



Revitalizing Worcester

Turtle Boy: A Beacon of Hope

An Interactive Qualifying Project Proposal: submitted to the Faculty of

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by:

Ryan Garcia

ryangarcia@wpi.edu

Ryan Moadlo

moad@wpi.edu

Margaret Wigley

mwigley@wpi.edu

Pattipong Wisanpitayakorn

pwisanpitayakorn@wpi.edu

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Faculty Advisors:

Professor Chickery Kasouf

ABSTRACT

Downtown Worcester lacks the qualities that should make it the life of the city. The goal of this project was to research ways to revitalize downtown Worcester, specifically the Common area, through the restoration of the historic Burnside Fountain. We proposed sustainable options to the City of Worcester for powering and restoring Burnside Fountain, otherwise known as “Turtle Boy,” to initiate this revitalization. Through the use of case studies, interviews, cost analysis, and a survey, we devised a detailed schematic for the sustainable restoration of Burnside Fountain and provided recommendations to the City of Worcester for breathing life back into the area.

EXECUTIVE SUMMARY

The downtown area of a city should encompass life, excitement, prosperity, and vibrancy. Currently, Worcester's downtown area is lackluster, and is in great need of revitalization. One area that is in particular need is the Common. Surrounding the area are vacant storefronts, lack of foot traffic, and an overall sense of disinterest. Despite all of this, downtown Worcester has great potential to become the heart of the city.

Worcester was once the leading manufacturer of railroad cars, roller and ice skates, leather belts, and auto-crank shafts. The city was full of excitement and life. Over time, successes and failures have brought Worcester to its current status. "One by one, industries that had been the cornerstone of Worcester's economy in the 19th century either moved away or went out of business" (Erskine, 1981). Manufacturing, which had been the base of Worcester's success, diminished as the use of railroads declined. The city was forced to turn to alternative methods, leading to an extensive process of urban renewal at the end of the 1900s. The renewal was characterized by the relocation of streets, highways, railroads, and the rebuilding of the center of the city. This rebuilding, which continues even today, completely disrupted the retail trade in the city.

The diversity of Worcester has been a leading factor in the survival of the city through the years. This diversity is present today in the form of multiple insurance companies, banking industries, courts, hospitals, and twelve colleges and universities. The success of these diversified trades, however, does not reflect on the downtown area. With little entertainment, restaurants, or activity, people are not attracted to the downtown area for reasons other than business. Following the typical workday, the common is barren and people turn to nearby towns and cities for entertainment and shopping needs.

One area of the common that greatly represents the decline of Worcester's vibrancy is the Burnside Fountain. The fountain was once an attractive and functioning memorial. Like Worcester, the fountain has a rich history of its own that has been forgotten over time. Left in disrepair, the monument would benefit extremely from a restoration that would highlight its beauty and historical significance.

Burnside Fountain, also known as “Turtle Boy,” was originally constructed as a memorial to Samuel Burnside, a prominent Worcester lawyer. After a donation of \$5,000 from his daughter, Harriet, the fountain was constructed in 1912 on Salem Square. Its designers included Henry Bacon, who also designed the Lincoln Memorial, Charles Harvey, and his colleague, Sherry Fry, who completed the sculpture of the “Turtle Boy” after Harvey’s untimely death. Originally intended as a watering trough for horses and dogs, the fountain has fallen into disrepair. By the time the memorial was constructed, horse and carriage were a trend of the past and the automobile was the transportation of choice. With little use, the fountain was soon forgotten. Water stopped flowing, the bronze sculpture slowly corroded, and the granite basin became weathered. The changes over the past century can be seen in Figure 1.

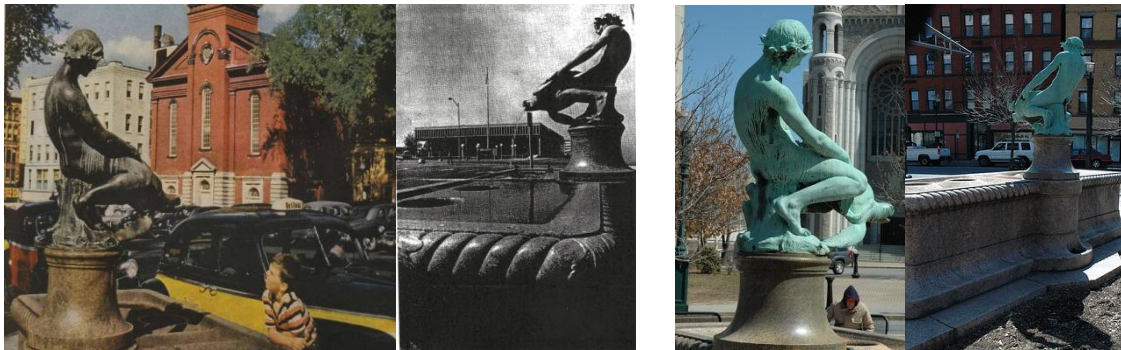


Figure 1: Burnside Fountain in the past (left) and present (right). Courtesy of Worcester Historical Museum.

Restoring Burnside Fountain to a functioning state is important to initiate the revitalization of the area. As 2012 is the 100th year anniversary of the construction of the fountain, its restoration is long overdue. By implementing attractive lighting, new plumbing, and restoring the water flow, the fountain can be the focal point of the Common. Our project focuses on the restoration of this memorial and the impact it can have on downtown Worcester.

By identifying and interviewing people with longstanding opinions and experience in Worcester we were able to identify the city’s flaws as well as what could be done to improve the downtown area. These people have had a plethora of interaction with Worcester residents and have a sense of the public’s opinion. During our interviews, we discussed methods the city could incorporate into future projects that would make the area more successful. We also probed what the impact restorations like that of Burnside Fountain would have in Worcester. We used

archival information and sources found online to define the current status of Worcester. We uncovered what was successful in the past as well as what failed and why. We compared this information to what has proven beneficial in a successful mid-sized city, Providence, R.I. Through use of a survey distributed to students at Worcester Polytechnic Institute, we obtained a better understanding of what college students would like to see implemented in Worcester. With this information, we were able to make recommendations to the city to help attract businesses and people in hopes of making the area vibrant again.

Our second goal of this project was to provide a detailed schematic for a sustainable restoration of Burnside Fountain. A case study of the fountain located on the WPI campus was an excellent source in our efforts to provide information on the various parts needed to restore “Turtle Boy.” As Burnside Fountain is a historical staple in Worcester, it was necessary to research the proper way to treat it. By working closely with Rob Antonelli Jr., Preservation Worcester, and the information gathered from our research, we provided a schematic for the restoration of Burnside Fountain.

Our recommendations fall into two categories: Worcester’s revitalization and the Burnside Fountain restoration. Recommendations for Worcester include ideas for future projects that could benefit the city. We also stress examining how every project will affect Worcester as a whole. It is also necessary for Worcester to build a strong and interesting city for its current residents before catering to visitors.

For Burnside Fountain, we recommended strategic placement of the fountain’s components and methods for treating the stone and bronze. We also provided cost estimation for a restoration with and without the use of solar panels. The implementation and placement of attractive LED lighting at the base of the fountain was also detailed in our schematic.

Improvements to the downtown areas, such as “Turtle Boy,” are essential to the success of Worcester. When planning future projects, Worcester must be cautious of past mistakes and examine how every decision affects the Worcester community. Following these steps can make Worcester a prosperous city and a better, more desirable place to live.

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AUTHORSHIP

All members of the project team contributed equally to the authorship of this paper and the completion of the project.

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CHAPTER 1: INTRODUCTION

The downtown areas of cities are usually considered the heart and life of the city. They bring entertainment, restaurants, and beauty to an area. For some time, Worcester's downtown has been lacking. There are many pieces of art, monuments, and beautiful architecture in the area, but, in our opinion, there is no cohesive attractiveness to any of it. In short, the Common is in need of revitalization. A solution to this starts with a small piece of public artwork on the Common.

Public works of art have been and always will be a major contribution to cities and towns. Not only are they an expression of beauty and create lovely points of interest, they represent history of people and events of the past. Many sculptures serve as a reminder of what once was and often have an incredible story of origin. They can serve as a symbol of hope, as a memorial, or serve as an icon for a certain location. Unfortunately, quite often these expressions of creativity are forgotten; left to corrode and weather. Often times the story and history they represent corrode with them.

For quite some time now, a little boy and his turtle have kept watch over a lonely corner in Worcester Common. In the early 1900s, Harriet Burnside, the daughter of a prominent Worcester lawyer, donated a sum of money to the city to erect a memorial for her father. Shortly after, the quirky "Turtle Boy" fountain was unveiled. What once was a great point of attraction and the "mascot" of Worcester is now slowly being forgotten by the residents that once loved this landmark (Semon, 2011). As the fountain's 100th Anniversary nears, it is clear the effects of weather, lack of upkeep, and even vandalism have taken its toll on this piece of art. Worcester has many works of art and sculptures throughout the city, all representing their own story and history, but none are quite like Burnside Fountain.

The fascinating history of this quirky statue has touched many people and spawned many support and fan clubs, songs, and even books written for and about "Turtle Boy" (Semon, 2011). Located in Worcester Common, the fountain was once a central figure and made the Common a place of attraction in downtown Worcester. Unfortunately, as the statue deteriorates, so does the historical significance and interest of Worcester residents, and it is taking its toll on the appeal of downtown Worcester. For many decades now, the jolly turtle has not spouted any water and the once glistening bronze statue is corroded in green.

The fountain is coming up on its 100th year anniversary after being erected in 1912. The memorial needs serious restorations in order to be functional again and restored to its former glory. These restorations would be highlighted with an LED light show to make the fountain attractive again in hopes that it will be the start of a great transformation for the Common.

The driving force behind our main goals was finding what would breathe life back into downtown Worcester. When did downtown Worcester become lackluster? Was it gradual? What can we do to improve the attractiveness and popularity of the area? We researched these questions as well how to revitalize the Common by taking one of its highlights, Burnside Fountain, and making it into a symbol of hope. If we can successfully propose a plan to restore “Turtle Boy” we hope it will set a tone for the rest of the invigoration of downtown Worcester.

An ideal outcome includes a functioning fountain that has a pump and LED lighting that are both powered sustainably. Most importantly we hope to return “Turtle Boy” and all that he represents back to the hearts of Worcester and make him a beacon of hope for turning the Common around. We hope to make suggestions to the City of Worcester as to how the downtown area can be improved upon.

There are multiple objectives associated with this project that we wanted to fulfill to coincide with requirements requested by the City of Worcester. These include as listed:

1. Surveying and categorizing public opinions concerning the restoration and Worcester’s current condition.
2. Obtaining a pump that will meet the requirements of Burnside fountain.
3. Taking qualitative data concerning the power needs of the pump.
4. Determining a feasible sustainable power source that can meet the energy demands of the pump and LED lights.
5. Choosing the optimum solution for Burnside Fountain restoration.
6. Make informed suggestions on ways to revitalize the downtown area.

A successful restoration of Burnside Fountain required a substantial amount of research into the many different issues of the project. One of the most important research questions was what is wrong with Worcester’s downtown currently? Why is it not as successful as it could be? How can we improve upon its status currently and what works for other mid-sized cities? Concerning Burnside Fountain, we were faced the questions of how does a pumping and filtering

system work within a fountain? How did Burnside Fountain originally function? How can LED lighting be added to the fountain? Can the fountain be run sustainably? While performing sustainable energy research it was also important to ask, is a sustainable fountain restoration feasible?

All of these areas were extensively researched and considered, and well informed data and recommendations were presented.

CHAPTER 2: BACKGROUND

As in any revitalization project, some baseline information was needed. Many works of art have a story behind them including where they originated, who they represent, and what event in history inspired its creation. Burnside Fountain, also known as “Turtle Boy,” has a very intriguing and interesting history, to say the least. We will introduce sustainable options for powering the fountain to later research which of these options will be feasible in this particular case. We will also examine some examples of where these options are used. In this chapter, we will examine the state of the fountain, the attractiveness of Worcester Common, and the rich history of both.

2.1 Revitalizing Worcester, MA

In early 2010, the City of Worcester created a Five-Year Consolidated Submission for Community Planning and Development. Goal 1 of this plan, which extends from July 2010 to 2015, is “Promote a Livable, Viable and Sustainable Community” (City of Worcester, MA, 2010). For years, Worcester has been diligently working to revitalize a once great city that is now struggling from a slowing economy and rundown neighborhoods. According to the Five-Year Plan, the City of Worcester expects to receive approximately \$5 million per year over the next five years. These funds will dramatically boost Worcester’s efforts to restore the city’s appearance and quality of life. The creation of the Neighborhood Revitalization Strategy Area (NRSA) was a major step in the revitalization process. The NRSA defined the goal of its program as:

“Bring[ing] together neighborhood residents, small business owners, and property owners, as well as larger community stakeholders to forge partnerships that commit to neighborhood building, make neighborhoods attractive for investment, ensure that economic activity benefits are reinvested in the neighborhood, and foster growth of resident-based initiatives to identify/address their housing, economic and human service needs” (NRSA, 2010)

Worcester’s request to have Burnside Fountain restored is part of the city’s aim to improve aesthetics and historical icons and is cohesive with NRSA’s goal of attracting investors.

2.1.1 “Going Green”

Worcester’s request to have Burnside Fountain powered sustainably is not a new concept. The idea of sustainability is one that has been around for years and Worcester has adopted efforts of becoming a more sustainable city. The concepts of “Going Green” and being “Earth-friendly” have roots stemming from centuries ago. On September 6, 1789 Thomas Jefferson stated,

“Then I say the Earth belongs to each ... generation during its course, fully and in its own right. The second generation receives it clear of the debts and encumbrances, the third of the second, and so on. For if the first could charge it with a debt, then the Earth would belong to the dead and not to the living generation. Then, no generation can contract debts greater than may be paid during the course of its own existence.” (Jefferson)

Jefferson’s observation has become more important now than ever. The City of Worcester, in an effort to improve quality of life and relieve future generations of this “debt”, has continued to persevere in its effort to create a sustainable city. In December 2006, Worcester completed its Climate Action Plan. The goal of this plan is to enable Worcester to be a leader in sustainability by reducing energy use and greenhouse gas emissions. Abiding by the plan will put “Worcester on a course towards a sustainable future and improve the quality of life for Worcester’s residents, visitors, workers, businesses, and institutions” (City of Worcester, MA, 2006).

Becoming a leader in sustainability would create countless possibilities for Worcester’s growth. In the event that sustainable power options such as wind or solar powered generators produce more energy than needed, it can be sold back to the utility companies. This creates profit which can be invested directly back into the city’s economy. Environmentally, benefits include cleaner air and healthier communities. Therefore, it is clear that improvements such as that to Burnside Fountain should be done in accordance with Worcester’s vision for a sustainable future. A restored fountain would also be a great improvement to the aesthetic of the Common

2.1.2 Downtown Worcester and the Common

In many cities the downtown and Common area are its heart and life. Other mid-sized cities in the area such as Providence, have mastered a central area of attraction and life in their downtown areas. Unfortunately in Worcester, the Common is lacking. There have been many changes made to the area since the 1970s such as the addition and quick extraction of a strip

mall. The City of Worcester has wanted to revitalize the downtown area for quite some time according to Kate Toomey.

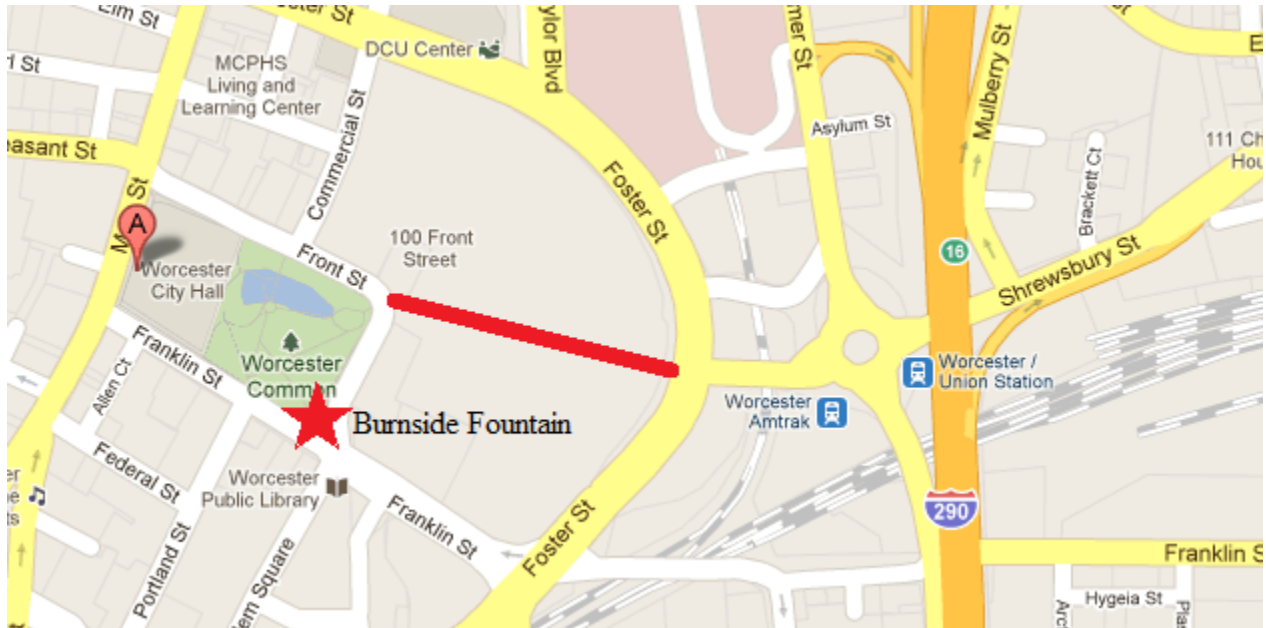


Figure 2: Downtown Worcester as taken from Google Maps.

There are many plans to change the Common in the coming years. The Common is boxed off by the remains of a mall. It is secluded from Shrewsbury St., which is a restaurant hotspot in Worcester and draws many Worcester residents and even people from other towns. Plans for remediating this include the demolition of a section of the vacated mall to make way for a connecting street to Washington Square, which then connects to Shrewsbury St. This can be seen in red in Figure 1. This street is planned with the hope that there will be a better traffic flow of both cars and people through the Common area. Unfortunately, this plan is only in the beginning stages and the Common has some problems of its own. The appeal of the Common could be improved. There are many areas, such as benches and lamp-posts, which have different themes and styles. Some of the monuments are decaying and corroding. Overall, the Common is dull. At night, there is no livelihood, hardly any lighting, and safety becomes a real issue. One of the monuments, Burnside Fountain, is especially unattractive and in need of some attention. We hope that by harnessing the uniqueness of the fountain and its history, we can make it a focal point and it will contribute to the appeal of the Common and be a start to its revitalization.

2.2 Relevant Burnside Fountain History

2.2.1 A Brief Burnside Family History

The fountain was a gift from Mrs. Harriet Pamela Foster Burnside in memoriam to her father, Samuel M. Burnside. Harriet Burnside was one of the wealthier Worcester residents of her time, living in the Burnside Mansion on Chestnut St (Semon, 2011). Born in 1827, she had come from a very wealthy family and her and her sisters, Sophia and Elizabeth, were called “throughout their lives the most notable figures in the life of Worcester” (Pierce, 1899). According to Frederick Clifton Pierce, they loved reading and music and erected a library to benefit those in Worcester. They kept many beautiful gardens that they opened their house to those who wanted to view them. Their hospitality was one to admire, and their charity was great as Pierce says, “those who have been privileged to come in intimate relationship with them know how bountiful has been their life in benefit and pleasure to others” (Pierce, 1899).

Harriet’s charity was seen again when her father died in 1850. She donated \$5000 in 1905 to the City of Worcester for a fountain to be erected in memoriam of her father, Samuel.

Mr. Samuel M. Burnside was a prominent lawyer in Worcester. He studied law at Dartmouth University and continued his education in the office of Honorable Artemas Ward. He eventually became Chief Justice of the Court of Common Pleas (Pierce, 1899). As for his character, he was beloved by many in Worcester as is described beautifully by Frederick Clifton Pierce,

“No one was more able or willing to afford aid to his students. Familiar acquaintance with the principles of the common pleader, with uniform kindness and liberality, justified their affectionate reverence for the character of that able jurist and excellent man.”

(Pierce, 1899)

He resided in Worcester until his death on July 25, 1850. He was survived by his wife, Sophia, and three daughters; Sophia, Harriet, and Elizabeth (Condarcore, 2011).

2.2.2 History of Burnside Fountain

After Harriet Burnside’s generous donation, Daniel Chester French was commissioned to design and erect the fountain. He assigned the design of the basin to Henry Bacon, future designer of the Lincoln Memorial in Washington D.C. The design of the statue on top of the

fountain was designated to Charles Y. Harvey (Beall, 1986). Burnside requested a design that would serve as a drinking trough for her horses and dogs when she was out in horse and buggy.

Charles Harvey was a graduate from the American Academy at Rome (Beall, 1986). After beginning the design of the “Boy with his Turtle,” Harvey began to hear voices coming from the unfinished statue commanding him to take his own life,

“The work of his hands dissatisfied him and, as he tried to make headway, he was haunted by the voices of unseen persons, who bade him take his life. The command was explicit. The voices, from which he could not escape, directed relentlessly that he lay aside his tools and kill himself.” (Semon, 2011)

Mr. Harvey soon after obliged to the voices coming from the statue and killed himself in Bronx Park on January 28, 1912. Soon after his death, a colleague and fellow Academy graduate Sherry Fry completed Harvey’s work according to his original design (Semon, 2011).

The statue was completed and given to the City of Worcester in 1912. The basin that Henry Bacon designed on which the turtle and his boy sat consisted of four horse-muzzle-shaped troughs carved into the pink granite and one smaller trough in the back for her dogs to drink from. Unfortunately, when the statue was placed in Central Square in 1912, transportation by horse and carriage was becoming less popular and the fountain was not used as a watering trough (Southwick, 2007).

Since its construction, the fountain has been through quite a lot. In 1969 the fountain was moved from Central Square to its current location in Worcester Common and was facing Salem Square. This was in compliance with a request from a Mr. Albert Freeman on November 15, 1939 (Freeman, 1939). He wrote a letter to a Mrs. Seelye asking that the fountain be moved to a more suitable location and to be displayed in the way he felt it was meant to be showcased; in a place where the fountain could be enjoyed.

“Turtle Boy” has gone on some adventures as well. In May of 1970, the 100lb boy and turtle was stolen off of the basin and was gone for many months. In September, it was returned to the Worcester Police Department anonymously, who did not pursue charges against the thief. After the damage was assessed and a new bronze ring was made to reattach the statue, the boy and his turtle were returned to public perch in May of 1972. The statue was allegedly a target of another theft in 2004 when a few teenage boys knocked the statue off of his pedestal. After realizing what was done, they tried to replace the boy but left him precariously perched on the

basin tilted at an angle. Fortunately, no serious damage was done to the statue or basin and the statue was orientated correctly and reattached shortly after (Semon, 2011).

The quirkiness of the monument has attracted some big fans, and we hope to expand upon that by making him the focal point of the Common.

2.2.3 Burnside Fountain's Significance to Worcester

“Turtle Boy” has quite the strange following here in Worcester. At one time, “Turtle Boy” was known as Worcester’s mascot, much like the Mannken Pis is to Brussels (Semon, 2011). There are countless songs, books, t-shirts, and YouTube videos honoring this statue. There is even a blueberry flavored beer brewed by the Wormtown brewery called the “Turtle Boy Blueberry Ale” (Miller, 2010). From 2005 to 2009 there was an “Annual Turtle Boy Music Awards” where bands would perform and solicit donations for local Worcester charities (Bistro, 2009). There is even a children’s book written about “Turtle Boy” called The Cloud Bird (Southwick, 2007).

Many people have fallen in love with “Turtle Boy,” even since 1939. In a letter to the City of Worcester, Albert Freeman wrote, “Personally, I think the little fountain is the loveliest memorial that we have” and went on to plea for a more suitable location for it (Freeman, 1939). Many people would love to see that “Turtle Boy” is given the attention it deserves. Local resident J. Stuart Esty was quoted in the Worcester Telegram and Gazette saying,

“Why isn’t Worcester wrapping its head around and taking ownership of the ‘Turtle Boy?’ ... Why am I the only person on the planet selling ‘Turtle Boy’ postcards?... [It] is one of the things that makes Worcester unique” (Semon, 2011).

For many people, Burnside Fountain has grown near and dear to their hearts and they hate to see it decaying in front of them. There is a Turtle Boy Urban Gardeners club that waters the plants in the surrounding garden. Many of them would love to see something done for the centennial celebration (Turtle Boy Trivia, 2011).

Local and worceserturtleboy.com co-creator, Cathy Walsh, was quoted in the Worcester Telegram and Gazette as saying, “there’s something about ‘Turtle Boy’ that he has a personality and approachability (Semon, 2011). For these reasons, Burnside Fountain has become a mascot and icon to Worcester and deserves a place in every residences hearts.

We hope to harness the current interest in “Turtle Boy” and expand upon it. Burnside Fountain’s restoration can be the start of turning the Common around. One step at a time, the Common can become more attractive. Not many people know the history of this fascinating and slightly odd looking fountain. If “Turtle Boy” becomes the focus of the Common, he can be a reason people start to visit the area. Its small, but it is a start. There is some work to be done before that can happen, however.

2.2.4 Burnside Fountain’s Current Condition



Figure 3: Photo by Claudia Snell.
<http://www.flickr.com/photos/claudiasnell/47408525090/sizes/m/in/photostream/>

Currently, the fountain does not show any resemblance to the lovely memorial it once was. What once was a glistening bronze statue is now corroding and green. The polished pink granite basin is now chipped and dull. From personal viewing we have seen that the plumbing of the fountain is in need of some serious repair. All four of the bubblers, the spout in the turtle’s mouth, and the pump are dysfunctional. The fountain does not currently run, and has not run for many decades (Southwick, 2007).

There are many chips in the stone and the rust from the statue has stained the surface. There is very little representation of the fountain’s origins and history other than a dedication banner on the front of the basin. The fountain sits

lifeless with only the occasional gawker coming by to have a look. The condition of the fountain can be seen in Figure 2 above.

The fountain needs to be restored sustainably, and there are many options Worcester could work with, the main option being solar energy.

2.3 Solar Energy

A big part of the project was deciding whether it would be feasible to run the fountain using a renewable energy source. To achieve this, different components of the fountain would

need to be run off of an alternative energy source such as harnessing energy from wind, solar energy, or water. Based on the area the fountain is located in and the recommendations and restrictions given to us by our sponsor, solar energy was the best option to research implementing. These recommendations and restrictions are discussed further in Chapter 3: Methodology.

Solar energy technology was first developed by Charles Fritts in 1883 when he was able to apply gold to selenium to make the first solar cell (Bellis, 2011). Even though solar technology has existed for quite some years it was not widely used because of its high cost and low efficiency. With global warming and oil prices peaking more research has been given to solar technology and how these panels work. With this new respect for the technology, researchers have been able to improve the efficiency of these panels while decreasing the cost per watt of energy. As oil prices increase and more people turn to solar technology, the understanding and power of solar panels will continue to increase.

Solar panels collect the energy that the sun gives off, called photons, and converts these directly into electricity. These solar panels are made up of many photovoltaic cells that are connected in order to work together and capture the sun's radiation. In early research, most of these photovoltaic cells were made of a semi conductive material called silicon, which is derived from sand (Aldous, 2003). Sand consists of a compound known as silicon dioxide and undergoes a purification process to obtain the pure silicon. This process can be very expensive but the availability of sand keeps raw material costs low, which in turn creates a reasonable market price. Many companies have investigated different materials that can be used to decrease the overall price of production (Komp, 2002).

With the new research given to the field of alternative energy scientists have been developing different types of materials that can be used as solar cells. These cells all have some characteristics in common. For example, they are all semi-conductors. The biggest difference between these different materials is the fact that some have a lower cost per watt of production. What this means is that some cells have a higher efficiency than others, but also have a much higher production and installation cost. The problem for scientists was finding a cell that has a high enough efficiency, while still keeping a low initial cost.

2.3.1 Silicon-Based Cells

Silicon-based cells, shown below in Figure 2, are currently one of the most used cells in production because of their high efficiency. Nowadays, the silicon in silicon solar cells is separated into 2 layers: p-type and n-type. This creates a p-n junction which is key to efficient solar-electric power conversion. The silicon crystals in the p-type layer mix with a very small portion of boron to create impurities in the silicon, which increases the number of positive charges available to move through the circuit after the layer absorbs the energy from photons. These charges are called holes. Similarly, the silicon crystals in n-type layers mix with a very small portion of phosphorus to increase the number of the negative charges, called electrons. When the solar cell absorbs light energy, these holes and electrons will start moving through the electrical circuit, creating electrical current. (Komp, 2002). There are a couple of silicon-based cells that are currently popular in the market. One type, the monocrystalline silicon solar cell, is highly efficient. The rate of energy conversion from light for this type of cell is in the range of 18-21%. Despite its high efficiency the monocrystalline silicon solar cell is very costly. An alternative to these cells is the polycrystalline silicon cell with a lower efficiency of around 13-14%. Although these cells have a lower efficiency, they come at a lower price and account for around 63% of the market today (Bagnall, Boreland, 2008).

2.3.2 Second Generation PV Cells

Second generation cells are those that were developed to decrease the cost per watt of solar panels. These photovoltaic cells can range from amorphous silicon to CdTe/CdS cells, which have many different characteristics affecting the amount of solar radiation they can collect (Bagnall, Boreland, 2008). These second generation cells have a lower efficiency than the silicon based cells that are widely used, but have a lower overall cost. One of the biggest problems holding these types of cells back is the problem with scaling the cells up. Researchers have found that once these cells are scaled up they lose some of the efficiency they had (Bagnall, Boreland, 2008). The problem with scaling up the cells is once they are brought out of lab testing, where the cells are small scale, to an industry setting, where they are blown up to fit the need of the buyer, they lose efficiency.

2.3.3 Polymer Solar Cells

Polymer solar cells are a good alternative to silicon based cells because of their lower cost of production. These cells use a combination of plastic polymers in order to convert light energy into electricity. One of the biggest problems holding these polymer cells off the market is their low efficiency. Polymer cells currently only have an efficiency of up to 7% which is about 3 times lower than that of silicon based solar cells (Yang, et al., July 12, 2011). As these cells progress and efficiency is increased they might be able to match silicon based cells in performance, while greatly reducing the price. This kind of technology, however, will not be available on the market for a number of years.

Solar energy can be harnessed to power many things. In a case such as this, we will be researching how to power the fountain's water pump and the LED light show using solar energy. Running both the pump and the light show with solar electricity will eliminate the overall working cost of the fountain. We hope that running the fountain using green energy will be the first step in making Worcester sustainable.

2.4 Solar Powered Water Pumps

Since there is very little documentation on solar-powered water pumping systems, we explored the components that actually make up a fountain to see how they have been adapted in other cases to run on solar energy. These pumps are found mostly in developing countries where common methods of obtaining electricity are difficult but solar energy is readily available. After analyzing these water pumps and how they are adapted to run off of solar energy, we can get a better understanding on how to modify Burnside Fountain to run off of solar energy.

2.4.1 Photovoltaic Water Pumps in Developing Countries

Solar power water pumps have become a staple in most developing countries. These pumps are used frequently in these areas because most of their residents are not "on the grid." This means that they do not have access to the energy supplied by their country (Hahn, 2002). Without electricity these citizens have to rely on only hand pumps or gas powered pumps that are easily broken and require abundant amounts of fuel (Hahn, 2002). With more than 1.1 billion people unable to access clean water, filtration systems with solar powered water pumps were thought of as a way to supply these people with clean water (Oldach, Short, 2002).

Photovoltaic pumps are usually the pump of choice because they are able to generate free electricity. They are readily used in areas that obtain a high amount of sunlight throughout the day (Hauat-Elias, 1988). These cases are what we will explore when examining the possibility of running the fountain sustainably.

2.4.2 How Photovoltaic Water Pumps (PVPs) Work

Photovoltaic water pumps get their electricity from the solar panels that collect energy throughout the day. The panels that are used are chosen based off of what they would be surrounded by. Characteristics such as temperature, sun radiation levels, and land elevation influence which panel is used. (Oldach, Short, 2002). The area is usually surveyed to avoid factors that would interfere with the panel receiving direct sunlight such as buildings and plant life.

These pumps are not directly powered with the energy harnessed by the solar panels. First the DC energy collected by the solar panel is converted to AC energy by the controller (Oldach, Short, 2002). The biggest problem with the controller is that with extra parts the chances of malfunction or power loss is possible. After the controller converts the energy from DC to AC it is sent to the battery. This battery is then used to supply the energy to the pump and its motor in order to drain water from the water supply to a reservoir for use (Oldach, Short, 2002). The biggest use of the battery in this system is to supply the pump motor when there is no direct sunlight to charge the battery. This means that during the day the battery is being charged by the solar panel, while providing electricity when needed to the pump. Once solar radiation is no longer available the solar panel and controller part of the pumping systems are no longer in use. Instead the charge that the battery has been storing over the day is used to directly power the pump until the time comes where there is more solar radiation to collect.

2.4.3 Drawback of PVPs

One of the biggest drawbacks of PVPs is the initial installation cost of the photovoltaic cells and the pumping system. The installation cost of a PVP system is about three times more expensive than the installation cost of a diesel pump with the same efficiency (Hahn, 2002). Even though the PVP system has over three times the initial cost, over time the PVP pays for itself. The diesel system needs constant fossil fuels, while the PVP generates energy free of cost.

This constant need for fossil fuel causes the diesel system to reach a point where its initial cost and operating cost will surpass the PVP system and then continue to increase.

Another drawback to the PVP system is the reliability of the components in the system. Since these PVP systems have so many different working parts there is a lot of room for a breakdown of one or multiple components. The part of the system that seems to have the most problems is the inverter or the controller component of the PVP system. It has been found that the inverter has around an 18% chance of failing, which causes the whole PVP system to shut down (Oldach, Short, 2002). To make matters even worse, once the inverter is broken it is nearly impossible to fix and has to be replaced almost every time, which can be very expensive (Oldach, Short, 2002). One fix to this drawback is to have the motor for the pump run directly from direct current. A DC motor would allow the energy to come in directly from the solar panel to run the pump without having to pass through an inverter. The only problem is that DC motors tend to be more expensive than the standard AC motors.

2.5 Light Emitting Diodes (LEDs)

In our opinion, the addition of light to a fountain greatly increases the visual appearance and attractiveness of the monument. Magic Fountain in Barcelona was in a similar state of disuse as Burnside Fountain. In preparation for the 1992 Olympic Games, the fountain was restored with the addition of a brilliant lightshow. When this lightshow is activated during summer evenings it attracts hundreds of visitors who watch the spectacular display of light and water (Magic Fountain, 2011). The positive feedback that fountains with light shows receive makes it clear that Burnside Fountain would also benefit from the incorporation of lighting.

The previously discussed solar cells are devices which turn light into electrical power. LEDs, however, have the ability to turn this electrical power into light. LEDs provide lighting solutions that are energy efficient and long lasting. Two common types of lighting are incandescent and fluorescent lighting. Fluorescent lighting is efficient, emits excellent color, and uses 75% less energy than incandescent lights. Their lifespan is also ten times as long (RS Means, 2002). LEDs, however, have an average lifespan of about 50,000 hours. This is close to four times that of fluorescent lighting. Compared to traditional incandescent bulbs and fluorescents, LED lighting can save up to 85 percent and 50 percent electricity, respectively

(LED 101, 2011). Further comparison of LEDs, fluorescents, and incandescent lights in greater detail can be found in Table 1.

Feature	Light Emitting Diodes (LEDs)	Incandescent Light Bulbs	Compact Fluorescents (CFLs)
Life Span (# of hours)	50,000-100,000	1,200	8,000
Watts of electricity used (equivalent to 60 watt bulb)	6-8	60	13-15
Kilowatts of Electricity Used per Year (30 Incandescent Bulbs per year equivalent)	329	3285	767
Annual Operating Costs* (30 Incandescent Bulbs per year equivalent)	\$32.85/year	\$328.95/year	\$76.65/year
Sensitivity to low temperatures	None	Some	Yes, may not work out of the range of -10°F-120°F
Durability	Very Durable-can be subjected to bumping and jarring	Not Very Durable-glass and filament can break	Not Very Durable-glass and filament can break
Turns on instantly	Yes	Yes	No
Can be submerged in water	Yes	No	No
*estimate based on national average of electrical cost, actual cost may vary			

Table 1 - Comparative Features of LEDs, Incandescent Bulbs, & Compact Fluorescents (Com11 ,2011).

2.6 Summary

After researching different sustainable options for powering the pump and LED show, we found there are many advantages and disadvantages to each. As of now, polymer solar cells can be ruled out as an option due to their low efficiency which keeps them off the market. Further research and estimates will be needed when working on site to propose the best option. As we research further into these options, various methods and field research will be conducted to reach a conclusive suggestion.

CHAPTER 3: METHODOLOGY

The City of Worcester is seeking to revitalize the downtown area of the Common while simultaneously promoting its goal of becoming a more sustainable city. Burnside Fountain, located on this Common, is similar to downtown Worcester in that it has slowly diminished. The primary objective of this project was to develop a detailed plan for the restoration of the “Turtle Boy” fountain using sustainable power methods. This will add to the aesthetic appeal of Worcester’s Common while also abiding by the city’s plan to become “green.” When going forth with at a total restoration, there are many different aspects to consider in order to restore the fountain to its full potential. A major step involved examining different sustainable methods capable of running the pump and LEDs we proposed for installation. Lastly, we predicted the potential impact a “Turtle Boy” restoration may have and how it can help to improve the view of the downtown area through the eyes of Worcester citizens and tourists.

The importance of this project is rooted in the fact that downtown Worcester is in urgent need of revitalization. Revitalization would bring much needed revenue to the city through various forms of restaurants, businesses and entertainment. Thus, it is important to analyze what types of attractions downtown Worcester lacks in comparison to successful cities similar in size. Improving the quality of the Common is an essential step to revitalizing downtown, and the “Turtle Boy” restoration is a prime example of where improvements can be made. A sustainable power source for Burnside Fountain would lead to a minimal cost of operation for the city and serve as an example for future projects. Additionally, an LED light show would increase the aesthetics in what is currently an unsightly corner of Worcester Common.

Enhancing downtown Worcester is vital to ensure the city’s future economic growth and success. It is important that this success be achieved through methods that preserve Worcester’s historic integrity while also establishing a lively downtown area comparable to other cities similar in size to Worcester. The sustainable restoration of Burnside Fountain is one example of this goal that will be presented in this project.

Method	Purpose
Case Study	To determine what attractions Worcester lacks that would benefit the city's prosperity most.
Fountain Design	To achieve an understanding of how the fountain operates and what steps must be taken to restore the fountain to working order.
Sustainable Energy Research	To know what forms of sustainable energy will be feasible and how they may be implemented in the restoration.
Interviews	To obtain a view on the current condition of downtown Worcester from professionals that have worked in Worcester. Specifically those who have worked with the opinions of Worcester residents
LED Research	To implement LEDs into the fountain in order to increase appeal of the fountain after sundown.
Cost Estimation	To be able to give an accurate estimation for the price each option for restoration presented in the project would cost.
Worcester Polytechnic Institute Student Survey	To understand what college age students want to see implemented and what would attract them to the downtown area.

Table 2 - Summary of Methods.

3.1 Research

The following section elaborates on the methods summarized in Table 2.

3.1.1 Solar Power

Becoming a more sustainable city is a very important goal of Worcester and its residents (City of Worcester, MA, 2006). When we researched the possibility of running the fountain in a sustainable way, the only feasible solution was solar energy. We came to this decision by analyzing the space we had on the common and also the guidelines given to us by Rob Antonelli Jr.

Rob Antonelli Jr. asked us to take into consideration a variety of different things when researching what would be best to power Burnside Fountain. One was to consider how whatever we installed would affect the aesthetic and functionality of the surrounding area. This came to mind when we were considering wind power and possible placements of wind turbines on the Common. Another aspect Rob asked us to be conscious of was price. Ultimately, solar energy was decided to be the best option for what Rob was asking and feasibility in powering the fountain.

After deciding on the use of solar energy we had to determine how we could set up such a system. We first had to research different methods of running the pump using both solar and city electricity. We needed to understand how the pump would run using both types of electricity because we needed to propose not only a fountain that could run off of solar energy but also a backup plan if solar was not feasible. In order to find a solution to how the pump would work we researched a wide range of fountains, which covered both sources of electricity.

Once we found the solution to the pump we needed to determine where and how to place the solar panels on the common in a way that was both functional and aesthetically pleasing. We decided the best placement for these panels would be on the light poles that surround the common. When talking with Rob Antonelli Jr., he informed us that we needed to make sure there were no rules or restriction for placing solar panels on street poles. We spoke with an engineer from inspections services who informed us there were no restriction on the addition of solar panels.

After we found there were no restrictions, we had to determine how to go about attaching the solar panels directly to the poles. This problem led us once again to online research the different methods used to attach the solar panels to street lights. We found a company that sold both solar panels and the mounts we would need to attach them to the light poles. We then researched the price range of photovoltaic systems that were similar in size to the system we hope to install.

Photovoltaic systems tend to have a very large upfront cost that could range in the tens of thousands. We needed to calculate how much money it would cost not only buying all of the different components but also the cost of installing such a system. We researched the average installation cost for a photovoltaic system that was around the same size as ours. This information was not only useful to see if the system would fall in our budget range, but also the amount of time it would take to make a profit. To calculate the payback time of the photovoltaic system we had to research how much solar radiation the panels would collect throughout the year and the cost of electricity in Massachusetts. Once we knew the amount of electricity the solar panels generated, in kilowatts, we were able to calculate the amount of money we would save per year. We did this by simply multiplying the current cost of electricity by the kilowatts we had generated using our photovoltaic system. Once we had this number we were able to calculate the

payback time of the system by dividing the overall cost of the system by the amount saved per year.

3.1.2 Lighting

The addition of an LED lightshow to Burnside Fountain would aesthetically add to the appearance of the historically rich fountain. An illumination of the fountain would also ensure that it could be enjoyed both night and day. Researching LEDs will be important to calculate how much additional solar energy will be required. It will also allow for the proposal of LED locations that will provide an aesthetically appealing fountain after sundown.

3.1.3 Cost Estimation

As with any project, staying under budget is absolutely essential. We researched prices for necessary components as well as their installation in order to provide an accurate estimate for how much a restoration would cost. Since it is anticipated that the fountain will be restored in a sustainable manner, it is not expected that the fountain will have a cost for year round operation other than maintenance.

3.2 Worcester Research

In order to understand more fully the scope of our project, we needed to conduct some background research on the area. This included past events, places, and people that had made changes (whether successful or not) to the area. We also examined archives that showed us what works and does not work for other cities. Our main objectives included researching what was successful for Worcester in the past? What happened that things fell through? What was the public's opinion on the downtown area during these times? It was essential for us to grasp the past so we would not recommend something to the city that had already been tried and failed in the past.

It was also important to analyze research done by others concerning city life, growth and decay and see how it related to Worcester's current situation.

3.2.1 Archival Research

The Worcester Public Library has a plethora of information when it comes to city structure, planning, entertainment, studies on what people enjoy and dislike about cities, as well as what has worked and what has not worked for cities in the past.

Here we found documentation on focus groups held by the City of Worcester in the past which showed three different demographics opinions' on Worcester and the downtown area. This was extremely helpful when analyzing what people would like to see in the downtown area. We found various books such as *The American City: What Works and What Doesn't*, a book that divulges what has worked in all types of cities. This was helpful in pulling information from other midsized cities.

The Worcester Polytechnic Institute Gordon Library also provided us with invaluable information. They have archived not only information on Worcester, but also Burnside Fountain. Our research conducted here revealed the history of the Common, as well as the development of the downtown area.

We also used the Worcester Historical Museum's library as well to find archived documents of newspaper articles dating back decades. From this we found our first images of the fountain actually functioning, articles describing student surveys about the downtown area, as well as information surrounding the face lift the Common received earlier in the decade.

3.2.2 Worcester Polytechnic Institute Student Survey

As we went forward with our research, it became apparent that the opinion we were overlooking was that of the college community. As Worcester boasts 12 colleges and universities, college-age students make up a significant population of Worcester. If we were trying to see what would attract more people to the downtown area, we could not overlook such a large population's opinions. We constructed a survey through a program called SurveyMonkey. From this we were able to construct a ten questions multiple choice and open ended survey on questions concerning the downtown area. We then distributed it to the undergraduate and graduate students at WPI through email. This was done to understand of what college students desire in Worcester. Screen shots of the survey can be seen in Appendix B.

3.2.3 Online Research

Internet searches of online literature and journals proved to be a very useful tool when researching what aspects of a city attracted people and made it a successful location. Utilizing Google Scholar searches as well as Gordon C. Library's online media database, studies concerning what works and what does not work in cities was readily available. Online research was coupled with traditional archival research and case studies to provide Worcester with recommendations for future improvements.

3.3 Interviews

For the social aspect of our project we decided to interview people who have worked in Worcester, either for the media or with historical statues. For these interviews we chose Deborah Packard and Susan Ceccaci of Preservation Worcester, Sherman Whitman of WCRN, and Jim Dempsey who worked for the Telegram and Gazette. The reason we chose these people is because they have had a long standing opinion of Worcester and the downtown area.

Each of these people was chosen for a select reason and they all brought forth something valuable to the project. Deborah Packard and Susan Ceccaci were selected to reveal to us what is important to remember when restoring a historical site. As they have taken part in many historical restorations around the city, they were valuable in telling us what to be cautious of and give us some examples of other restorations.

Sherman Whitman of WCRN has been a local radio personality for years and is located directly on the Common. The station overlooks the corner on which "Turtle Boy" sits. We selected him because he talks with the public everyday about issues surrounding Worcester and he has a good grasp on public views. He has seen many things come and go in Worcester, what has worked and what hasn't worked, and has many ideas as to what Worcester needs.

Jim Dempsey was selected for similar reasons as Sherman Whitman. As a former journalist for the Worcester Telegram and Gazette, he has a good standpoint on what Worcester is all about. He has spoken and written about Worcester for nearly 25 years. He also had an enthusiasm about the Burnside Fountain and had many ideas as to what we could do with the memorial.

During these interviews we asked them questions that ranged from what is your opinion of the Burnside fountain, to what they feel could be done to revitalize the downtown area of

Worcester. We will use their answers to these questions to give recommendations on how to spark new life to Worcester's downtown.

3.4 Case Studies

3.4.1 Providence

Research was conducted into cities of similar size to Worcester that have experienced success in the social and economic fields over the years. Based on proximity, it was decided that Providence, Rhode Island would be our main focus when observing which attractions were most successful. Pictures as well as notes were taken in order to create a comparison between Providence and Worcester. Research into the history of Providence was also performed to gain insight as to what struggles the city encountered and how they were overcome. Incorporating all the facts and knowledge gained from this case study allowed the group to make recommendations that would be beneficial to Worcester's future.

3.4.2 Fountain Design

Because of its size and ease of access, the WPI fountain was exceptional for use as a case study. To give us a firsthand look at how a fountain of this scale functions we contacted WPI Facilities who were able to explain to us how the fountain located on campus functions. Additionally, we examined the reservoirs under the stream of water as well as where and how the drainage, pump, filter, and valves functioned. Facilities provided advice on how to clean the fountain, how long to keep it running as well as how to prevent vandals from disrupting the water. We received a book from them that contain and index of prices, schematics of all the parts of the fountain, how to clean the water, as well as maintenance information. From this we went forward with planning a schematic for the restoration of Burnside Fountain as well as performing supplementary research more specific to the Burnside Fountain.

Our supplementary research started by examining Burnside fountain, taking measurements of height, width, depth of various areas of the fountain. This included pipe width, length, basin diameter, the various collecting pools depth and volume. Using our measurements we were able to calculate the volume of water the fountain could hold. Using information gained from our case study about how pumping systems work within a fountain enabled us to recommend a pump that could meet the fountain's water supply needs. An understanding of

what type of pump was required also provided the information needed to calculate how much energy must be provided to the pump as well as any additional components that needed to be purchased. An essential component was an underground station to house the pump, filter, and other utilities. The sizes of the proposed components for the Burnside Fountain were similar in size to that of our case study. Using a map of underground utilities on the common obtained from Worcester Parks and Recreation, a safe location for the underground station could be chosen.

CHAPTER 4: RESULTS AND DISCUSSION/ANALYSIS

Implementing our methods, we were able to find a great deal of useful information and data to aid in the completion of this project. The following chapter presents our findings in both research on the fountain and our research on revitalizing Worcester.

4.1 Fountain Research

4.1.1 Solar Power

We first explored different types of photovoltaic cells, or solar panels, which could be used on the common in order to power the different components of the fountain. After performing research on the Internet to determine what types of cells would be feasible, we found a website that contained both the panels and the mounts needed. To power the fountain we decided to use 80 watt (2'x4') solar panels that would be mounted to street lights using Iron Ridge pole mounts.

After choosing both the pump and lights we found the total power consumption of the fountain to be 560 watts/hour without the LEDs and 600 watts/hour with the LEDs. Once we determined that the fountain would be consuming a range of 560 to 600 watts/hour, it was agreed that eight solar panels would be needed to power the fountain. Eight solar panels were decided upon based on the budget for the project and the limited amount of space on the common to place these panels. The overall cost of the photovoltaic system would be around \$11,417. This price takes into consideration the cost for the solar panels, mounts, batteries, inverter, and installation cost; the calculations can be found in Appendix H.

One problem encountered was the fact that the solar panels themselves would not collect enough sunlight every hour to supply enough energy to the fountain. The solar panels would generally only collect around 512 watts every hour, while the energy consumption of the fountain would be 48 to 98 watts higher. We decided that the fountain would have to be run using both city electricity and the electricity generated by the solar panels. During the morning hours the fountain would be run using only city electricity, while the energy collected from solar panels would be charging the batteries. Once the batteries were charged to full capacity, the fountain would begin to run off of both the electricity generated from the solar panels and

supplemented by electricity stored in the batteries. After sunset, the fountain and LEDs would run solely off of the energy stored in the batteries throughout the day.

After some calculation, found in Appendix H, we determined the photovoltaic system would generate around 6.65 kW of electricity per day. With the current price of electricity at 14.71 cents/kWh, a savings of about \$ 0.98 would be seen each day (Compare Electric Rates in Massachusetts, 2012). This would add up to a total savings of only \$130/year if the fountain begins running in April and is shutdown in September.

4.1.2 Lighting

Our initial idea for installing LED lights was to place them in the four draining basins in order to light up the water troughs at night. After speaking with Rob Antonelli, he informed us that we would not be able to drill into the granite of the fountain. Once we received this information we had to devise an alternative method to securely, yet attractively, illuminate the fountain at night. The solution to this problem was found when researching different types of LED lights on various lighting websites. It was decided that the most feasible option would be to place four LED lights in the garden area in front of the monument. These LEDs would light the fountain from the bottom up at night, allowing people to enjoy the fountain during the evening hours. The LEDs themselves would only have an energy consumption of 10-15 watts each and consume a negligible amount of energy stored throughout the day in the batteries.

4.1.3 Cost Estimation

To ensure the restoration remained under budget, we had to compile a cost estimation to see how much money would be spent on the different components of the project. We calculated cost estimation with and without the photovoltaic system. These prices were all placed neatly in tables that can be seen below.

For our project the copper tubing we chose was 2” type L piping, which cost \$12.89/ft (Copper Tube Price Sheet, 2011). We chose this type of piping because it is a thicker, more durable pipe commonly used for outdoor projects. Once we chose the type of piping, we determined the average cost for installing the pipe. We researched online to find the average national hourly cost for a contractor, which ranged from around \$10.00/hour to \$30.00/hour. We determined that \$30.14/hour would be a sufficient estimate for the labor needed on this project

because of the expertise needed to perform the work (Plumber Cost per Hour, 2010). We estimated that the time for installation would be eight hours a day for seven days. These two estimates give a rough figure of the cost to restore the fountain to working order.

Aside from the installation prices of the fountain and the photovoltaic system, a design cost and contingency cost were also factored in. The design cost was 15% of the total cost, which covers having a licensed professional create stamped engineering documents required for the restoration. After the design cost was added to the total, there was a 15% contingency cost added on as well. This cost serves as a buffer should unforeseen costs arise during the execution of the project. We added a miscellaneous cost of \$15,000 to take into consideration fluctuating prices of rental equipment and other services associated with water and electrical utilities that cannot be known until the project commences.

Cost for Restoration (with PV system)		
Component	Number Needed	Price (\$)
Pump/Filter (Pentair-Clean and Clear, 2011)	1	355
Sharp 80W (Large Solar Panels, 2011)	8	3040
Iron Ridge Mount (Solar Panel Racks, 2011)	4	740
12V/105 AH Battery (MK 8A31DT Sealed AGM Batt, 2012)	4	1030.64
Samlex 12V Inverter (Samlex 12V Sinewave Inverter, 2010)	1	205.85
RGB In-Ground LED (RGB Color Changing In-Ground LED, 2012)	3	240
Installation PV-\$10.00/W (Installed Cost of Solar Photovoltaic Systems, 2011)	640 watts	6400
Piping-\$13.00/ft (Copper Tube Price Sheet, 2011)	40 feet	520
Installation Piping-\$34.00/hour (Plumber Cost Per Hour, 2010)	56 hours	1904
Miscellaneous		15000
Contingency	15%	4415
Design Price	15%	5078
Total		38928

Table 3 - Price for the restoration (photovoltaic system included).

Cost for Restoration (without PV system)		
Component	Number Needed	Price (\$)
Pump/Filter (Pentair-Clean and Clear, 2011)	1	355
RGB In-Ground LED (RGB Color Changing In-Ground LED, 2012)	3	240
Piping-13.00/ft (Copper Tube Price Sheet, 2011)	40 Feet	520
Installation Piping-34.00/hour (Plumber Cost Per Hour, 2010)	56	1904
Miscellaneous		15000
Contingency	15%	2703
Design Price	15%	3108
Total	23830	

Table 4 - Cost of the project (without the photovoltaic system).

4.1.3 Interview with Deborah Packard and Susan Ceccacci (Preservation Worcester)

On January 26, 2012 we met with Deborah Packard and Susan Ceccacci of Preservation Worcester with the goal of obtaining more information on what is important to consider in a historical restoration. Preservation Worcester is an organization dedicated to the preservation of “structures which are significant to the culture, history, and architecture of the city and to encourage excellence in design in the future” (Preservation of Worcester, About Us).

During this interview, Ms. Packard and Ms. Ceccacci discussed the restoration of various monuments around the city. An important topic of discussion was the Rogers-Kennedy Memorial in Elm Park. They informed us that this particular restoration encountered many difficulties before its completion. The stone at the base of the monument was old, very soft, and fragile. When a stone mason was hired to oversee and restore the stone, the individual was not as experienced as was necessary and did more damage than good to the stone. As a result, financial restraints and time forced the restoration to come to a halt and the monument was covered for years as money was raised to continue the project. Finally, after local funds were raised, the correct staff was hired and the project was completed extremely over budget and well outside the project’s original timeline.

When asked what particular aspects to consider when restoring “Turtle Boy,” Ms. Packard advised us that “you want to conserve it, but you don’t want to just conserve it without having somebody knowledgeable working on it or you can make it worse than it already is” (Packard, 2012).

4.2 Worcester Research

Worcester was not always a city struggling with a slowing economy. In fact, during the early 1900s Worcester produced the most roller skates, ice skates, 90% of the world's auto crank shafts and 75% of the world's bicycle and auto chains (Erskine, 1981). Additionally, the Osgood Bradley Car Company held the title as the largest manufacturer of Railroad Cars in the world.

The effects of the stock market crash in October of 1929 were felt nationwide. Worcester's economy at the time was largely based on banking and industry. As people lost confidence in the banks, they withdrew their money and hoarded it in the form of gold and coins. Growth of the automobile also contributed to the movement of people to small towns surrounding Worcester. Industries that had once played a vital role in the success of the city either relocated or went out of business. A small amount of prosperity was achieved as war waged on in Europe and new orders came in for wartime goods to be manufactured. A steady flow of European immigrants accompanied the flow of orders. "This prosperity was short lived, however, and by 1932 one quarter of Worcester's work force was unemployed" (Erskine, 1981). An increase in car popularity additionally led to the decline of railroad use and in 1958, Union Station was demolished. "Worcester was struggling into the second half of the 20th century, but it was still a 19th-century city in many ways" (Erskine, 1981).

An immense variety of industries is what ultimately contributed to Worcester's survival through depression and World War II. The realization that Worcester was struggling because it was still a 19th-century city began urban renewal. The improvements, which continue even today, consisted of the relocation of streets, highways, railroads and the rebuilding of the city's center. Demolition, in conjunction with slow reconstruction, completely disrupted retail trade in the city. This disruption is noticeable even today as successful retail stores are near impossible to find in downtown Worcester. As it has done for decades, Worcester is pushing through the struggles with help from its wide variety of industry. Currently, there are several hospitals, thirteen private and state colleges, as well as a large array of courts, banks, and insurance firms.

4.2.1 Interview with Jim Dempsey (WPI)

On January 24, 2012, we interviewed James Dempsey, who was an experienced and talented journalist that came to work for WPI. He had been working in Worcester for over twenty years and was once a metro columnist for the Telegram & Gazette of Worcester,

Massachusetts. Thus, he was the ideal person to ask for a professional opinion about revitalizing Worcester.

In the interview, Mr. Dempsey expressed his impression on the Turtle Boy as a beautiful statue with great reputation. A group, who call themselves Turtle Boy Urban Gardeners, started looking after the statue about two years ago. With the effort of these people, Turtle Boy currently symbolizes the hope of people who want to revitalize Worcester.

Mr. Dempsey was not against the idea of bringing the successful aspects from other cities to Worcester but he stressed that one big project would never single-handedly create the steady growth Worcester so badly needs. As an example, he mentioned the rise and fall of the Worcester Common Outlets. He also suggested that Worcester should focus more on making the city a better place to live which would in turn create more opportunities. Smaller projects that appeal to a wider range of demographics would have more of a lasting power than one large “Messiah of a project.” In that way, younger people would not only be interested in visiting Worcester, but perhaps consider establishing their homes and families in the city.

4.2.2 Interview with Sherman Whitman (WCRN)

On February 14, 2012 we met with Sherman Whitman of WCRN to discuss his opinion about how to turn Worcester around. Sherman has lived in Worcester for over twelve years and has the privilege of speaking with the public on a daily basis about issues surrounding Worcester. Thus, he has a good understanding of what Worcester residents would like to see done to improve their city.

In the interview, Mr. Whitman described Worcester as “the city that takes a few steps forward and a step backward” (Whitman, 2012). The Worcester Common Outlets, similarly to our interview with Jim Dempsey, was again the example used to describe Worcester. We also learned one of the reasons that the mall was unpopular was the collection of a parking fee, so some people were inclined to travel to surrounding, newer malls which offered free parking. Nevertheless, he saw the potential of Worcester to grow into a successful and appealing city.

Mr. Whitman found Worcester uncomfortable at first, and it took quite some time for him to call it his home. That discomfort was mainly due Worcester’s reputation, which he feels will take time to change. The crime rate of Worcester is not high compared to other mid-size cities, but the reputation that causes people to view Worcester as a dangerous city. One of the ways to

change that mindset, he suggested, would be for the city to attract college students by bringing various businesses, restaurants and activities to the city and downtown in particular. Improving public transportation was also important to Sherman given the fact that schools are spread out across Worcester and providing both residents and students convenience would be key.

Performing these changes would help create a good image for the city, which is important if there is to be any hope of attracting newcomers and keeping locals. Another reason would be to provide incentive to students graduating from local universities to begin their careers in Worcester. By bringing those “new bloods” to Worcester, the overall attitude of people towards the city, along with the reputation of the city, would be gradually improved.

When asked for his opinion concerning the restoration of Turtle Boy, Mr. Whitman said that the fountain was once a major attraction of the Worcester Common and that he is a major proponent for its restoration. With the radio station located directly across the street from the Burnside Fountain, he was able to share multiple accounts of tourists witnessing the fountain for the first time. He felt strongly that it was an excellent attraction and a restoration would really benefit the Common.

4.2.3 Worcester Polytechnic Institute Student Survey

When analyzing the results from our survey we were able to collect different student opinions on downtown Worcester. Right from the start, out of 508 responses, we found that 52% of students rarely visit the downtown area (1-2 times/month), while 33% said they never visit the area. The survey also revealed that many students did not even know where the downtown area was located. This was alarming because many of these students have been living in Worcester for months or even years.

We were able to see that the students’ main concerns with downtown Worcester are the lack of activities, poor accessibility, and the overall safety of the area. Many students would like to see more of a night life in downtown Worcester. A large amount also stated they would like to see more bars and clubs that were not only 21+ but also more 18+ clubs for younger college students. Students were hoping for better public transportation to and from these attractions. A few commented suggesting buses that run from the colleges to the downtown area every couple of hours.

The final and biggest problem most college students have with the downtown area is the overall safety. About half of the students surveyed, 45.3%, answered that what keeps them from visiting more often is a feeling of unease while walking the streets of Worcester's downtown. We observed this problem again when we asked students for any last comments. Even the students who enjoyed the restaurants and bars located downtown commented that they do not feel safe walking in the area. If new bars and restaurants are brought to downtown Worcester the lack of security could still deter many students from visiting. Full analysis of each survey question is available in Appendix J.

4.3 Case Studies

4.3.1 Providence, R.I.

“At the beginning of the 1970s, Providence was much reduced from its peak years” (RISD Museum, 2013). City leaders recognized the need for private-public investment plans in order breathe new life into Providence. Their valiant efforts resulted in the restoration of historic downtown buildings, revitalization of Community centers and parks, and refurbishment of historic neighborhoods. In the 1990s investments paid off in the form of a new sports arena, convention center, appealing waterways, a train station, hotels, a large shopping mall, performing arts venues, and a variety of new restaurants. The success experienced by Providence in spite of early hardships and size made it the ideal city to study as the group searched for what other cities possessed that could make Worcester vibrant and prosperous.

The group traveled to Providence to achieve a first-hand view of what made the city successful. Upon arrival to our destination, one factor became immediately clear. An extensive parking garage as well as signs directing us to numerous others made it obvious that visitors could find parking with ease. Had parking not been so accessible, the trip could have been made troublesome before even exploring the city. The parking garage was attached to the Providence Place Mall, which proved to be yet another one of the city's big attractions. Although it was early afternoon, the mall was bustling with people shopping and enjoying lunch at its restaurants. Exiting the mall, we found ourselves facing an elegant scenery consisting of high end condos, sky scraping hotels, and countless restaurants all lining the waterfront of an attractively restored canal.

Navigating the city was also made easy and enjoyable by the presence of a visitor center located a short walk from the Providence Mall. Here, a friendly representative directed us to different fountains and monuments around the downtown area. Our group was also provided with maps that added to the simplicity of our visit. We followed the map to a nearby fountain and public ice skating rink where vandal proof lights were observed. Along this short walk, however, an enormous yet appealing office building caught our attention. A sign indicated the company was GTECH, a leading gaming technology and services company, and the office building served as its worldwide headquarters. In *The American City: What Works, and What Doesn't*, Alexander Garvin lists financing and entrepreneurship as two key ingredients to a successful city. Large companies stationed in cities provide an excellent source of tax revenue which can in turn finance projects. Entrepreneurs are equally important in the fact that they find opportunities where larger companies may not be willing to take a risk.

Ultimately, the most important aspect of Providence that the group observed was cohesiveness. There was no single factor that allowed the city to prosper. The restaurants, lodging, entertainment, businesses and accessibility all working together as a unit is made the city what it is today.

4.3.2 Fountain Design

When deciding upon the final design of the fountain, we made two assumptions:

1. The base of the fountain was hollow.
2. Most or the entire original plumbing system (pipes, pump, filter, valves) would have to be replaced.

Going on these assumptions, we were free to design a rough schematic on where the major components of the fountain were to be placed and wired into existing water and electrical lines.

Using the information we obtained from Gary Weagle, Mike Lane, David Lindberg, and Alan Carlsen of WPI Facilities was extraordinarily helpful in deciding upon what would be necessary to restore Burnside Fountain. We decided on the following major parts. A full parts list is available in Appendix E-G.

- 3/4 horsepower pump (Appendix E)
- 75 gpm (gallons/minute) Filter (Appendix E)
- 6ft x 6ft x 6ft utility storage container (Appendix F)

CHAPTER 5: CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusion of Fountain Research

Many important factors will be involved in restoring the historic Burnside Fountain to working order. Dealing with a piece of Worcester's history reinforced the fact that our conclusions had to be well researched and thoroughly planned. We concluded that Worcester Common would benefit from the fountain restoration which would serve as a focal point for the dull and lackluster space.

5.2 Recommendations for Burnside Fountain

Following our research, we have provided our recommendations for the technical aspects of the fountain restoration.

5.2.1 Solar Recommendations

The use of solar panels as a source of clean, sustainable power to the fountain would save the City of Worcester \$130 a year. At this rate of savings, profit would not be generated by the system until approximately 88 years after installation. On average, solar panels have a life span of about 25 years (The Cost of Solar Panels, 2012). This would mean replacing the panels at least three times before the savings matched the project's cost, assuming no other components failed during the 88 years. This assumption leads to another major issue with using solar power which is dependability.

We performed calculations with the understanding that the installed solar panels would generate 512 watts every hour. This wattage, however, is only achieved in ideal conditions. Cloud coverage or shade from trees, both inevitable, would be detrimental to the generated power. As a result, a greater amount of electricity would have to be purchased from the city; increasing the time it would take for the system to generate profit from the already immense payback period. The combination of these factors constitute our decision to advise against the use of solar panels in the fountain restoration.

Despite the long payback period, it is understood that the City of Worcester may want to still incorporate the use of solar panels into their design in order to keep "Worcester on a course

towards a sustainable future” (City of Worcester, MA, 2006). In this case, the sustainable restoration would serve as an example for future projects wishing to abide by Worcester’s advancement towards becoming “green.” Should the city decide to move forth with the solar panel solution, it is recommended that eight solar panels be mounted at least ten feet above ground on the light poles running along Franklin Street. Figure 5 below shows how the light poles may look like after the solar panels have been mounted. Specifications for the panel and mounts can be found in Appendix F. The use of solar panels requires an inverter and four batteries which are also detailed in Appendix F. The location of these two components will be specified in the schematic. The panels should be angled at 15.80 degrees from the horizontal and face south in order to achieve the highest levels of sunlight and therefore perform at the greatest efficiency (Optimum Tilt of Solar Panels, 2012). A schedule for recommended times of operation can be found in Appendix I.



Figure 4: Visualization of solar panels on the light poles along Franklin Street.

5.2.2 Fountain Recommendations

A system similar to that of an above ground pool is recommended for providing water to the Burnside Fountain. The pump and filter listed in Appendix E will effectively transport water that is safe for human interaction to the fountain. The underground station will house the pump, filter, batteries, and inverter. An in-depth view of the substation is located in Appendix K, Sheet 1 of 2. Additionally, the recommended location of the station in relation to the Common as well as the location of various components of the system is shown and labeled in the schematic (Appendix K).

Restoring the surfaces of both the bronze statue as well as the pink granite is of equal importance when preserving the Burnside Fountain for years to come. Oxidation over a long period of time has turned the brown bronze to green and the porous granite base needs to be sealed. With the 100th Anniversary of the fountain approaching, high levels of corrosion are to be expected. When dealing with historic pieces of art, however, it is vital that extreme caution be taken when performing treatments on the sculpture and granite. We acquired the Proposal for the Conservation of The Burnside Fountain which contains the results of a condition assessment performed by the company Daedalus, Inc. in January of 1995. A significant statement found in this proposal read, “The conservators of Daedalus, Inc. are pledged to perform all work in accordance with The Code of Ethics and Standards of Practice of The American Institute for Conservation of Artistic and Historic Works [AIC].” The AIC is a committee formed in 1961 that is dedicated to combining art and science to save historical treasures for years to come (About Us, AIC). Because the assessment is over ten years old, we recommend that Daedalus, Inc. or another qualified conservator willing to abide by the AIC’s Code of Ethics and Standards of Practice reassesses the monument’s condition.

5.2.3 Lighting Recommendations

We propose that four color-changing, in-ground LED lights be placed at the front base of the Burnside Fountain to provide attractive illumination during night hours of operation. To prevent vandalism, it is also recommended that these lights be installed in a small concrete slab. To supplement the in-ground lights we propose that the two existing floodlights

surrounding the fountain be exchanged for spotlights to provide an additional source of lighting to parts of the statue that would not be illuminated by the base LEDs. After sunset, these lighting techniques would create an attractive focal point on the Common for pedestrians and people driving past the fountain.

5.3 Conclusion of Worcester Research

Worcester, like other cities, has had its share of ups and downs. There are many studies and literature on both the success and failures of the “American city.” From researching what does work and what has not worked in the past for other mid-sized cities, we were able to make observations and conclusions about Worcester’s current status.

Worcester has both light and dark in its recent history. The downtown area has tried many strategies over the last 30 years. One strategy was renovation of the Common by removing a large fountain and reflecting pool and replacing it with grassy area. Walkways, benches, and lighting were also replaced throughout the entire Common. Overall, the goal was to make the Common an attractive lunch area for those who worked in close proximity (Jacobs, 1961). What was the start of a great idea, eventually gave way to the very lackluster common that it is today, void of people and life.

We concluded through interviews at WCRN that one of the greatest challenges Worcester faces is its reputation. People tend to accept the negative aspects of Worcester, and there is no lack of negative media or reporting on its shortcomings. This has a very damaging effect on visitor’s opinions and an even greater effect on whether or not people would consider living in Worcester. Safety concerns have always been an issue when one thinks about Worcester, regardless of whether accusations are true or not.

An additional problem we observed that has arisen in other cities is generalization. When planning a city, the people that will be using the area are rarely taken into consideration. The people surrounding an area in a city is the greatest variable in the success and failure of projects implemented in a city. A great example of this can be found in Philadelphia. In this city there are four equidistant squares with identical features. Surrounding the squares are four identical housing complexes. Naturally, four drastically different populations of people moved into these housing complexes. No two squares were used in the same way and their use depended on their

surroundings. Uses ranged from a gathering place for the homeless to an abandoned area that is pleasant scenery to drive by (Jacobs, 1961).

A major project in Worcester that failed was the Worcester Common Outlets, originally opened as the Worcester Central Galleria. This mall began as a successful venture and drew people into Worcester from all over. The mall contained high end outlet stores such as Saks Fifth Avenue Off Fifth and Lord and Taylor's. This success was short-lived however. Over time, the outlets that were featured in the mall slowly lost attraction for both Worcester residents and visitors alike. People were more drawn to the Wrentham Premium Outlets, a short forty minute drive from Worcester in Wrentham, MA. The mall lost more and more foot traffic and it was officially closed in April of 2006.

One of the biggest mistakes made with this mall was overlooking the category of people that would be shopping at the outlets. Worcester is an extremely diverse city and has cultures of all kinds. The mall only catered to one demographic and when that demographic was attracted elsewhere, such as the Greendale Mall, the Wrentham Outlets or the Providence Place Mall, there was no one left to keep the mall successful because it appealed to so few others. Planners accounted for the selection of people they were trying to attract to Worcester, but overestimated the staying power of the outlets. We concluded that a recurring theme in the success and failure of projects in Worcester has been the overlooking of public opinion and failing to cater to the desires of its residents. This trend was also observed by Jim Dempsey of WPI, formerly of the Worcester Telegram and Gazette.

5.4 Recommendations for Worcester, MA

Worcester is an urban location with many quirks and its uniqueness is why there is so much potential to transform the region into a great city. From our research, observations, and results we provided recommendations for how to make Worcester lively, attractive, and the city it was meant to be.

5.4.1 City Projects

Over the years Worcester has made an effort to “rescue” the city with various projects (Jim Dempsey). Examples, as stated earlier, include the Worcester Common Outlets. From our research we have deduced that when considering future projects in a city as diverse as Worcester,

there are special considerations to take into account. As stated articulately by Jim Dempsey, “what a city should be doing is making it a great place to live for the people that live there. I think that’s where you start. Then if you make an interesting place, people will come here.”

We strongly recommend reaching out to multiple demographics so that Worcester can have lasting interest for both those who currently live here and potential newcomers. Worcester is currently working on the City Square project, a large scale renovation that includes the demolition of the Common Outlets, the implementation of high-scale, loft living quarters, a parking garage, restaurants and entertainment areas. One concern that should be kept in mind is to whom do the restaurants, entertainment and shops proposed in this project appeal to? This project should make it a high priority to implement components that appeal to a broad range of people.

Another consideration are the businesses that are currently rooted in the surrounding areas in order to ensure success into the future. Taking into account what will be adjacent to the City Square project is major for the success of the project and overall success in Worcester. Implementing shops and restaurants that would create competition for surrounding businesses is dangerous to the revitalization of the area. One of the effects the Common Outlets had on Worcester is that they caused neighboring businesses that were previously successful to close due to competition from the Outlets. Then, when the Outlets failed, there were no businesses left to keep foot traffic in the area.

Essentially, our biggest recommendation would be to evaluate the effect of a proposed project on the city as a whole. Much like Providence, all of the parts have to work together for the city to be successful. One large scale project that is planned without taking into consideration its audience and how it will work with the rest of Worcester will not, and has not worked in the past. Moving forward, Worcester must focus on smaller projects that work towards a common goal of making the city a wonderful place to live for its current residents.

5.4.2 Highlighting the History

We have discovered that Worcester has a fascinating history, much of which is not common knowledge. We believe the city’s history is one of its greatest strengths. Throughout our research, new and interesting facts emerged that we had not previously known, especially in our trips to the Worcester Historical Museum. In our interview with Sherman Whitman, he

informed us that it took time for him to “call Worcester his own,” and that he is really proud of the history of Worcester.

We recommend that Worcester highlight its rich and unique history. Erecting plaques and signs that divulge the stories behind prominent Worcester landmarks and monuments would greatly improve the experience of walking through downtown Worcester. This would be extremely beneficial to implement in front of Burnside Fountain as well. We believe that the history we uncovered in Section 2.2.2 History of Burnside Fountain is definitely worth telling and will only increase “Turtle Boy’s” popularity.

Although some monuments already possess signs detailing their stories, the foot traffic around them is minimal. This can be changed by implementing a Worcester Historical Tour. Currently, there is a “car tour” available for the Canal District, but nothing for the downtown area. A tour of this magnitude could bring more people to the area, and if successful, reveal to visitors and residents alike the fascinating history behind this city.

5.4.3 Events

There have been many successful events in the downtown area. In the recent past, there have been a series of events and concerts on the Common that have brought “hoards of people” to the area as recounted by Jim Dempsey. Such events include the Latin Festival, Movies on the Common presented by Worcester Film Works, and the “Out to Lunch” concert series. In the past, there has also been ice skating during the winter months. Events like these are key to attracting residents to the Common and the downtown area (Jim Dempsey).

Holding annual and year round events will slowly improve upon the reputation of Worcester as well. People that have preconceived concerns with the safety of the Common would have the opportunity to see that the Common is a safer place than they originally thought. It is our hope that the more time people spend in the downtown area at these events, the more comfortable they will be with frequently visiting the area.

Of course, our recommendation would be to heighten security around the area during these events. Media and press coverage tend to highlight the negative side of Worcester which has given the downtown area a bad reputation. Holding safe events can get Worcester positive media coverage and start to improve Worcester’s reputation.

5.4.4 Reaching Out

In our discussion with Sherman Whitman, he analyzed Worcester's current situation and stated that a reputation is a hard thing to change: it takes time. He stressed that working on the reputation from within Worcester is the best place to start. He believed that the best way to revive the city would be to implement aspects that would attract college students to the downtown area. If the students' opinions concerning Worcester can be made positive, they will be more likely to stay in Worcester after graduation, whether it would be to live or work. High numbers of college students in Worcester creates a constant flow of students into the city. Impressing these students and providing them with a positive outlook will increase the chances of creating vibrant, young population and allow city's reputation to slowly improve overtime.

From the results of our survey, we are able to make recommendations as to how Worcester can attract more college students to visit the downtown area. Some of these include:

- More restaurants and bars on and around Main St. More specifically, roughly 60% of the comments included requests for restaurants with student discounts and/or easy access.
- More night life activities. These included both 18+ and 21+ bars and clubs.
- Easy accessibility and well lit sidewalks at night.
- More events, concerts, and activities on the Common. More specifically, events targeted at college aged students. We recommend possible collaboration between the city and the Worcester Consortium.
- Information. Many students did not even know where downtown Worcester was and requested more information on what is happening around Worcester. We again recommend collaborating with the Worcester Consortium.
- Increased police enforcement of loitering and suspicious activity.

We recommend the implementation of a public relations campaign to benefit Worcester greatly. The more that people, including students in the Consortium, know about events in Worcester, the more people will get involved and support the downtown area.

5.4.5 Accessibility

From our research and the survey sent out to WPI students, accessibility and parking in downtown Worcester is a concern for the success of any future projects the city has planned. According to our online research, pedestrians are only willing to walk an average of 1,500 feet to their destination. Outside of that range, they look for other means of transportation. This should be taken into consideration when planning new attractions downtown (Leinberger, 2005).

Our recommendations for parking include either improving the availability of public parking or reducing the price of parking in public garages. One of Providence's greatest strengths was the availability of parking.

5.5 Conclusion

Overall, the revitalization of downtown Worcester would be extremely beneficial for the city's current and future residents. The collaboration of everyone in the city, from officials to business owners to project planners, is essential for a positive future.

The restoration of Burnside Fountain can be an excellent start to the revitalization of the Common and from there, working outward, revive the entire downtown area. Every project begins somewhere, and the restoration of "Turtle Boy" can be the symbol of hope that Worcester needs.

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APPENDIX A

Description of Sponsoring Agencies

Parks and Recreations Department-Robert Antonelli Jr.

The mission of the Parks, Recreation & Cemetery Division is to provide operations, programs and maintenance relative to parks, recreation, cemetery, forestry and building maintenance (Parks, Recreation & Cemetery, 2012).

They provide ground maintenance for over sixty parks and playgrounds, cemeteries, and the maintenance and repair of public buildings. We worked closely with Robert Antonelli Jr., the Assistant Commissioner to complete this project.

City Council-Kate Toomey

Kate Toomey of the Worcester City Council is very enthusiastic about the history, culture, and dynamic of Worcester. She is currently serving her sixth year as City Councilor at Large, and she has high hopes when it comes to the revitalization of downtown Worcester. She has wanted to revitalize Burnside Fountain for many years now and is very committed to seeing the project to fruition.

APPENDIX B

Interview Discussion Points

1. Are you a resident of Worcester and if so for how long? If no, how long have you been working in Worcester?
2. What are your thoughts on the current state/situation of the Common/ downtown Worcester?

- a. What do you foresee for the future of the Common/downtown Worcester?

In your professional opinion, what do you feel would be key in drawing more people to the Common?

What do you think is holding Worcester back from being as lively and successful as other mid-sized cities such as Providence and Hartford?

Do you feel that revitalizing the Common would have an effect on downtown Worcester? If so, in what ways?

Are you familiar with Burnside Fountain? If so, what are your thoughts on a possible restoration of “Turtle Boy?”

- . What do you think are the benefits and downfalls of the idea?
 - a. Do you think it would be worthwhile?
 - b. Do you feel it would make an impact on the revitalization of the Common?

Is there anything else you would like to add?

APPENDIX C

Interview Consent Form

I agree to participate in one tape-recorded interview for a study about revitalizing Worcester Common. I understand I will be asked about my personal and professional opinions (concerning the Common). I understand that I do not have to answer any questions I choose not to answer. I understand that any excerpts taken from this interview, written or spoken, will only be used for this study alone. I understand that I will not receive feedback on my interview. I understand that at the end of this study, the audiotapes will be kept in the privacy of the researcher's archives for future reference if needed. I understand should I feel like discontinuing the interview for any reasons we may do so at any time.

If you have questions about the study at any time, contact:
Burnsidefountain@wpi.edu

x Debra Packard
Susan Mearns @ccca

Interview Consent Form

I agree to participate in one tape-recorded interview for a study about revitalizing Worcester Common. I understand I will be asked about my personal and professional opinions (concerning the Common). I understand that I do not have to answer any questions I choose not to answer. I understand that any excerpts taken from this interview, written or spoken, will only be used for this study alone. I understand that I will not receive feedback on my interview. I understand that at the end of this study, the audiotapes will be kept in the privacy of the researcher's archives for future reference if needed. I understand should I feel like discontinuing the interview for any reasons we may do so at any time.

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Burnsidefountain@wpi.edu

x J. Duffey

APPENDIX D

Interview Consent Form

I agree to participate in one tape-recorded interview for a study about revitalizing Worcester Common. I understand I will be asked about my personal and professional opinions (concerning the Common). I understand that I do not have to answer any questions I choose not to answer. I understand that any excerpts taken from this interview, written or spoken, will only be used for this study alone. I understand that I will not receive feedback on my interview. I understand that at the end of this study, the audiotapes will be kept in the privacy of the researcher's archives for future reference if needed. I understand should I feel like discontinuing the interview for any reasons we may do so at any time.

If you have questions about the study at any time, contact:
Burnsidefountain@wpi.edu

X  Sherman K. Zlotman

APPENDIX E

Fountain Pump and Filter



Figure 5

<http://www.pentairpool.com/pdfs/cleanclearagsysdynoptDS.pdf>

APPENDIX F

Photovoltaic System Components

Solar Panel

Sharp 80W NE-80EJEA



<http://www.solarpanelstore.com/solar-power.large-solar-panels.sharp.80ejea.info.1.html>

Figure 6

Mount

Iron Ridge UNI-SP02A



http://www.solarpanelstore.com/solar-power.racks.universal_spm.sp02.info.1.html

Figure 7

Inverter

Samlex 12V Sinewave Inverter, 600W-1000W Surge - Pst-60S-12A



<http://www.solarhome.org/samlexpstseries600wपुर esinewaveinverter12vdc120vac.aspx>

Figure 8

Battery

MK 8A31DT SEALED AGM BATT 12V/105 AH@20 HR



Figure 9

[http://www.solarhome.org/deka12v86amphourgelb
attery-1.aspx](http://www.solarhome.org/deka12v86amphourgelbattery-1.aspx)

APPENDIX G

LEDs

RGB Color Changing In-Ground LED Landscaping Lights



Figure 10

<http://www.theledlight.com/In-ground-LED-Lights.html>

APPENDIX H

Solar Calculations

Cost and Power Consumption		
Component	Quantity	Price (\$)
Sharp 80W (PV) (Large Solar Panels, 2011)	8	3040
Iron Ridge (Mount) (Solar Panel Racks, 2011)	4	740
12V/105 AH (Battery) (MK 8A31DT Sealed AGM Batt, 2012)	4	1031
Samlex 12V Inverter (Samlex 12V Sinewave Inverter, 2010)	1	206
Installation PV (\$10.00/W) (Installed Cost of Solar Photovoltaic Systems, 2011)	--	6400
Total Cost (\$)		11417

Table 5 – Total cost of the photovoltaic system. The installation cost was found using an average of \$10.00 per watt for systems that are under 2kW.

Energy Needed (Watts)	
Amount of power generated per hour	512
Charge on battery after 9 hours	4608
Watts needed to run at night	4200
PV energy needed	2240
PV energy generated	2048
Difference	192

Table 6 – Amount of energy generated by the photovoltaic system per day.

APPENDIX I

Schedule for pump

Energy Needed Throughout Day (Watts)					
Time	Part of Day	Energy Needed	Energy from PV for Fountain	Energy from Grid For Fountain	Energy from Batteries
6:00 - 15:00	Fountain Start-Up Run off City Electricity. Charge Batteries	560	0	560	0
15:00 – 19:00	Run off PV and Batteries	560	512	0	48
19:00 – 2:00	Run off Batteries	600	0	0	600
2:00 – 6:00	Shutdown for the night	0	0	0	0

Table 7 – Proposed schedule for running the fountain.

APPENDIX J

Full Analysis of WPI Student Survey

Out of 508 Participants

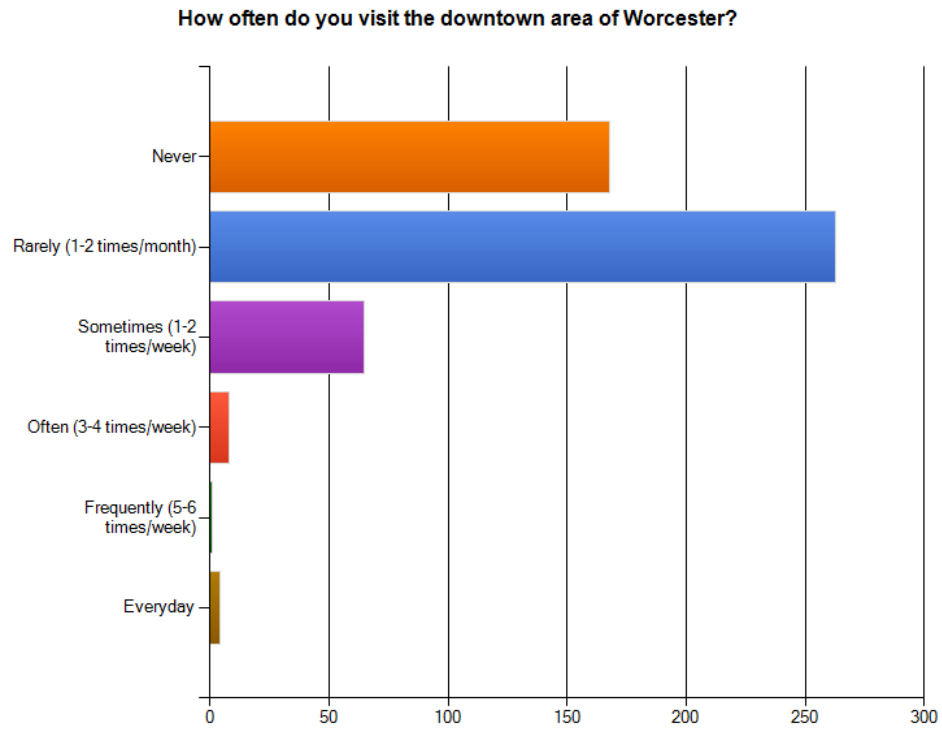


Figure 11 – Survey Question 1

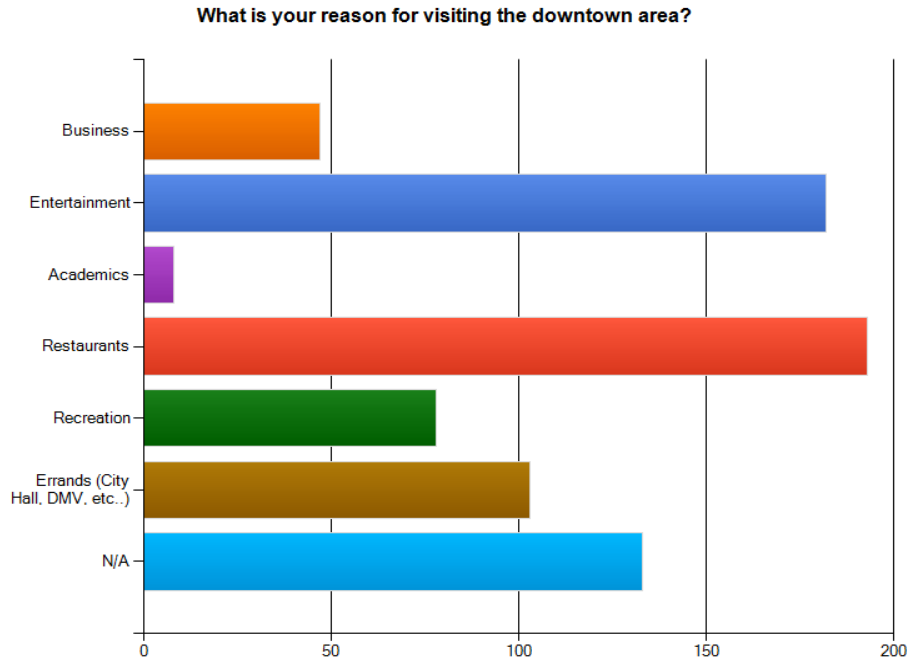


Figure 12 – Survey Question 2

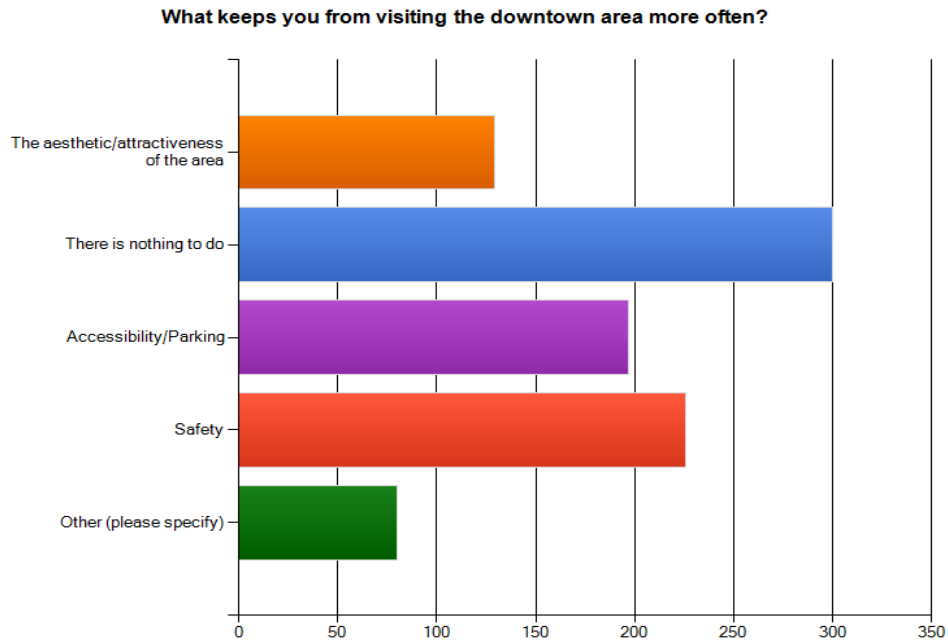


Figure 13 – Survey Question 3

If the downtown area had more events (shows, concerts, etc.) would you be more likely to visit the area?

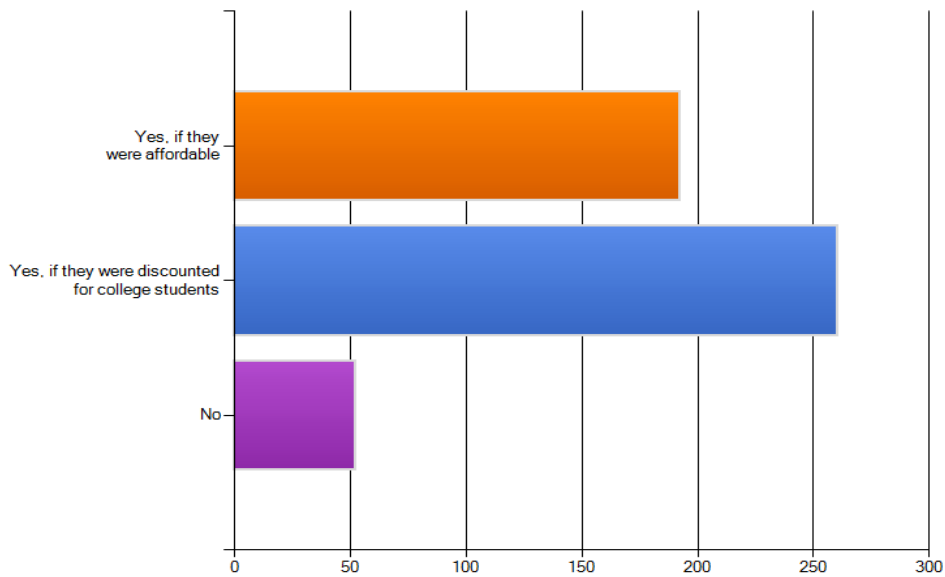


Figure 14 – Survey Question 4

Are you familiar with the Burnside Fountain, a.k.a. "Turtle Boy" located on Worcester Common?

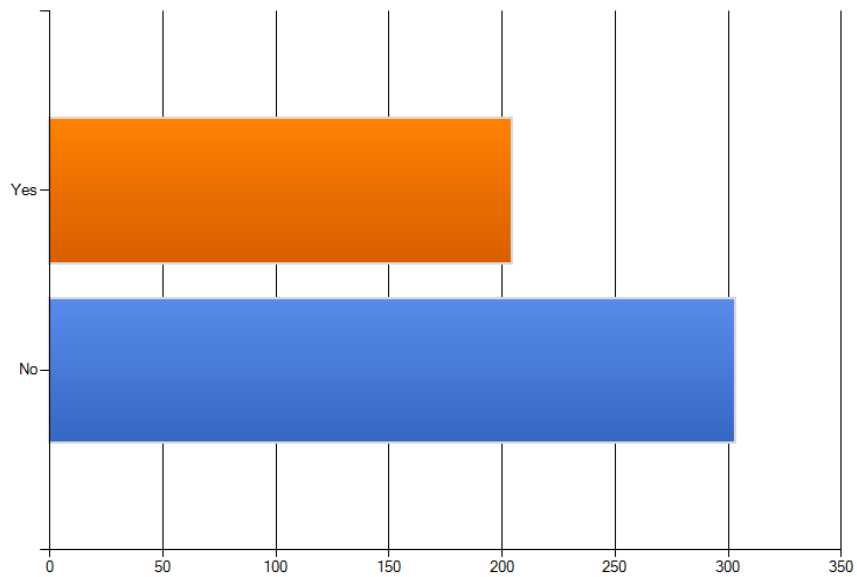


Figure 15 – Survey Question 5

Do you believe that a restoration of Burnside Fountain would improve the appeal of the downtown area?

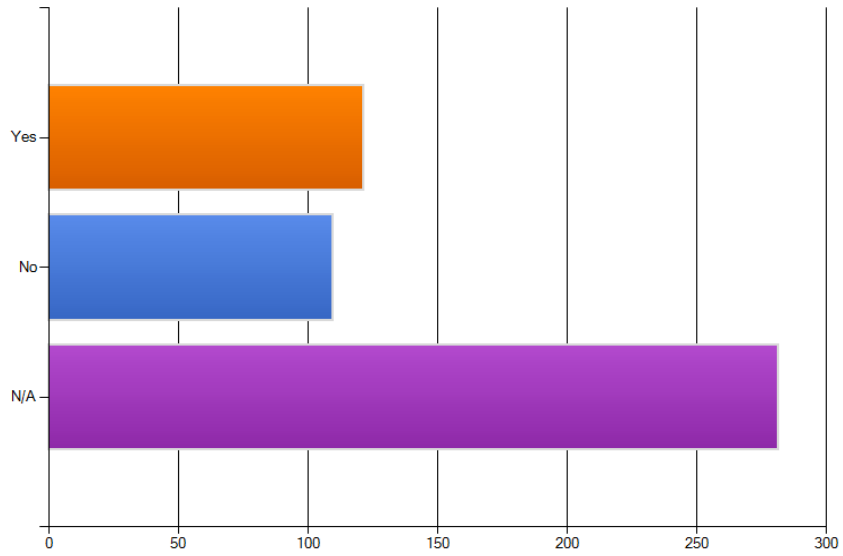


Figure 16 – Survey Question 6

What would you like to see in the downtown area?

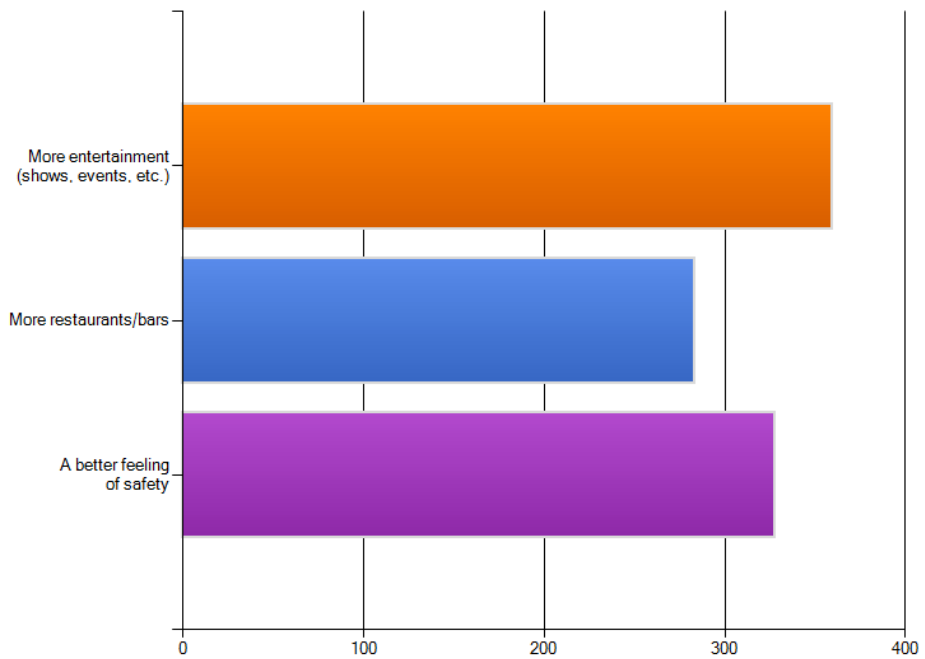


Figure 17 – Survey Question 7

APPENDIX K

Fountain Schematic

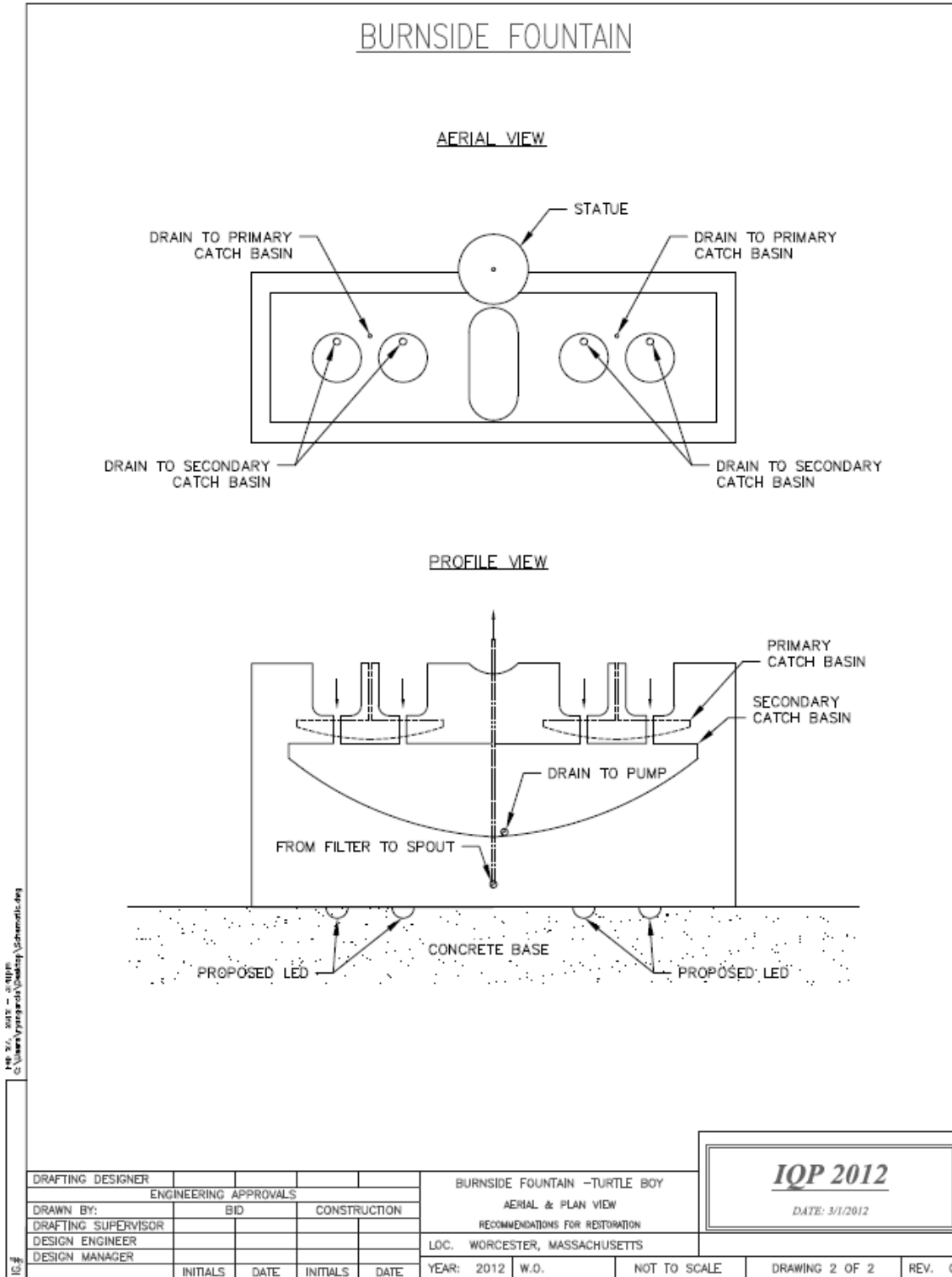


Figure 18 – Profile and Aerial View of the Fountain.

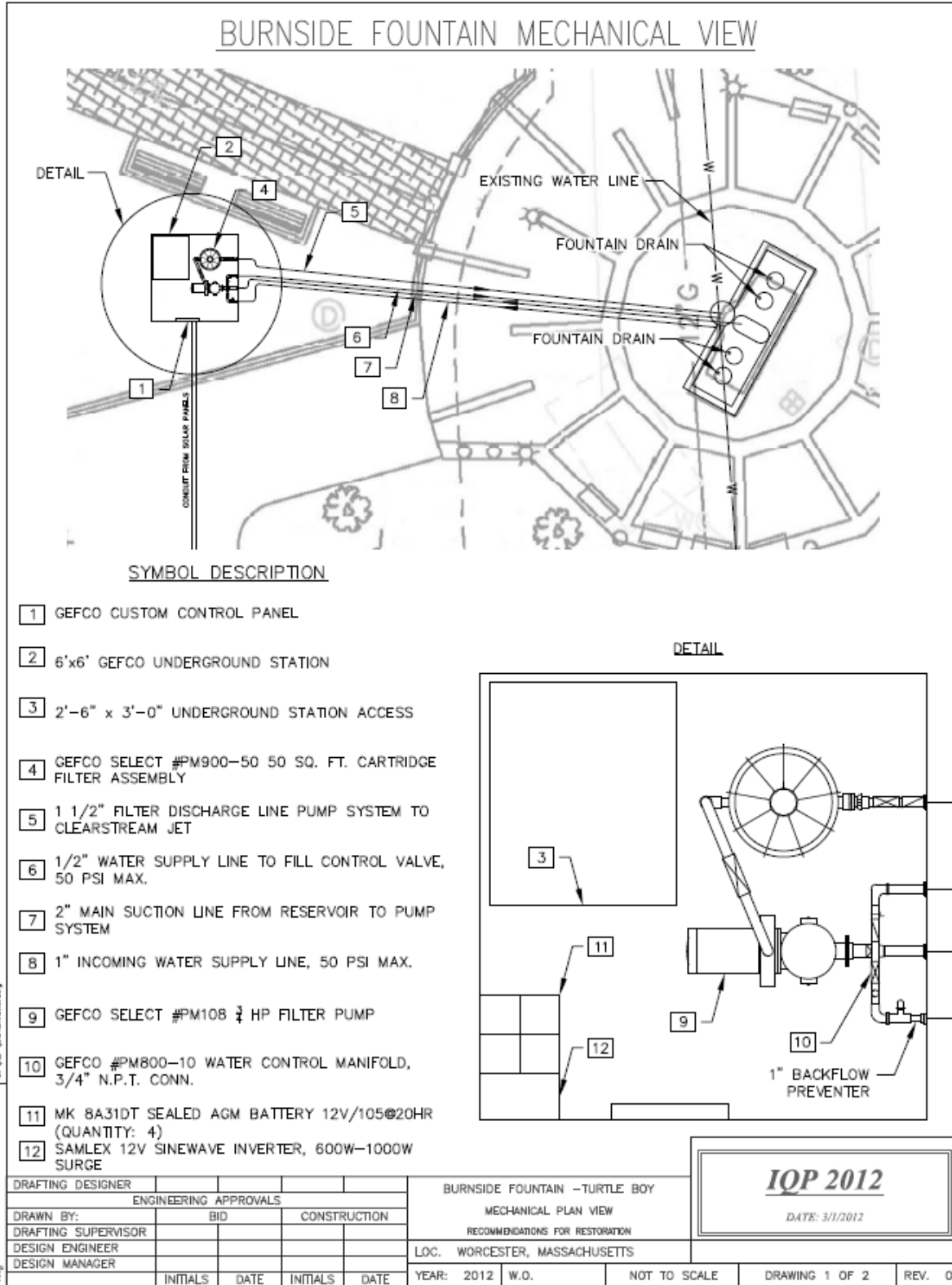



Figure 19 – Schematic of the Burnside Fountain.

APPENDIX L

Underground Housing Unit



Georgia Fountain Company, Inc.

**GEFCO SELECT Model
ST Series Vault Systems**

DESCRIPTION

The GEFCO #ST-Series Underground Stations provide a structurally sound and watertight housing for pumping systems. There are several different standard size units available. The Station is used when it is desired to locate the pumping system underground and in close proximity to the fountain rather than in a mechanical room far away or if lease able space can not be sacrificed. All mechanical and electrical controls are pre-installed, pre-wired and pre-valved inside the station. All penetrations through the walls will be made, water-proofed, and provided with stub outs ready for accepting pipe and electrical conduit for runs to and from the fountain.

These units can also be used for other equipment requirements such as lift stations, electrical distributions centers, telephone exchange centers, cable tv amplifier stations and booster pump stations to name a few applications.

The Station is accessed through a 2'- 6" x 3'- 0" opening located topside which is covered with a single leaf, spring loaded hatch. Depending on the actual location of the station, three styles of hatches are available. If the station is to be buried in a landscape area, covered with topsoil, a GEFCO Select #ST801 Landscape hatch is favorable. Should the station be buried in a plaza or a walkway where pedestrian traffic is expected over the station, a GEFCO Select #ST802 Tile Set hatch would be desirable. The third type of hatch is a GEFCO Select #ST803 checker plate type. Whichever hatch is chosen, it will be pre-attached to the station prior to shipment.

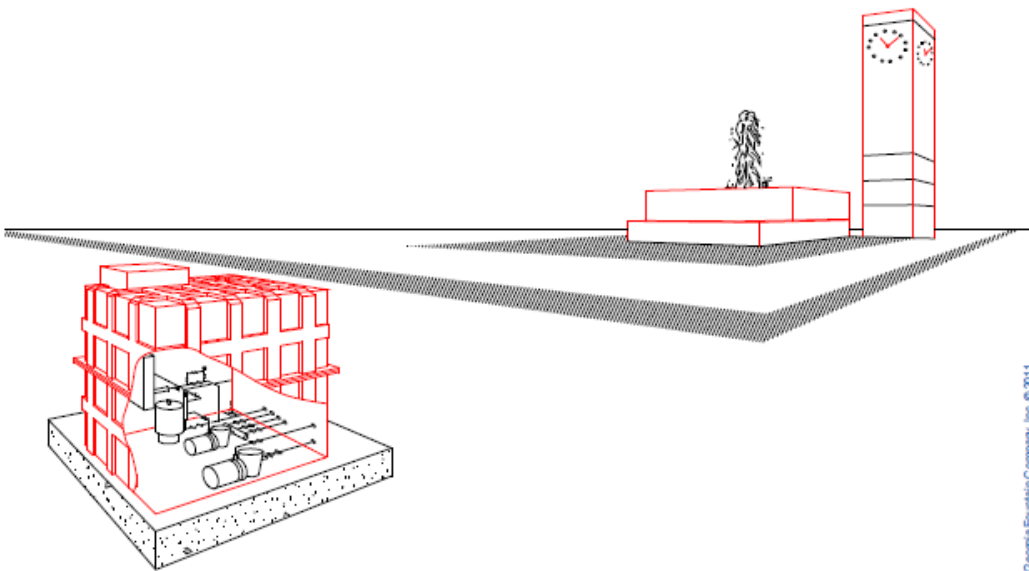
The GEFCO #ST-Series Pump Stations are provided with the basic following equipment pre-installed in the unit:

- 1ea. GEFCO Select #ST810: 8'- 0" 'D'-rung type ladder for entry into station.
- 1ea. GEFCO Select #ST815: wet locations, fluorescent light, 2x40 Watt, 120 Volt.
- 1ea. GEFCO Select #ST820: pre-wired duplex utility outlet.
- 1ea. GEFCO Select #ST702: pre-installed ventilation system consisting of a 1/3 HP vent fan delivering 484 cu.ft./ min. at 25" HG and (2) C.I. vent pipe fittings.
- 1ea. GEFCO Select #PM502-02 Sump Pump Assembly including float switch activated pump, valving, and 1-1/2" outlet through the station wall. The pump shall deliver 34 GPM @ 10 ft. TDH.

In addition, the display, filtration, control panel, and automatic fill systems are installed at the factory with all the associated pumps, valves, mechanical and electrical controls pre-piped and pre-wired as designed for the specific project.

IMPORTANT NOTE:

THESE UNITS ARE NOT RECOMMENDED FOR USE IN AREAS WHERE GROUND WATER CAN NOT BE DRAINED OR WHERE GROUND WATER TABLES ARE WITHIN 8'-0" FROM THE SURFACE AT THE PUMP STATION LOCATION UNLESS THE CONCRETE ENCASED PROCEDURE IS FOLLOWED.



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2513 Royal Place Tucker, GA 30084 USA V: 770.934.3297 F: 770.934.8770 mail:info@georgiafountain.com www.georgiafountain.com

Figure 20 – Housing unit for components.