1 Land Use in the Cook Conservation Area

The area that is now the Cook Conservation Area is referred to as "Shoeshank" in many historical texts. On the property, approximately a quarter mile in the woods from Lunenburg Road, there are remnants of an old mill. This was an important waterpower site and a saw-mill founded by David Whitcomb was operating in the vicinity as early as 1721 [Hurd 1889, 35; MHC 1978]. A saw and grist-mill was constructed by Sewall Carter, a local merchant, around

1828 and ultimately fell into the hands of the Shakers [Hurd 1889, 35; Marvin 1879, 605]. The name Shoeshank is derived from the American Shoe Shank Co., which purchased this mill sometime in the mid-19th century. The mill produced leather boards and shoe shanks and operated for several years before it burnt down in December, 1883 [Hurd 1889, 35; MHC 1984, 12-13]. The mill was never rebuilt and only the foundation and a portion of the spillway remain visible today. There was a tenant house for mill workers which remained for on the property for several years after the mill burnt down before it was demolished. The Lancaster Historical Commission owns a photograph of the dilapidated house taken between 1910 and 1915.

Little information has evidently survived on the operation of the mill itself, but the Massachusetts State Board of Health did survey the mill in its comprehensive examination of the Nashua River Watershed in 1877. The mill employed 10 workers at this time and the report states that the 'head and fall' (the height of water behind the milldam) was nine feet. The production of leather board is noted to be detrimental to water quality. In the process, lime and sulfuric acid were used to reduce scraps of rope, canvas, and/or leather to a suitable working condition [MSBH 1877, 38]. When discharged into streams, these chemicals can cause significant changes to pH, which can be harmful aquatic life. The mill used approximately 500 barrels of Venetian-red (a dye derived from ferric oxide, a naturally occurring mineral), 250 carboys of sulfuric acid (1 carboy = 5 gallons), and 160 barrels of lime annually. The water downstream of the mill was reported to red at times, which is most likely a result of the Venetian-red [MSBH 1887, 28].

In 1893, the American Shoe Shank Co. sold the land to Charles and Herbert Wilder. The land later passed to Charles E. Gould and Frank H. Cook. On December 23, 1975, George Cook

signed over the land to the Conservation Commission [The Commonwealth of Massachusetts 1975; Richards 2013].

Our group was able to consolidate the available data from local historical texts and the Lancaster Historical Commission to form a more complete chronicle of the land use history in the Cook Conservation Area. The site of the mill is marked on the trail map produced by this project group as a point of interest for visitors. A short description of the mill site and its history is also included in the brochure/trail map (Appendix F).

4.3.2 Interviews

At the encouragement of our advisor and our sponsor, the group interviewed Marion Stoddart and Bill Flynn to gain insight in the cleanup of the Nashua River and its significance.

4.3.2.1 Bill Flynn

Mr. Bill Flynn was elected mayor of Fitchburg in 1967 at the age of 25.

When we started the interview, he first focused on the situation of the pollution. He said, the river on the south branch was less polluted and only a few companies there cleaned up their act and reduced the pollution that they discharged while they were in production. However, the paper mill complexes that were built along the North branches polluted the river and its tributaries. These mills dumped dye and paper pulp into the water and caused the river to flow in different colors. The worst polluter was the Independent Lock Co., a prominent lock manufacturer at the time. When Mr. Flynn and his colleagues first analyzed the water quality, they found arsenic, mercury, and several other heavy metals. They came to the conclusion that this company used these metals in the process of polishing brass. As a result, the Army Corps of

Engineers does not want to remove the dams just because there are so much harmful metals deposited in the sediment behind them.

Mr. Flynn shared with us an important lesson he learned from the cleanup. He said, "When you are too close to something, you don't realize what's going on." He grew up in Fitchburg and accepted the river the way it was. It was only when he started listen to the thoughts and feelings of outsiders, he began to understand the environment he was living in.

When he was the mayor and working at the City Hall of Fitchburg, a letter from a businessman gave him a rude awakening:

"Dear Mayor Flynn, I came to your city to do business… When I drove over the river at Bemis road and looked down and saw the sewer that was running through your community I made the decision that I would not do business in a community that had such low self-esteem as to allow that to continue."

Mr. Flynn said the reasons he supported the cleanup effort of Nashua River as mayor were: (1) the federal government and the state had made laws to clean up polluted rivers; (2) the water treatment facilities in Fitchburg had been in service for 63 years and needed replacement; (3) he was a white water canoeist.

The federal government helped fund the new wastewater treatment facilities in the City of Fitchburg – 85% of the cost and expense was reimbursed. However, the cleanup was not just a governmental effort, it was driven by the society – A lot of college students at that time went to the streets calling for clean rivers.

In his opinion, there is still a lot to be improved with Nashua River. According to him, some of the most pressing issues include separating storm and sewer drains and persuading landowners to give away lands to create a greenway along the river.

4.3.2.1 Marion Stoddart

Marion Stoddart has been the key catalyst in the restoration of the Nashua River. The cleanup effort she initiated in the late 1960's brought together citizens, businesses, and politicians to restore the river. Even at her advanced age she is still actively involved with the restoration efforts and the NRWA.

Mrs. Stoddart was enthusiastic about our project and was eager to share her vision for the Nashua River with us. She chronicled the evolution of the Nashua Greenway and its purpose in the interview. She and her colleagues started the project in the early 1970's. At this time, there was no floodplain zoning or wetland protection along the Nashua River. The river needed a long-term protection plan to ensure the victories that the citizens had fought so hard to achieve were not lost. The tenants of the plan called for a 300 foot buffer zone on either side of the river, which would include a recreational trail running the length of the river. In 1972, Greenway Committees were formed in every town in the watershed with the mission of securing and protecting land along the Nashua River. As a result of this project, more than half of the land is protected today.

Mrs. Stoddart shared with us what actions she believed made the cleanup a success. She sought out people who cared about the river (the stakeholders) and gained connections in different towns. Furthermore, she identified the people who had the power to implement change (e.g. mayors, selectman, legislators, etc.) and involved them in the process. However, the most important lesson that she took away from this experience was to "Only associate yourself with positive thinking people" [Stoddart 2013]. She felt this was the key to success for this particular environmental campaign.

4.4 Recommendations

The project group generated a list of recommendations for the sponsor and the town organizations involved with the Cook Conservation Area and the neighboring parcels. The recommendations are organized according to the section of the project to which they are related.

4.4.1 Surveying

4.4.1.1 Locating Surrounding Deeds

In order to more accurately locate and record boundary point around the Cook Conservation Area, we suggest locating the deeds of the plots of land abutting the property. Locating the deeds will help in determining if there are any discrepancies in where the boundary pins are located and where the boundary pins should be located according to the deeds. Locating the deeds may also help in determining the boundary lines of the south side of the river as the group believes that there are no boundary pins located on that side of the river.

According to the deed for the Cook Conservation Area from 1975, the names of owners and previous owners of the surrounding plots of land include Wilder S. Thurston, Eugena Gains, James Sartelle, William Powers, William H. Blood, Charles L. Wilder, William J. Gurry, and the Commonwealth of Massachusetts. These are the names to look for when locating the surrounding deeds.

4.4.2 Trail Mapping

4.4.2.1 Additional Trail Mapping

As discussed previously, the trails mapped by our group are located on the north side of the North Nashua River in Lancaster. However, the MRPC trail inventory alludes to an

extensive trail system on the southern bank of the river as well (Appendix A). Some of the trails may be part of the Ballard Hill Conservation Area {off of Route 117}, but the map does not distinguish between public and private property. Nonetheless, the conservation land on the opposite side of the river affords similar opportunities and should be considered.

4.4.2.2 Trail Signage

In addition to the trail map, the trails mapped by this group would benefit from some form of signage to further guide visitors. The Appalachian Mountain Club provides many resources for mapping and maintaining trails. If the area does receive signage, the identifying marks for each trail should be incorporated in the trail map.

4.4.2.3 Potential Problems with Abutters

A portion of the existing trail system is located outside of the designated conservation land on land owned by Central Mass Sand & Gravel. Approximately a half mile of the trail runs through this property, but the majority is forested and undeveloped. Only a few hundred feet of the trail crosses land that has been cleared. The conservation commission indicated that there have been problems with this abutter before, specifically with encroachment on conservation land. The group recommends that a formal agreement be pursued to protect the trails or that they be rerouted within the conservation land to avoid further loss.

5.0 Conclusion

The IQP project focused on improving public access to the Nashua River, a river with a remarkable history of restoration and a promising future, but one that can only be secured through environmental stewardship. The Lancaster Friends of the Nashua River asked our group to resolve some outstanding issues in town-owned property along the Nashua River that are an essential basis for their efforts in expanding recreational opportunities along the river. The prioritized tasks laid out by the organization included mapping the trails in the town-owned land along the North Nashua River, surveying the Cook Conservation Area parcel, and researching the land use history of the area as well. Our group worked with faculty members from Worcester Polytechnic Institute, volunteers, and town officials to accomplish all of these tasks.

Our group mapped all of the preexisting trails in the Cook Conservation Area and the adjacent parcels successfully and created a trail map of the entire area using GIS software. The group decided to create a tri-fold brochure (Appendix F) for the area that included the trail map, which will be made available for visitors. Representatives of our sponsor organization have indicated that they are planning to build an information kiosk at the trailhead to display an enlarged, laminated version of our trail map as well as to house copies of our brochure. The brochure includes information on the Nashua River Greenway initiative, local ecology, and the history of the American Shoe Shank mill. These materials will help introduce visitors to the area and the map will help them to navigate the expansive property.

The mapping component of this project captured the interest of several individuals and organizations not directly affiliated with our endeavor. Fortuitously, shortly after we completed the inventory of the trails, a group of individuals from the town formed a new entity called the Lancaster Trails Coalition. This group's mission is to inventory all of the trails in Lancaster and

to connect these trails where possible to form a more complete trail network. Noreen Piazza, the Town Planner for Lancaster, requested all of the mapping data that our group collected to support the ongoing work of the trails coalition. Our mapping data can serve as a valuable starting point for the trails coalition project. Al Futterman, the Land Programs & Outreach Director at the NRWA, expressed interest in our mapping data as well. He intends to share the data that we have provided with the Montachusett Regional Trails Coalition.

The boundary survey of the Cook Conservation Area was by far the most challenging component of this project. The group had to overcome many technical, as well as physical obstacles to survey the Cooks parcel. An unusually high frequency of late-winter snowstorms and blizzards forced us to postpone surveying until the spring. The densely forested land and uneven terrain hindered the accuracy of the GPS equipment. In addition, inaccuracies in the deed and missing property markers further impeded the process. Fortunately, Professor John Hall was able to assist us in the process and the group was able to collect fairly reliable surveying data on the property. The data that we collected will support the Town of Lancaster's ability to protect its open space, specifically to prevent further encroachment by abutters.

The group performed extensive historical research to confirm the identity of the mill remains in the Cook Conservation Area. The group was unable to locate a comprehensive chronicle of the land use history in the area. Much of the information that we gathered was scattered amongst various sources, most of which were local histories from the late 19th Century. The group was able to construct a coherent in-depth history of land use in the area and, through careful reasoning and analytical thinking, decipher the mystery of the identity and location of the American Shoe Shank Company's mill.

The documented interview with Marion Stoddart and Bill Flynn constitute an important byproduct that our IQP project generated, even though this task was not initially specified by our sponsor. These interviews provide a firsthand account of the river's nationally recognized restoration efforts from two of the most important individuals involved. Furthermore, these interviews offer two complementary perspectives of the cleanup. Mrs. Stoddart detailed her approach to the river cleanup and the techniques she employed, whereas Mr. Flynn discussed how he balanced the interests of the citizens and businesses to reach a compromise.

On April 24, 2013, the group made a final presentation to a joint meeting of the Lancaster Friends of the Nashua River and the Lancaster Conservation Commission. These individuals were very pleased with what our project accomplished and our presentation sparked dialogue between members of both organizations on the properties and the river. The list of organizations and entities who have requested a copy of our final report includes: the LFNR, the Lancaster Board of Selectmen, the Lancaster Trails Coalition, the Lancaster Conservation Commission, the Lancaster Historical Commission, and the Thayer Memorial Public Library. In addition, the LFNR is in receipt of electronic copies of all our GIS and surveying files.

Our IQP project represents another step in the ongoing effort to revitalize the Nashua River. This project supports the Town of Lancaster's ability to preserve it river greenway and enhances public access to the river. Although our contribution is significant, more work is required in order to restore and protect the river. Future projects aimed at improving access and spreading river awareness would benefit the Cook Conservation Area and the town. In particular, the long term vision for the Nashua River will be materially advanced when other projects build upon our project by introducing trail signage and implementing environmental education programs that incorporate our findings.

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A report compiled by the Massachusetts Historical Commission that chronicles the settlement and economic patterns of Lancaster from its founding to the present.

Massachusetts State Board of Health . 1877. *Eighth Annual Report of the State Board of Health of Massachusetts*. Boston: Albert J. Wright, State Printer

This report is concerned with the effects of water pollution. The Nashua River watershed was chosen as the area of study for this report. As part of their investigation, the MSBH surveyed all of the operating mills in the watershed. The report provides details regarding the operation of these mills and their effects on water quality.

Nashua River Watershed Association. 2012a. "NRWA Founders and Incorporators." *Nashuariverwatershed.org*. Nashua River Watershed Association, 2012. Web Accessed, December 9, 2012.

Nashua River Watershed Association. 2012b. "NRWA Historical Highlights." *Nashuariverwatershed.org*. Nashua River Watershed Association, 2012. Web Accessed, December 9, 2012.

Nashua River Watershed Association. 2012c. "Recreation in the Nashua River Watershed: A Benefit of Conservation." *Nashuariverwatershed.org*. Nashua River Watershed Association, 2012. Web Accessed, December 9, 2012.

Nashua River Watershed Association. 2012d. "NRWA Historic Water Monitoring Data." *Nashuariverwatershed.org*. Nashua River Watershed Association, 2006-2011. Web Accessed, December 9, 2012.

Nashua River Watershed Association. 2013a. "Our Rivers and Streams." *Nashuariverwatershed.org*. Nashua River Watershed Association, 2012. Web Accessed, April 10, 2013.

Nashua River Watershed Association. 2013b. "Nashua River Watershed Statistics" *Nashuariverwatershed.org*. Nashua River Watershed Association, 2012. Web Accessed, April 21, 2013.

Nashua River Watershed Association. 2013c. "Mission and History Overview." *Nashuariverwatershed.org*. Nashua River Watershed Association, 2012. Web Accessed, April 28, 2013.

The Nashua River Watershed Association website proved to be an invaluable source. This site contains historical and current water quality data, historical information about the Nashua River, information on current public use of the river, and historical photographs of the river in different states of pollution and from different locations.

Richards, Joan. 2013. Email communication on January 29. (Ms. Richards is an Associate Member of the Lancaster Historical Commission.)

Steinberg, Theodore. 1991. *Nature Incorporated: Industrialization and the Water of New England*. Cambridge: Cambridge University Press. Print.

This text details the physical transformation of New England waterways that occurred as a result of the Industrial Revolution. It also examines the ideological and legal changes that accompanied these transformations.

Stoddart, Marion. 2013. Oral history interview conducted on March 5 in Groton, Mass. (Notes from interview provided in Appendix B)

U.S. Government. 1936. Works Progress Administration. State Planning Projects. *Sources of Pollution Nashua River Valley*. Boston, MA: Massachusetts Department of Public Health. Print.

This source provided some historical data on the pollution of the Nashua River.

Appendices

Appendix A: Maps

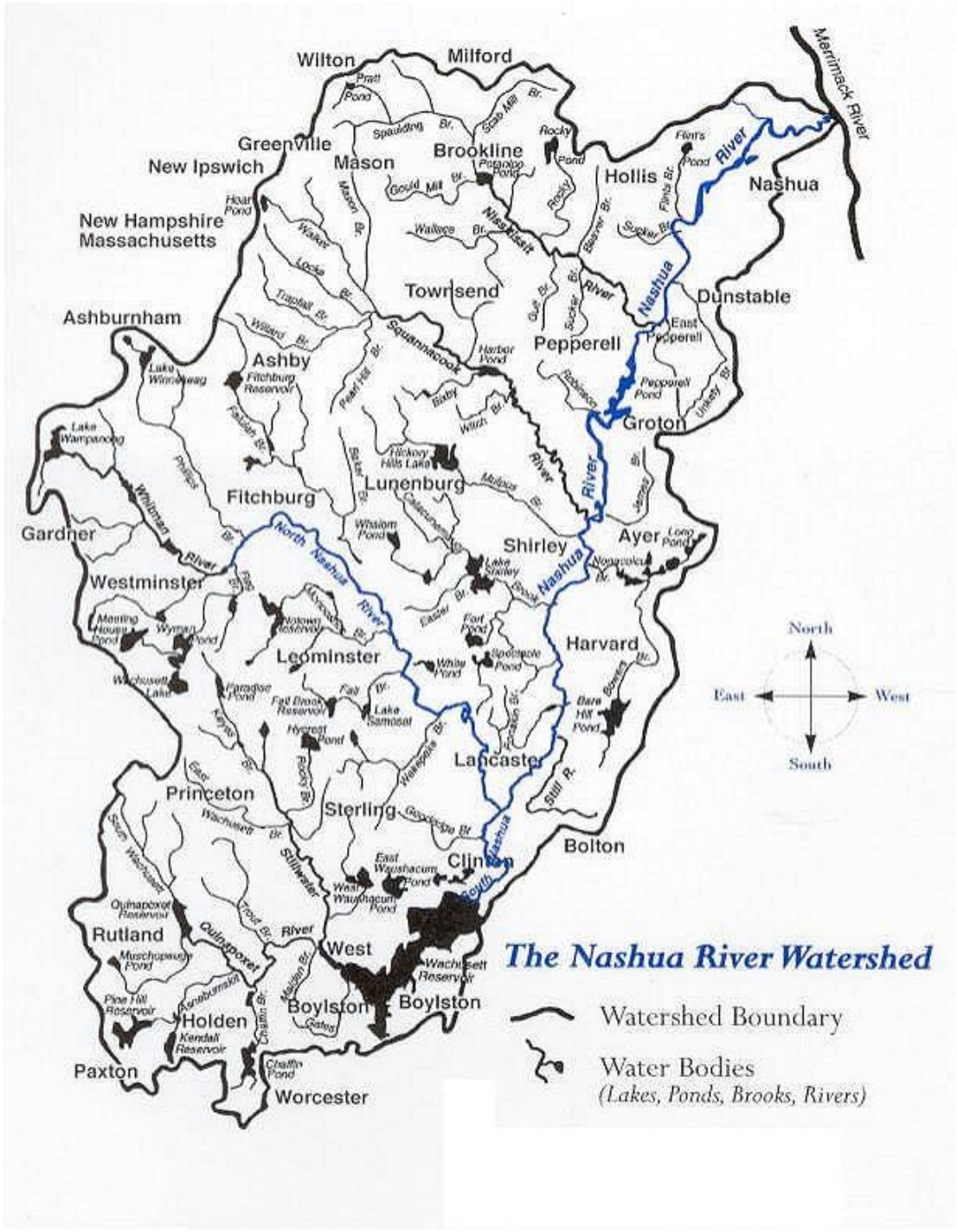


Figure 9: Map of the Nashua River Watershed

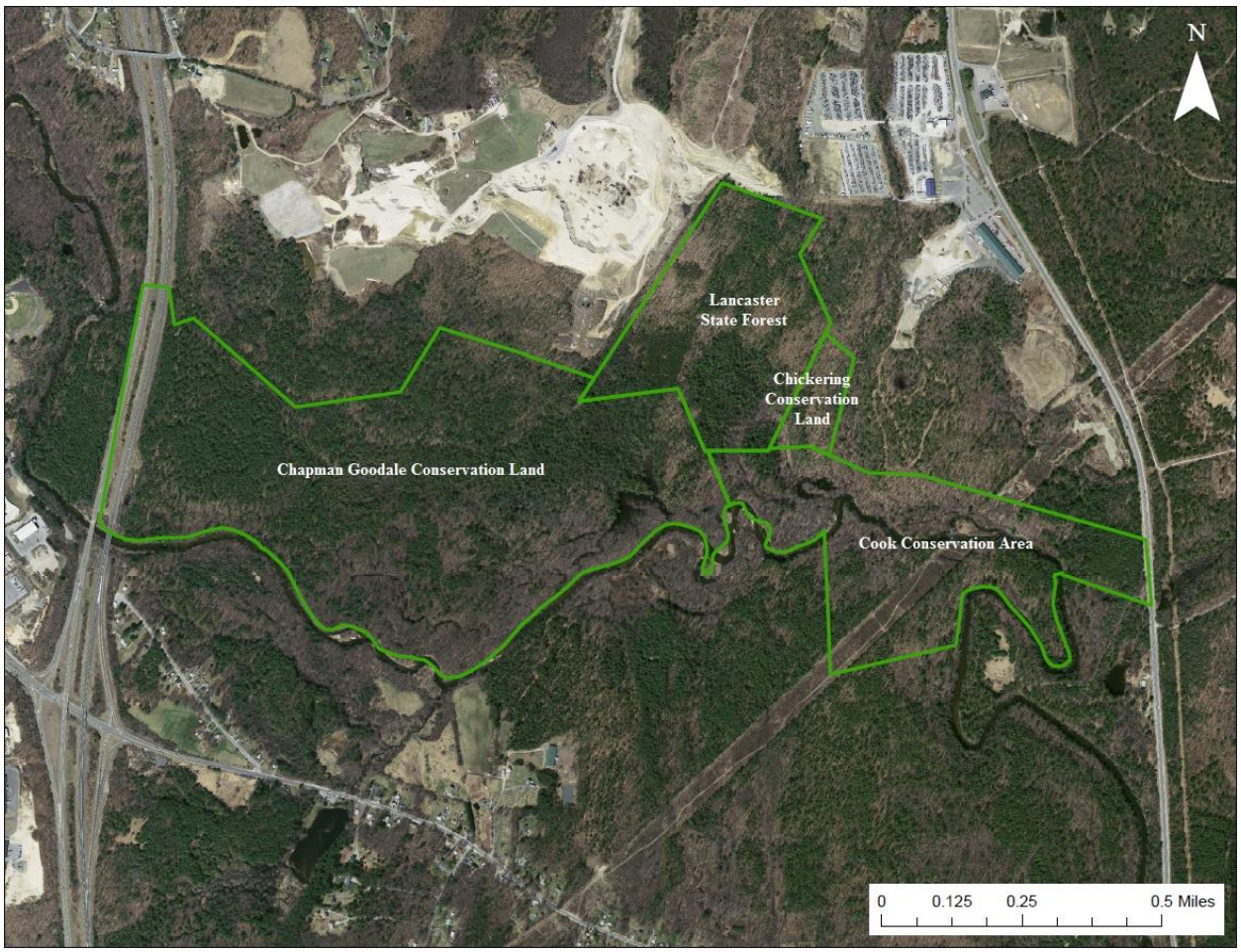


Figure 10: Outlines of the individual town-owned parcels

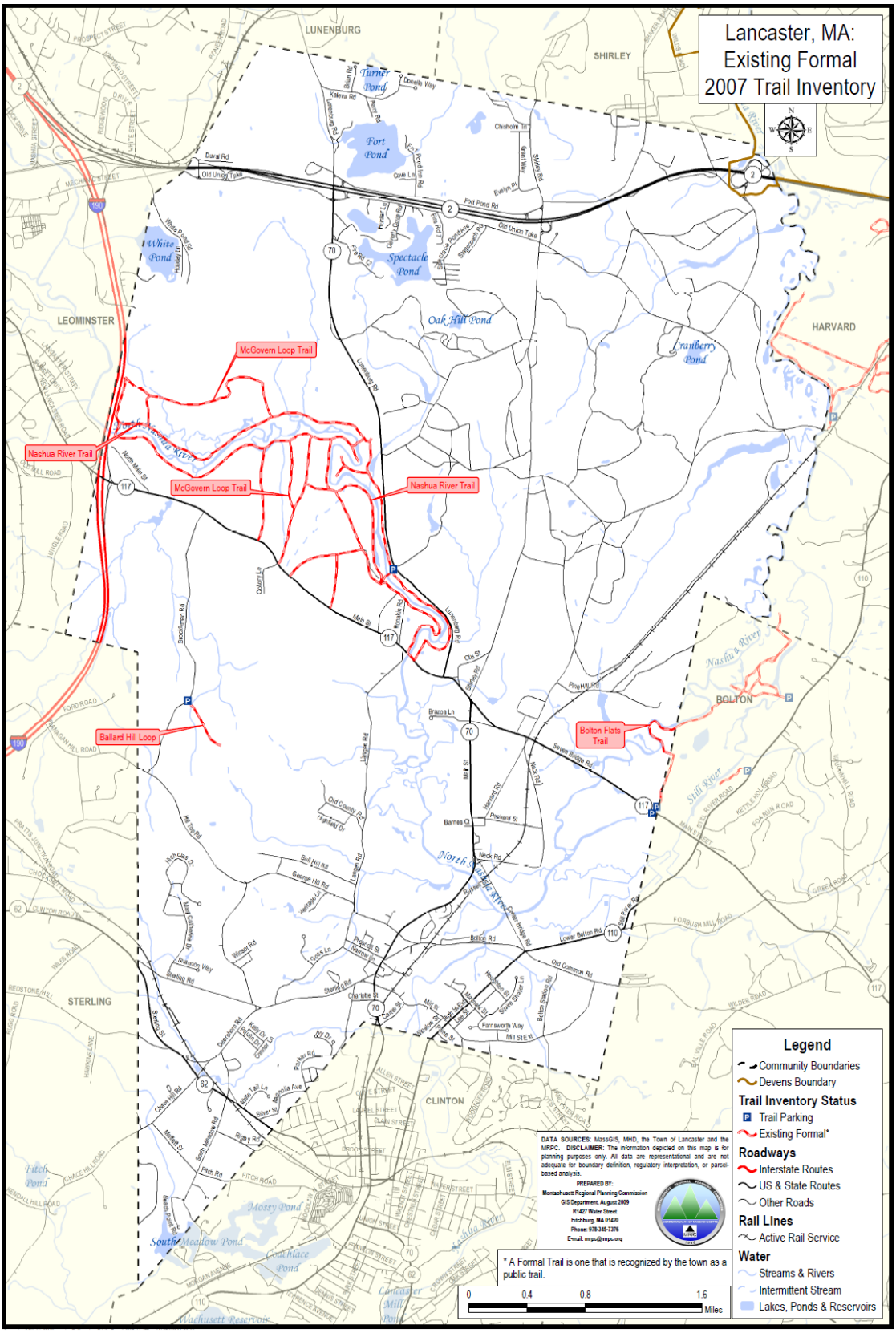


Figure 11: MRPC 2007 Trail Inventory for Lancaster, MA

Appendix B: Interviews

Transcript for Bill Flynn Interview

Question: What do you remember about the Nashua River before the clean up?

Flynn: Nothing other than what everyone else says. It was grey most of the time and there were a lot of muskrats and so forth in it. When the water was low, you could actually walk out onto it because of the paper pulp that was in the river.

Question: Really?

Flynn: Yeah, it was bad.

Question: And that was the case in Fitchburg too, even from where the pollution was mostly coming from?

Flynn: Oh yeah. It started, in fact… there are two branches, you're aware of that. One of them, when they built the reservoir that took care of most of the problems coming into that one, although there were a few companies in Clinton, I think, that had to clean up their act. But the bulk of the river comes from the North Nashua branch and if you go up into that area there are a whole bunch of tributaries, their beautiful. And then it hits the where the paper mill complexes were. In fact, the other tributary rivers are all damned up because the paper companies needed a year round flow of water. However, as bad as the paper companies were with the color and so forth, the worst pollutant was a company called independent lock company. There was a time when….just about everybody would have a key from independent lock. And when we did the analysis of the river to determine what type of processing would be needed to deal with it, we found high levels of arsenic, mercury, and all those dangerous heavy metals because independent lock company used them to polish the brass and then dumped them into the river. That was the really bad stuff. In fact, even today the [Army] Corps of Engineers doesn't want to remove the

damns that are there because there is so much bad stuff built up behind them. The watershed association has the report on that if you need to see that for some reason.

An interesting less that I learned though, when you're too close to something, you don't realize what's going on. I grew up in Fitchburg. And we accepted the river, that's the way it was. And often times… listen to the outsider. Sometimes the best information you can get about your organization comes from the person who just came into the organization, because they see things that nobody else see because we become acclimated to our environment. And I got a knock on the side of the head when I was in City Hall one day and I got a letter and it said, "Dear Mayor Flynn, I came to your city to do business… When I drove over the river at Bemis Road and looked down and saw the sewer that was running through your community I made the decision that I would not do business in a community that had such low self-esteem as to allow that to continue." That gave me an economic reason why the river had to be cleaned up, but we sometimes let things happen and accept them because that's the way it's always been. Listen to outsiders. Marion Stoddart came from Nevada, and she saw the problem with the river. That's a lesson in life.

Question: Do you know what impact the river played in normal citizens' lives during that time?

Flynn: Not much really. Well, huge economic impact. It was a convenient place for "A" for the paper companies to get raw materials and "B" a convenient place for paper companies to dispose of raw materials. All the paper mills would have gone away eventually anyway because it was just the rout of industrialization. In about 1965 they all sold out. So it was just a matter of time when this thing would have been eliminated of whether we cleaned up the river or not. As the river runs through Fitchburg.. its in a canyon really, it's very difficult to get to the river so to the average citizen, it was there but it wasn't a thing of beauty or anything, and now efforts are being

made for waterfront parks are being made so that will all change. Back then, water front property didn't have any value, now it has some value.

Question: When you received the letter stating that the writer would not do business in the town due to the conditions of the river, was that point when you started working toward getting the river cleaned up?

Flynn: No, it gave me another strong argument and an awareness that this thing was a testimony to what the city was all about. I was working on an All American city application and cleaning up the river because in the late sixties… it was positive in the standpoint of community action. I was involved in it primarily because "A," we were going to be under federal and state regulations to do something, secondly I was a white water canoeist so I like rivers and naturally gravitated towards that, but the real pragmatic reason was the City of Fitchburg's waste water treatment facility was 63 years old and needed to be replaced. By doing this project and by creating a regionalization approach to it were going to be able to clean up our act and get 85% federal reimbursement, so it was the cheapest way to solve the problem we were going to have to solve one way or another.

Question: Were you able to get some business owners involved?

Flynn: Oh yeah.

Question: And how were you able to do that?

Flynn: Well there's nothing like the strong arm of the federal government to help you. They had to comply. The government has role. Sometimes if government sets the policy and sets the standard people will start to change their behaviors. …But you could see that it was the college students out on the streets calling for clean water clean air that it actually moved the

governmental process. Government rarely leads, it follows what the social thinking of the times are.

Question: What made Marion Stoddart's efforts different than other people of the time?

Flynn: She was really the only one. She was the driver; there was no question about it… And because she had the League of Woman Voters behind her. Back then the League was pretty influential. I knew (Marion) because she was on city council.

Question: Do you think there is still a lot of improvements to be made to the River?

Flynn: Oh yeah. They're beginning to separate storm and sewer drains, that's the biggest thing. You don't want to go into that river after a heavy rain because it has everything in it. Then there's what we're doing at the Lancaster Friends of the Nashua River. We're trying to first bring awareness that the river's there and that it's an important resource but secondly, we want to get land owners to give rights away and actually create a greenway along the river so that people have access to it.

Key Points from Marion Stoddart Interview

Nashua River Greenway

- 300 foot buffer on either side of the river
    - This would provide long term protection for the river
- NO floodplain zoning or wetlands protection when this project started
- Provide a recreational trail running the length of the river
- More "urban trails in cities where preserving the buffer would be difficult/impossible
- 1972 – Greenway Committees formed in every town in the watershed
- More than half of the land is protected today, but connections need to be made

- Lancaster has the most land along the Nashua River (includes the North and South branches and main stem)
- Bill Farnsworth chaired the Lancaster Greenway Committee

Nashua River Cleanup

- Backed by the League of Women Voters
- Gained connections in the different towns. Sought out people who cared about the river.
    - "Only associate yourself with positive thinking people"
- Identified people who had power (e.g. mayors, selectman, legislators, etc.)
    - Brought a bottle of dirty Nashua River water to the Governor
- Business owners would never locate their business in a city that cared so little about their river
- Industries wanted Class D status – suitable for transport of sewage/waste
- Residents wanted Class B status
- At the time the river was Class U
- Making friends, identifying the stakeholders, meeting people on the state and federal level (Marion on accomplishing environmental change)

Appendix C: Surveying Data

Table 2: Coordinates of boundary points in Latitude and Longitude

Points/Name	Latitude	Longitude
1	42°29'37.57534"N	71°41'10.56498"W
2	42°29'40.48789"N	71°41'19.11910"W
3	42°29'40.27414"N	71°41'20.40860"W
4	42°29'34.29646"N	71°41'32.66962"W
5	42°29'31.97672"N	71°41'49.78342"W
6	42°29'42.53712"N	71°41'50.37668"W
7	42°29'42.59672"N	71°41'50.48311"W
8	42°29'43.05312"N	71°41'51.29798"W
9	42°29'46.39175"N	71°42'02.68225"W
10	42°29'51.16767"N	71°42'06.02521"W
11	42°29'52.03726"N	71°41'52.94206"W
12	42°29'49.23109"N	71°41'43.07351"W
13	42°29'49.71053"N	71°41'38.99091"W
14	42°29'47.25169"N	71°41'26.27140"W
15	42°29'43.19143"N	71°41'09.99195"W
16	42°29'41.93993"N	71°41'09.95880"W
17	42°29'38.97043"N	71°41'10.58549"W
112	42°29'49.17827"N	71°41'43.12165"W
113	42°29'49.74811"N	71°41'39.05919"W
BM32	42°29'39.27825"N	71°41'11.58522"W
Cook−base2	42°29'47.90451"N	71°41'28.50824"W

Table 3: Coordinates of boundary points in Massachusetts state plane coordinates

Points/Name	Northing	Easting
1	3005014.699	605930.774
2	3005310.951	605290.577
3	3005289.527	605193.925
4	3004686.448	604274.012
5	3004454.544	602991.335
6	3005523.697	602949.362
7	3005529.75	602941.403
8	3005576.093	602880.464
9	3005916.061	602028.405
10	3006400.128	601779.113
11	3006485.862	602759.409
12	3006200.082	603498.034
13	3006247.919	603803.985
14	3005996.857	604756.285
15	3005583.134	605974.944
16	3005456.437	605977.151
17	3005155.931	605929.545
112	3006194.744	603494.415
113	3006251.735	603798.878
BM32	3005187.256	605854.717
Cook−base2	3006063.318	604588.863

Tables 2 and 3 show the coordinates of the boundary points for the Cook Conservations Area. Table 2 uses Latitude and Longitude as the coordinate system and Table 3 uses Massachusetts state plane coordinates as the coordinate system. Points 1 through 17 are the points labeled in Figure 4. The locations of these points were estimated using the Topcon Tools computer program and the data collected while surveying. Points 112, 113, and BM32 are the surveyed points which coincide with points 12, 13, and 17 respectively. The point Cook-base2 is the location where the base station was set up while the survey was performed.

Appendix D: Facsimile of Deed for Cook Conservation Area

BOOK 5866 PAGE 132

MASSACHUSETTS QUITCLAIM DEED INDIVIDUAL (LONG FORM) 888

GEORGE H. COOK, JR.

of Leominster Worcester County, Massachusetts

being unmarried, for consideration paid, and in full consideration of One Dollar ($1.00)

grants to Lancaster Conservation Commission
Town Hall, Main Street

of Lancaster, Massachusetts with quitclaim covenants

the land in Lancaster, Massachusetts

(Description and encumbrances, if any)

THE LAND in the Northerly part of Lancaster in said County of Worcester containing 104 acres, bounded and described as follows:

COMMENCING at a stone bound located in the Southeast corner of the property which is 141.24 feet S 10°45' W of road bound No. 32 of Old Lunenburg Road;

THENCE running in a N 53° 40' W direction along land now or previously owned by Wilder S. Thurston for a distance approximately 712.14 feet to a point on the Easterly bank of the Nashua River;

THENCE in a S 88°45' direction for 99 feet more or less across said to the West bank;

THENCE following the West bank of the Nashua River in a generally Southerly direction to, through, and including Westerly, Northerly, and Southerly directions of said river, for a distance of 2,592.68 feet more or less, to a point at which said river bank intersects a bound of land now or formerly owned by Eugena Gaines;

THENCE in a N 89° W direction for a distance of 1,303.5 feet by land now or formerly owned by Eugena Gaines and land now or formerly owned by James Sartelle;

THENCE in a N 9° E direction for a distance of 1,032.9 feet along land now or formerly owned by James Sartelle to a point

THENCE in a N 41½° W direction along land now or formerly owned by James Sartelle to the east bank of the Nashua River;

THENCE following the same line crossing said Nashua River in a N 41½° W direction for a distance of 76.56 feet to the West bank of said river;

THENCE following the West bank of said river in a generally Southerly direction for a distance of 1,000.56 feet more or less to a bound on the North side of the river forming a boundary for land now or previously owned by heirs of William Powers;

THENCE following a boundary for a distance of 544.5 feet in a N 16° W direction to a point marking land now owned by the Commonwealth of Massachusetts but formerly owned by William H. Blood;

THENCE in a S 83° 45' E direction for a distance of 984.06 feet along land now or formerly owned by said Commonwealth of Massachusetts and land now or formerly owned by heirs of Charles L. Wilder;

THENCE running in a S 57° 36' E direction for a distance of 792 feet along land now or formerly owned by heirs of Charles L. Wilder and land now or formerly owned by heirs of William J. Gurry;

THENCE in a S 87° 45 E direction, continuing 307.56 feet along land now or formerly owned by William J. Gurry to a point separating said Gurry land from land now or formerly owned by heirs of Charles L. Wilder;

THENCE running along the boundary of said Wilder land in a direction S 62° E for a distance of 987.04 feet more or less to a bound again marking a division of the land of the heirs of Charles L. Wilder and

(*Individual — Joint Tenants — Tenants in Common — Tenants by the Entirety.)

continuing along said Wilder land in a S 59° E direction for a further 1,287 feet to a point on Old Lunenburg Road.

THENCE turning from point on Old Lunenburg Road in a S 10° 15' W direction and running 126.72 feet along said road to road bound No. 31;

THENCE continuing from road bound No. 31. located on Old Lunenburg Road in a S 20° 15' W direction running 304.26 feet to road bound No. 32 again located on Old Lunenburg Road;

THENCE continuing from road bound No. 32 in a S 10° 45' W direction a distance of 141.24 feet closing on said point of beginning.

ALSO one (1) other tract of land situated on the Northerly bank of the Nashua River located upstream and detached from the first parcel previously described, containing about 1 acre, bounded and described as follows:

COMMENCING at the South Westerly corner at a point on the Northerly bank of the Nashua River from a point that divides land now or previously owned by George H. Cook, Jr. and land now or previously owned by James Sartelle;

THENCE running in a N 2° 30' E direction for a distance of 165.0 feet along land now or previously owned by James Sartelle;

THENCE in a N 88° W direction for a distance of 224.4 feet along land now or previously owned by James Sartelle;

THENCE in a N 63° 30' W direction for a distance of 106.3 feet along land now or previously owned by James Sartelle;

THENCE in a N 70° E direction for a distance of 60.1 feet along land now or previously owned by James Sartelle to a creek called Dead River;

THENCE following down this creek called Dead River in an Easterly and Southerly direction for a distance Of 792 feet more or less along land now or previously owned by James Sartelle to the Northerly bank of the Nashua River;

THENCE following the Northerly bank of the Nashua River upstream for a distance of 412.5 feet more or less to the point of beginning.

CONVEYING, and intending to convey, hereby the premises conveyed to Charles E. Gould and Frank H. Cook by Charles T. Wilder by deed recorded on pages 490-492 of Book 1406 of the Worcester District Registry of Deeds and dated March 17, 1893. For my title see Worcester County Probate Docket No. 177568.

THIS CONVEYANCE creates no new boundaries.

BOOK 5866 PAGE 134

Witness my hand and seal this Twenty third day of Dec 1975

George M Cook Jr

Witnessed —
Donald Hunter
Phyllis A. Farnsworth

The Commonwealth of Massachusetts

WORCESTER ss. December 23 1975

Then personally appeared the above named George M Cook Jr

and acknowledged the foregoing instrument to be his free act and deed, before me

Notary Public — Justice of the Peace

My Commission Expires Aug 5 1977

Recorded DEC 30 1975 at 11 h. 29 m. A.M.

Appendix E: Trail Mapping Data

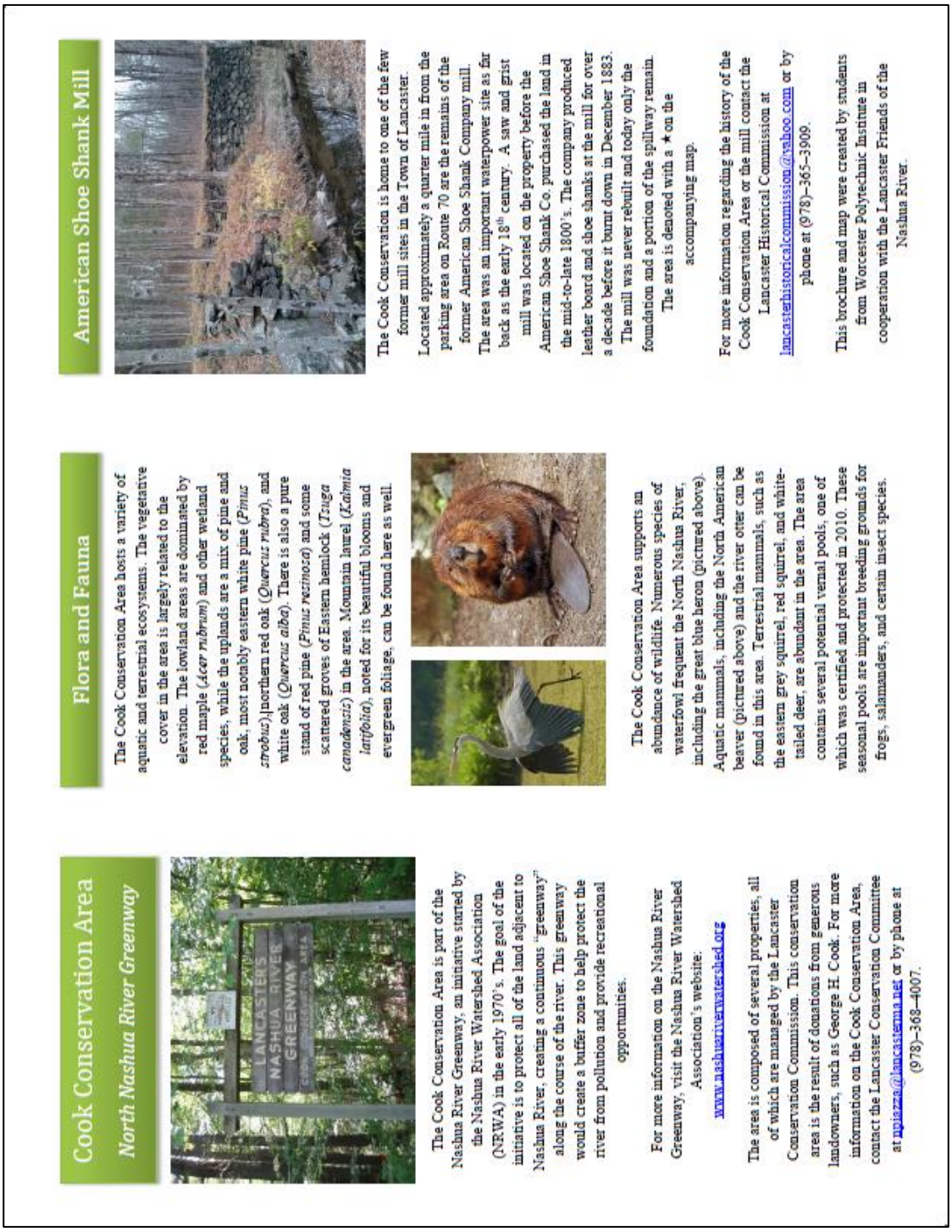
Table 4: Point data collected from trail mapping

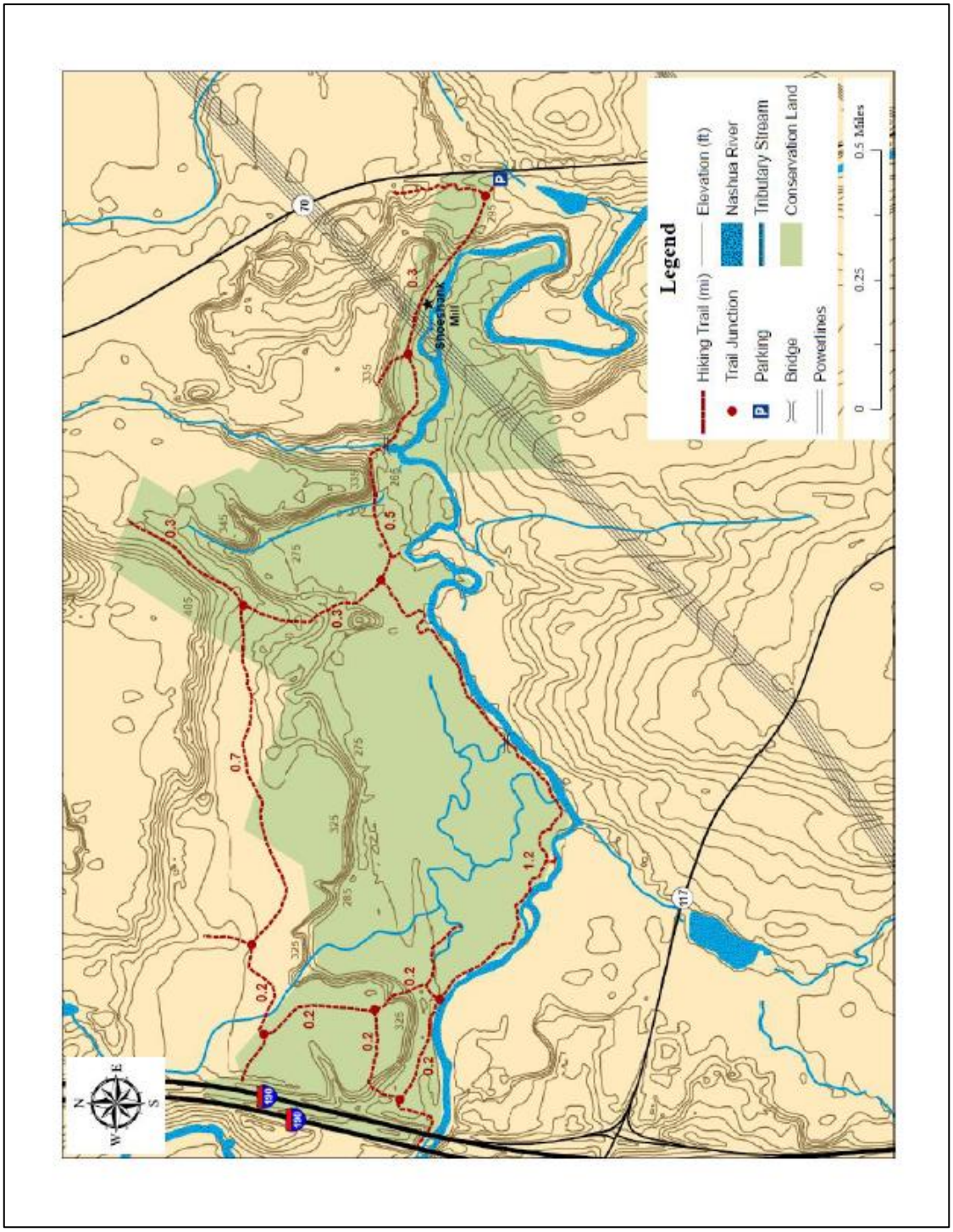
Latitude	Longitude	Notes	Latitude	Longitude	Notes
42.49508333	-71.68931667	Brook (McGovern)	42.50033333	-71.71026667	
42.49583333	-71.69071667	Foundation (POI)	42.50068333	-71.70883333	
42.49608333	-71.69156667	Junction	42.50063333	-71.70673333	Gravel pit boundary
42.49605000	-71.69398333		42.50081667	-71.70471667	Gravel pit boundary
42.49613333	-71.69505000		42.50085000	-71.70253333	Junction
42.49663333	-71.69606667		42.50116667	-71.70190000	Trail Continues
42.49688333	-71.69638333	Bridge/Brook with blue flags	42.49973333	-71.70300000	
42.49730000	-71.69673333		42.49898333	-71.70305000	
42.49716667	-71.69833333		42.49815000	-71.70238333	
42.49721667	-71.69875000	Wetland/stream	42.49763333	-71.70230000	
42.49685000	-71.70020000	Wetland	42.49738333	-71.70168333	Maker off trail
42.49646667	-71.70046667	River Bend (Viewpoint)	42.49700000	-71.70148333	Junction
42.49686667	-71.70110000		42.49626667	-71.69295000	Junction
42.49711667	-71.70150000	Junction	42.49670000	-71.69318333	
42.49658333	-71.70221667		42.49715000	-71.69420000	Marker for Cooks
42.49620000	-71.70283333		42.49411667	-71.68698333	Junction
42.49580000	-71.70276667		42.49490000	-71.68675000	
42.49593333	-71.70343333	Brook	42.49670000	-71.68678333	Solar Field
42.49551667	-71.70350000		42.49390000	-71.68660000	Trailhead
42.49480000	-71.70483333		42.49608333	-71.69153333	Junction (Power lines)
42.49463333	-71.70581667		42.49706667	-71.70145000	Junction
42.49350000	-71.70761667	Bridge/Brook	42.50086667	-71.70246667	Junction
42.49230000	-71.70930000		42.50121667	-71.70186667	
42.49195000	-71.71028333		42.50181667	-71.70136667	
42.49221667	-71.71085000		42.50255000	-71.70058333	
42.49245000	-71.71168333		42.50306667	-71.70001667	
42.49281667	-71.71315000		42.50370000	-71.69958333	
42.49318333	-71.71398333		42.50415000	-71.69915000	Terminus (Gravel)
42.49330000	-71.71518333		42.50058333	-71.70921667	Stream

42.49535000	-71.71735000	Junction	42.49965000	-71.71341667	Gate
42.49583333	-71.71936667		42.50060000	-71.71526667	Junction
42.49643333	-71.72148333	Fence	42.50193333	-71.71493333	Gravel Pit
42.49556667	-71.72176667	Marker	42.50038333	-71.71848333	Gate
42.49563333	-71.72230000	Drainage ditch under I-190	42.50025000	-71.71865000	Junction
42.49600000	-71.72298333	I-190	42.50025000	-71.71896667	Junction
42.49646667	-71.72110000	Junction	42.50085000	-71.72046667	Terminus (I-190)
42.49716667	-71.72073333		42.49996667	-71.71856667	Junction
42.49733333	-71.72045000		42.49715000	-71.71771667	Junction
42.49708333	-71.71890000		42.49683333	-71.71751667	
42.49715000	-71.71773333	Junction	42.49660000	-71.71716667	
42.49816667	-71.71763333		42.49630000	-71.71706667	
42.49926667	-71.71761667		42.49570000	-71.71676667	Junction
42.50000000	-71.71858333	Junction	42.49558333	-71.71706667	
42.50033333	-71.71856667	Gate	42.49535000	-71.71731667	Junction (Pipe)
42.50018333	-71.71893333	Junction	42.49555000	-71.71646667	
42.50008333	-71.71760000		42.49556667	-71.71575000	
42.50005000	-71.71676667		42.49533333	-71.71515000	
42.50065000	-71.71586667	Brook	42.49481667	-71.71455000	
42.50060000	-71.71625000	Junction (gravel)	42.49471667	-71.71458333	Terminus (Swamp)
42.49961667	-71.71335000	Gate	42.49236667	-71.71208333	
42.50016667	-71.71135000		42.49210000	-71.71195000	Viewpoint off trial

Appendix F: Brochure

This appendix includes an image of the front side of our tri-fold brochure for the Cook Conservation Area. The reverse side displays the trail map.




Legend
Hiking Trail (mi)
Trail Junction
Parking
Bridge
Powerlines
Elevation (ft)
Nashua River
Tributary Stream
Conservation Land
0
0.25
0.5 Miles
Shoeshank Mill
70
117
P
0.3
0.5
0.7
1.2
0.2