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Complete Streets: Redesigning Streets to Accommodate the Needs of the People and the Environment

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Complete Streets: Redesigning Streets to Accommodate the Needs of the People and the Environment

A Masters Three Course Option Final Proposal

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Introduction

While automobiles seem to be dominating the streets today, the idea of Complete Streets is to “shift a network of streets from automobile-focused to pedestrian-focused circulation patterns keeping the majority of vehicular traffic on arterials, allowing pockets of local streets to form pedestrian oriented zones” (Sarte, 2010). Unlike the typical street design that is more focused on automobile use, complete streets are designed to take the opposite approach, making significant segments of roadways more pedestrian focused instead. Complete streets are a way of addressing multimodal transportation needs. Other examples of transportation include commuting by bicycle and simply just walking. In addition, complete streets provide other positive benefits from an environmental, public safety, and ecological standpoint. The complete street design is the current way of addressing how street designs can be used for vehicles while also providing multiple benefits (ecosystem services) for both people and the environment.

For my three-course option I have taken two Landscape Architecture courses and one Regional Planning course. I believe that these three courses address my research interests, which include: sustainable transportation, climate change matters, public safety along streets, and the function and benefits of the ecosystem services that may be contributed to the complete street design. These courses are:

- Climate Change Adaptation for Urban Areas, Regional Planning 591LC
- Urban Design Studio, Landscape Architecture 606
- Advanced Topics in Green Infrastructure Performance Monitoring, Landscape Architecture 591K
I believe that these three courses provide opportunities for me to expand on my interests of complete streets and how the environmental quality and climate change, public life, and ecosystem services characteristics contribute to the overall complete street design also planning, and implementation. Each of these three courses will provide a different perspective of the various concepts within the complete street design approach.

I took *Climate Change Adaptation for Urban Areas* (RP 591LC) over the summer of 2015 as an on-line course. This course was taught by Ms. Ana Emlinger (a Regional Planning PhD Candidate). The goal of this course was to develop an understanding of what municipal, regional, state planners, and policymakers need to know about climate change mitigation and adaptation and how to provide leadership to communities in order to develop an effective climate change action plan.

In this course, we also learned strategies on how to adapt to climate change behaviors in the built environment and how to mitigate current challenges. One of the features of the complete street design is to mitigate climate change impacts. Learning also some of the climate change adaptation strategies gave me a better understanding of the benefits of the complete street design with regard to climate change adaptation. Please refer to the section of the report “Climate Adaptation in Urban Areas/RP 591LC” on page 22 for a more detailed explanation.

I took *Advanced Topics in Green Infrastructure Performance Monitoring* (LA 591K) in fall of 2015. Dr. Jack Ahern taught this course. This class was a research seminar where I was able to choose a research topic and then research that topic extensively. The topic that I chose was urban roadsides. The research information that I
gathered from this course was focused on the ecological perspective that complete streets provide. In other words, identifying the functions and benefits of the ecosystem services that contribute to the complete street design. I analyzed the functions of the trees on four different types of roadsides such as rainwater interception and carbon sequestration to determine how much of an impact they provide in an urban environment.

The final project of the course was to develop a visual presentation of a topic to identify the performance benefits that urban roadsides provide and the monitoring that is required to measure ecosystem-service performance. Since my topic is complete streets, the research gathered for the visual presentation provided me with a comprehensive visual understanding of the ecosystem services associated with the complete street design. Please refer to the section of the report “Advanced Topics in Green Infrastructure Performance Monitoring, Landscape Architecture 591K” on page 25 for a more detailed explanation.

I took the *Urban Design Studio* (LA 606) this spring semester. Professor Michael DiPasquale taught this studio. This studio course focuses mostly on a “public life” standpoint and how people view different spaces based on characteristics such as safety, social interactions, and the idea of third place, which is defined as “informal public gathering spaces where people can come together on neutral ground, free of charge, to develop friendships, enjoy conversation, voluntarily interact and enjoy being part of a larger spatial community” (Oldenburg, 1989).

Complete streets are designed to encourage multimodal transportation opportunities like walking and bicycling and to decrease the use of vehicles on the street. This is done by decreasing the area for driving and increasing the space for additional
modes of transportation. Pedestrians are encouraged to have a sense of place in the complete street design instead of feeling excluded from it because it is unsafe due to domination of vehicular use. I believe that this studio gave me an understanding of the values of public life characteristics along streets. Please refer to the section of the report “Urban Design Studio, Landscape Architecture 606” on page 32 for a more detailed explanation.
Research Questions

How do complete streets address environmental qualities such as air, water, urban heat island mitigation, and pedestrian safety?

How can complete streets contribute towards climate change adaptation and mitigation strategies?

How can the functions and benefits of the ecosystem services provided by conventional roadsides be improved with complete streets?

How can one determine how well the ecosystem services on roadsides are performing?

What features of the complete street design contribute to traffic calming and pedestrian safety?
Literature Review

Environmental Quality and Climate Change:

Many planners agree that the next greatest challenge in environmental planning in urban areas around the world is the issue of climate change. It is imperative that scientists, planners, and landscape architects, and other disciplines pay close attention to the effects of climate change before climatic conditions continue to worsen. “Responding to global warming will require an evolutionary step forward in humanity’s ability to plan for and manage its own future. As part of this process, people and societies will need to get better at understanding complex issues” (Wheeler, 2010 cited in Scout and LeGates, 2011). It is expected that our world will become more urbanized therefore, it is important that climate change mitigation and adaptation strategies are implemented in order to best serve future generations and still preserve the natural land in urban areas.

One reason climate change in particular, is such a challenge to mitigate, is the fact that vehicle emissions will continue to worsen, which is a significant factor in air pollution, especially in cities that are densely populated and congested. According to the Environmental Protection Agency, transportation accounted for more than one-third of carbon emissions in 2012 in the United States (EPA, 2015). More people and more vehicles on the road cause challenging traffic issues and ultimately cause higher emissions and pollution. However, there are a number of strategies being considered to reduce or mitigate climate change and improve quality of life for people. An example would include the addition of street trees and other varieties of vegetation to provide shading opportunities, sequestrate carbon emissions from vehicles (Akbari et. al., 2001), and cultural and recreational opportunities (Bolund & Hunhammar, 1999). Planners and
other disciplines have been finding ways to reduce independent driving. One way they have gone about this has been adopting a complete streets plan.

Complete streets is a “newer design of streets that treat all streets with diverse users in mind: drivers, transit riders, pedestrians, bicyclists, as well as older people, children, and people with disabilities” (Sarte, 2010). The complete street design is a way to make streets more sustainable. A “sustainable street design focuses on pedestrian orientation in an attempt to reallocate street space for more enhanced pedestrian and ecological system integration while still providing for the movement of vehicles and goods necessary for modern society” (Sarte, 2010). A sustainable street design helps create streets with multiple uses including “an addition in more walkable areas and bicycle lanes” (Sarte, 2010).

One idea of the complete street design is to accommodate multiple modes of transportation other than vehicular travel. It is a way of encouraging other modes of transportation such as bicycling or walking. The shifting from vehicular travel to non-vehicular travel can make a significant reduction of the amount of carbon sequestration over time. “Walking and bicycling for the shortest trips (less than 1 mile), rather than taking a car, could reduce carbon dioxide emissions--a major greenhouse gas--by 12-22 million tons per year in the US” (Gotschi & Mills, 2008 cited in McCann, 2011).

Actions have been made within the design of a complete street to respond to climate change issues. For example, the design of a complete street has implemented concepts of green urban infrastructure. Green urban infrastructure is the incorporation of natural and hybrid features in the built environment to provide ecosystem services. Examples of green urban infrastructure may include street trees or vegetation buffers.
along the street. These features contribute towards a way of “climate change adaptation through reducing air and surface temperature” (Demuzere et. al. 2014).

Urban areas suffer the most from the urban heat island effect because they often/typically have very limited natural and vegetated areas. The urban heat island effect can result in discomfort during the summer months as well as greater energy use for cooling. Unlike vegetated and natural areas, hard surfaces, such as tar and concrete roadways and sidewalks, which make up a significant portion of the urban area surface, absorb the heat from the sun resulting in higher surface temperatures (Demuzere et. al. 2014). Therefore, it is important to recognize that examples of green urban infrastructure such as street trees and other sources of vegetation are recognized because of the benefits they provide towards mitigation of the urban heat island effect.

Another reason why features of green urban infrastructure are used in a complete street design is because they create a sustainable stormwater management system. A sustainable stormwater system is one that will “aim to reduce storm-water runoff and lessen the impact of pavement on the natural environment” (National Complete Streets Coalition, 2008, cited in McCann, 2011). Some examples of features that would contribute to a sustainable stormwater management system would include bioswales, stormwater planters, rain gardens, permeable paving, and street trees. The purpose of having these features is to minimize the time from when the water reaches the ground to when it is collected. By minimizing stormwater runoff less sediments are collected, resulting in less total runoff, and greater quality of the water, which may allow it to be reused or recycled in some manner.
Public Safety:

Pedestrian fatalities are extremely common along roads. In fact, “56% of pedestrian fatalities take place on roads” (Ernst & Shoup, 2009 cited in McCann, 2011). Surveys have been conducted to help identify reasons why people choose not to walk or bike more in cities and results have shown that “in many U.S. cities cars are the overwhelmingly predominant means of travel because these cities lack convenient transit systems, bicycle lanes connecting to the commercial and recreational centers, and comprehensive sidewalk networks” (Sarte 2010).

Additional studies have been done to find out why pedestrian use of streets is such a challenge. “For example, almost 40% of Americans over the age of 50 say their neighborhoods lack adequate sidewalks” and “55% report inadequate bike lanes or paths” (Lynott & McCann, 2009 cited in McCann, 2011). Due to the unsafe conditions, people are often discouraged from using other means of transportation other than their own vehicle.

To reconfigure how streets should be designed, Fred Dock worked to develop the concept of complete streets, emphasizing how important it is to focus on the idea of safety within the complete street design. The idea of pedestrian safety was often not taken into consideration before the idea of complete streets was developed. He concluded that while streets that are wider and have faster speed limits seem more convenient it “separate[s] streets from land uses adjacent to them and marginalized pedestrians, bicycles, and transit, modes that is necessary for sustainable urbanism” (Greenberg & Dock, 2003 cited in S. T. Guidebook, 2008).
Automobile to be the primary mode of transportation (Cullingworth & Caves, 2003), but integrating alternative modes of transportation such as walking and biking is a way to design cities for people’s safety. Complete streets offer a wide range of opportunities for people at all ages to feel comfortable and safe along the street. These opportunities that may be included in the complete street design include: “narrower lanes, safer intersection designs, curb extensions and median crosswalks (to shorten crossing distances), bike lanes (to give bikes the same treatment as cars), wider sidewalks and street trees…” (US EPA, 2008 cited in S. T. Guidebook, 2008). Illustrations of these concepts are shown below.

To maximize the level of pedestrian safety, complete streets use traffic calming techniques. Traffic calming is the idea of “reducing the space or changing the geometry
where vehicles can travel” (Sarte, 2010). An example would be a curvilinear road design where the speed of traffic varies. Other features that may be used in a complete street design that encourage traffic calming include road narrowing. This is the idea that “creating features that take up a portion of the shoulder or parking lane can make the road appear narrower” (Sarte, 2010). This encourages drivers to slow down with perceived tighter road space.

Another strategy to slow down traffic is by implementing a woonerf. The general design of a woonerf may include “joint utilization of space by man and vehicle while freeing man from the danger of vehicle accident; use of road space not simply for traffic flow but also as living space; planned allocation of parking spaces for efficient utilization of land; and creation of a better landscape through vigorous planting and gardening efforts” (Ichikawa et. al., 1984). This design, which was developed in the Netherlands “involves removing traditional street elements like lanes, curbs, and road signs. This encourages drivers to be more aware of the people and buildings around them and creates a space that is safely shared by pedestrians, cyclists, and vehicles” (Sarte, 2010). An illustration of a woonerf is shown below.
**Ecosystem Services:**

The term ecosystem services is currently a common term that is used by planners, landscape architects, urban foresters, and many other disciplines when planning and designing for a sustainable environment. Ecosystem services are defined as “the benefits human populations derive, directly or indirectly, from ecosystem functions” (Costanza et. al., 1997). “Ecosystem services are classified as provisioning, regulatory, supporting, and cultural services.” (United Nations Millennium Ecosystem Assessment, 2005 cited in Ahern, 2010). For instance, “examples of ecosystem services related to water resources include: drinking water (provisioning), flood protection (regulatory), and recreational and aesthetic benefits (cultural)” (Ahern, 2010). Planners, landscape architects, urban foresters, and other disciplines thrive to create a sustainable environment, which is entailed of three components: environmental, economical, and social aspects (Kloepffer, 2008). Therefore, it is important that ecosystem services are highly recognized while planning and designing for a sustainable environment because they provide functions and benefits to each of these three pillars of sustainability.

Ecosystem services reduce several of the environmental issues that our world is currently facing. Some of these include issues from transportation and flooding from heavy rainfall events. The function and benefits that ecosystems provide can help mitigate or reduce these harmful effects that have been and are continuing to get worse. As emissions from transportation and as flooding rates continue to increase it is important that ecosystem services are recognized to create a more sustainable community.

Transportation causes a substantial amount of carbon emissions into the atmosphere. As mentioned earlier, the release of carbon emissions into the atmosphere is
a large contributor to the issue of air pollution. However, studies have shown that vegetation can increase the quality of air and decrease the amount of carbon emissions that are released into the atmosphere. The reason behind this is that vegetation filters carbon emissions and particulates from the air (Bolund & Hunnammar, 1999).

The more vegetation there is in an area generally means that there are less carbon emissions being released into the atmosphere. A park, for example, is generally made up vegetation such as trees and other various plant species. Therefore, the functions and benefits from the ecosystem services are greater than where there is less vegetation. For example, “Bernatzky (1983) reported that up to 85% of air pollution in a park can be filtered out” (Bolund & Hunnammar, 1999). A similar study showed that “trees of the Chicago region have been estimated to remove some 5,500 tons of air pollutants” over the course of a year (McPherson et. al., 1992). This ecosystem service that reduce carbon emissions is known as carbon storage or carbon sequestration where the plants are absorbing and taking in these air pollutants before they are released in to the atmosphere. These issues arise the most in the built environment where vegetation is limited because of the dominance of man-made features including roads and buildings.

Another issue that typically occurs in the built environment is flooding. A main reason to this is because of the hard paved surfaces and the lacking vegetated surfaces. The reason this why this is, is because these surfaces do not infiltrate rainwater. In other words, they are known as impervious surfaces. The majority of the built environment is made up of these impervious surfaces, so “a higher proportion of rainfall becomes surface-water run-off which results in increased peak flood discharges and degraded water quality through the pick-up of e.g. urban street pollutants” (Haughton & Hunter,
Vegetation reduces these issues. Vegetation is made of surfaces that allow the rainwater to infiltrate or seep in to the ground. These surfaces are known as pervious surfaces. “In vegetated areas only 5–15% of the rainwater runs off the ground, with the rest evaporating or infiltrating in to the ground” (Bernatzky, 1983 cited in Bolund & Hunhammar, 1999). Therefore, flooding and runoff quantities are significantly less as compared to vegetated-free areas. This ecosystem service is known as rainwater drainage.

Additionally, trees and other plantings intercept rainfall. This means that these plantings capture rainfall before it reaches the ground. This also reduces the runoff rates and so flooding rates are reduces as well. In fact, a one large tree over the course of a year can intercept 760 gallons of rainfall in its crown, thereby reducing runoff of polluted stormwater and flooding (McPherson et. al., 1992). This ecosystem service is known as rainfall interception, which as noted earlier provides many similar functions and benefits as rainwater drainage.

Ecosystem services provide economic benefits as well. In other words, ecosystem services provide several cost benefits. “They contribute significantly to human welfare, both directly and indirectly, and therefore represent a significant portion of the total economic value of the planet” (Costanza, et. al., 1997 cited in Bolund & Hunhammar, 1999). Several studies have been done to demonstrate the functions and benefits from ecosystem services that provide economic benefits.

Some benefits include a reduction of energy usage used to cool a building. During the summertime when it is hot, air conditioning is often utilized. One of the benefits of trees is shading and so the temperatures under trees are generally cooler than their
surrounding areas without trees. Studies have shown that a single large tree abutting a house can “[save] $29 in summertime air conditioning by shading the building and cooling the air (250 kWh), about 9% of a typical residential building’s total annual air conditioning cost” (McPherson et. al., 1992). Additionally, a study in California showed that a total of, “177 million urban trees are estimated save 6,400 GWh in annual electricity use for air conditioning” (McPherson, 2006 citied in McPherson & Simpson, 2003).

Cities have been increasing the number of trees for reasons like this, to reduce heating and cooling costs. In other words, cities are trying to increase their percentage of tree canopies throughout their entire city. A great example is New York City. The City’s goal is to have a 30% urban tree canopy by the year 2030, “30 by 30” (Grove, et. al., 2006). This ambitious goal requires an additional 12,000 acres of urban tree canopy. The City currently has a 20% urban tree canopy (Grove, et. al., 2006). A similar initiative has been done in Chicago. “In Chicago it has been shown that an increase in tree cover by 10%, or planting about three trees per building lot, could reduce the total energy for heating and cooling by US$50–90 per dwelling unit per year” (McPherson et. al., 1997 citied in Bolund & Hunhammar, 1999). Complete streets have the potential to contribute towards these ambitious urban tree canopy goals.

Ecosystem services also provide social benefits. Adding vegetation in built environments has been highly encouraged by people from various disciplines including therapists and psychologists because it has shown to increase the quality of life to human beings. For example, Botkin & Beveridge (1997) argue that “vegetation is essential to achieving the quality of life that creates a great city and that makes it possible for people
to live a reasonable life within an urban environment” Bolund & Hunhammar, 1999).
This may include therapeutic gardens or areas of plantings where people can simply visit and enjoy the aesthetically pleasing views.

Furthermore, accessibility to green spaces such as parks and areas with natural vegetation can reduce levels of stress and are important, psychologically. They can also increase the rate of recovery from an illness. An example of this was a study on the response of persons put under stress in different environments (Ulrich et al., 1991). “This study showed that when subjects of the experiment were exposed to natural environments the level of stress decreased rapidly, whereas during exposure to the urban environment the stress levels remained high or even increased” (Bolund & Hunhammar, 1999).

Similarly, vegetation that can be viewed from hospital rooms through windows has been also proven to speed recovery rates and so people’s hospital stays are often reduced. In fact, a study on recovery of patients in a hospital showed that patients with rooms facing a park had 10% faster recovery and needed 50% less strong pain-relieving medication compared to patients in rooms facing a building wall (Ulrich, 1984). Because of these benefits that vegetation can provide psychologically, they are valued in places like Stockholm, Sweden. Statically speaking, “more than 90% visit parks at least once during the year, 45% do so every week, and 17% more than three times a week (Stadbyggnadskontoret, 1994 cited in Bolund & Hunhammar, 1999).” Even though places where vegetation is limited, it is important for it can be accessible to anyone because as noted earlier, different environments can be stressful for different people.

When designing a complete street, it is important that the term ecosystem services remains a priority in the street design because of the substantial functions and benefits
they provide. Typically, in an urban setting, natural spaces such as parks often make up a small proportion of the land because urban land is primarily made up of grey infrastructure such as buildings, parking lots, and roads. Although this remains to be the case, it is important that natural elements such as trees and other sources of vegetation are a component in an urban setting.

A great place to have these elements would be along streets. Streets play a crucial role in the city because they serve as interconnected networks throughout the city. As Jane Jacobs once said about a city is that, “the streets and sidewalks are its most vital organ” (Jacobs, 1961). In other words, cities revolve around their streets. Because streets play such a vital role specifically in urban settings, it is important to recognize the functions and benefits provided from ecosystem services from an environmental, economic, and social standpoint and how they can fit in to a complete street design.

Complete streets offer a wide range of opportunities for people other than driving that include walking, bicycling, and a place for social interactions so it essential that the ecosystem services that can be provided in complete street design are incorporated in to the street design as they have been show enhance the overall quality of life.
Literature Review Summary

After reviewing the literature, I have learned that complete streets increase the vibrancy and the overall quality of life of a community from multiple different aspects. To be more precise, the complete street design offers opportunities including mitigation of climate change impacts, provides a wide array of ecosystem services, and increases public safety along streets. These opportunities that the design of a complete street offers have been recognized to provide positive implications on both people and the environment.

Carbon emissions is one of many driving factors that leads to climate change. Because of this, an essential aspect of the complete street design has been to mitigate some of the carbon emissions from vehicles. This is a primary reason why complete streets offer other modes of transportation rather than vehicular travel such as bicycling and walking. By offering these other modes of transportation, it encourages people to commute in ways that do not create carbon emissions, especially for shorter commutes. Another element in a complete street design to reduce carbon emissions is the implementation of vegetation. This is because several studies have shown that vegetation sequesters a portion of the carbon emissions from vehicles, thus resulting in a less amount of carbon emissions released into the atmosphere compared to a street without any sources of vegetation. This is one reason why vegetation is an essential element in a complete street design.

Vegetation provides a handful of benefits other than carbon sequestration. These benefits provided by vegetation are known as ecosystem services. For instance, when it rains vegetation plays a crucial role because vegetation such as street trees allows the
water to infiltrate into their pervious surfaces and it also intercepts rainfall, therefore preventing it from reaching the ground. A reduction of flooding is just one of several ecosystem services that vegetation along streets provides for both people and the environment. This is another why the implementation of vegetation may be an essential component in a complete street design.

Vegetation may also provide a sense of safety that may act as a divider between pedestrians on the side of the street and the vehicles. Public safety is another essential component in a complete street design. We know that one of the main elements of a complete is the idea of multiple modes of transportation. Without incorporating safety implications, it would be hard to encourage modes such as bicycling and walking along the street. This is why vegetation is used in a complete street design from a safety standpoint as well as traffic calming features, to reduce the speed of traffic. By having these features, it does not only allow for pedestrians feel more safe along the street, but it is also serves as an indicator for drivers to be more cautious while driving.

In conclusion, climate change mitigation strategies, ecosystem services, and public safety components in complete street design are essential components that provide several benefits for both people and the environment. Therefore, it is important that people such as planners, architects, and landscape architects are able to understand how these three components take part in a design of a complete street. This is so they are able to explain to community stakeholders to prioritize actions to implement complete streets because of these three components, which are essential elements in their design.
Methodology

Climate Adaptation in Urban Areas/RP 591LC:

This online class was a collaborative class in which students interacted with one another on a weekly basis and had the same structure for each of the six weeks. The class consisted of weekly videos that we watched and discussed, weekly readings with questions to respond to, and other weekly assignments. Some of these assignments were individual and several were group assignments. This climate change course consisted of multiple topics within the subject of climate change including climate mitigation, which is about finding ways and strategies to reduce the rate of long-term climate causes and climate adaptation, which is finding ways and strategies to reduce the impacts of climatic matters such as air pollution and flooding.

I learned throughout this class that establishing both climate change adaptation and mitigation goals is often a collaborative effort, not just an individual one. For long-term success, different groups, across different demographics, with their respective governments must come together to set goals for climate change adaptation and mitigation planning (Adger et. al, 2005).

While I was an intern this past summer with the City of Dallas Planning & Urban Design Department, one of the main lessons that I learned was that a climate change action plan must be a collaborative effort or the plan may not be accepted or used. A collaborative effort must involve active communication. Some work that I did included initiatives on how City staff can effectively communicate a climate change action plan to residents of the City to reduce carbon emissions.
There was one time when I was having a conversation about making a climate change action plan a collaborative effort with one of the Sustainability Coordinators of the City. He was explaining that one of the problems is that residents tend to see climate change as some sort of political agenda that they ignore and thus have no interest in participating by adjusting their lifestyles according to the climate action plan. Issues such as this may repeatedly appear when climate change action plans are addressed. Other reasons why people are unwilling or uncomfortable to participate are because they are afraid to take risks or try something new. For example, people may not feel comfortable reducing independent driving by taking public transportation to work because they may assume that they may not get to work on time or because they are used to taking the same route to work everyday. In order to avoid these issues, it is important that community stakeholders actively communicate issues of climate change in a way that people will change their habits.

Returning to the Climate Adaptation in Urban Areas Course I previously mentioned, one topic we spent a significant amount of time on in this course was exactly how to effectively communicate climate change plans to the public. A major communication challenge is that climate change communicators “fail to create a solid public understanding of the causes of anthropogenic climate change and hence of the potential solutions” (Moser et. al., 2004). Because of this failure to create a solid public understanding, Dr. Moser points out that in most communities in the United States “climate change does not register as a major concern” because for most people it falls under the category of “environmental issues [and] thus automatically assum[es] a lower priority” (Moser et. al., 2004).
Dr. Moser says that in order to overcome this barrier, we need to ask ourselves how can we “increase public understanding of civic engagement with the issue” (Moser et. al., 2004). To prevent this barrier, events such as public workshops have been done to gather insight from community residents. These events educate the local residents, but also give them the opportunity to discuss current climate change issues in that particular community and to help develop “options for adaptation to future threats” (Few et. al., 2007).

Aside from getting community residents involved in climate action plans, the final topic we discussed in this course was **urban resilience**, which when a city has “the capacity to respond to change or disturbance without changing its basic state” (Ahern, 2011 cited in Walker & Salt 2006) **urban vulnerability**, which is when a city does not have “the capacity to respond to change or disturbance without changing its basic state” (Ahern, 2011 cited in Walker & Salt 2006). These are two components that may impact climate change adaption and mitigation plans. When addressing urban resilience and urban vulnerability in a climate action plan or amongst community stakeholders, it is important to identify features that may have a significant impact on these two climate change components and how they contribute to either urban resilience or urban vulnerability.
This Green Infrastructure Research Seminar was a class in which the professor presented a variety of research topics from which we could choose to study. I focused on different urban roadside types and the ecosystem services that they provide, in four distinct components. The four different roadside types that I analyzed were: a major arterial, a minor arterial with no tree setback, a collector, and a local road, all located in Springfield, Massachusetts. Throughout the research I conducted several visits to Springfield to gather information about each type of roadside. In addition, I met with City of Springfield staff members such as the engineers and forestry personnel who were very cooperative and helpful in providing supporting information and data as part of the research.

The first component of this project was to identify what species of trees are associated with each roadside type. I identified sections of each of the roads, which were approximately 500 feet long and shared this information with one of the City forestry staff members. He was able to then provide me the types and numbers of trees that were associated within those sections of each of the road.

The second component of this project was to identify ecosystem services that are associated with the roadsides. I chose to study four types of ecosystem services: air quality, how trees improve the overall air quality; stormwater interception, when tree canopies intercept rainfall before it reaches the ground; carbon sequestration, the process of trees capturing and storing carbon emissions before it is released to the atmosphere; and urban heat island mitigation, when trees cool the ground temperature while at the
same time, pavement and other surface materials absorb solar energy, which increases the surface temperature.

To gather specific information on how well these ecosystem services perform, I used an online software tool called *i-Tree Design*, which “allows anyone to make a simple estimation of the benefits provided by individual trees” (United States Forest Service, 2006). This program enabled me to get an estimation of the amount of carbon sequestration, stormwater interception, and air quality improvement savings based on any given tree type, size, and condition within a 50-year time period for each of the four road types that I studied. The tree information that I used was based on information obtained from the City of Springfield forestry staff person that I met with at the onset of the research.

Urban heat island mitigation was the only ecosystem service that could not be calculated on *i-Tree Design*, however, it is an important ecosystem service in relation to urban roadsides. Therefore, I researched various publications to study the difference between temperatures in areas under trees compared with open areas. Although it is a different level of accuracy than the other three ecosystem services that were calculated using *i-Tree Design*, data found in the literature has shown that air temperatures of grassy areas under trees located in urban areas can be 1.3-2.4°F cooler than in adjacent areas with no tree cover (Souch & Souch, 1993). Similarly, there can be up to a 4-6°F difference in air temperature under mature trees in a suburban neighborhood than in newer developments with new or no trees (McGinn et. al, 1982).

The third component of this project was to research factors that may affect the performance of the ecosystem services. Tree belt space, underground utility
infrastructure, surrounding hardscape, and stormwater infrastructure are four factors that may interfere with the ecosystem performance level that these trees could provide.

Limited tree belt space, the first factor discussed, is detrimental for a tree to provide its full potential benefits. A tree tends to be healthier when there is a larger tree belt because as with a smaller tree belt, the roots are more constricted and there is less rooting space. “If the tree roots have no more room to grow, branches die, twigs do not grow as long, and the tree produces smaller and/or fewer leaves” (Urban, 2008).

Underground utility pipes and cable lines is a second factor that may affect the ecosystem services that roadside trees provide. Tree roots may penetrate into sewer and other underground utility pipes, which can cause damage to both the tree and the piping infrastructure because pipes are not always able to withstand the pressure of the growing root system. When pipelines or cables lines are installed and maintained, it may become necessary to cut and/or remove tree roots and this can have a major negative effect on tree health and ecosystem services.

Surrounding hardscape material is a third factor that may affect the ecosystem services that trees provide. The rooting space of trees intercepts with the pavement causing damage and deterioration. This has the potential to be very costly to repair or maintain. As a result of the damage, they are removed and may not be replaced. In addition, excavation near trees damages their roots. This process may remove some of the required soil and the transport and use of heavy machinery outside of the paved surfaces compacts the soil, which also affects root growth. This has resulted in decline and loss of street trees within the City of Springfield.
Lastly, stormwater infrastructure is a fourth factor that may affect the ecosystem services that trees provide. In Springfield the stormwater that runs along the side of the road runs directly into a catch basin and sewer. The vegetation and trees are separated from the stormwater by the roadside curb that runs along the roads so the stormwater rarely gets absorbed by the trees. Trees need this water, in addition to normal rainfall, as a source of moisture in order to remain healthy. “There is evidence that only one drought episode can be detrimental to tree establishment. Restricted water flow through roots can potentially increase dieback” (Watson, 2009). Altogether, this scenario results in a decrease in nutrients for the trees and increases runoff whereas if the stormwater were to be intercepted by the trees it would supply additional nutrients for the trees. Also, the roots enable increased rainfall infiltration through the soil and store water, which reduces the overland flow.

The fourth component of this research project is how to monitor the ecosystem service performance that these trees provide. For each of the ecosystem services which are: air quality, urban heat island mitigation, stormwater interception, carbon sequestration I chose one monitoring method for each of them.

To monitor air quality, I recommend using an AQM 65 Ambient Air Monitoring Station. One of the primary functions of this device is to monitor air quality along urban roadsides. In order to properly obtain adequate results, one station must be placed in an area where there is a dense tree canopy and another station in an area where there are no trees. This is because the difference in air quality between these two areas is likely to have the greatest difference, thus one could see that the trees have a significant impact on improving the air quality compared with the air quality in areas where there are no trees.
In determining the frequency of monitoring the air quality, I recommend that readings should be taken prior and during all major public events taking place in Springfield, such as the Big E, concerts and sporting events because that is when vehicle emissions will be at a maximum. Once the data is collected from each area, a location where there is a dense tree canopy and an area where there is not, the results could be compared and analyzed to see what the variations in air quality are between the two areas. This will likely prove the greatest benefits with an improvement in air quality in the tree area as compared to the other.

To monitor urban heat island mitigation by street trees, I recommend using a thermometer. Similar to setting up the monitoring system for air quality, a thermometer would be placed on the trunk of a tree and another placed on a pole of some sort in an open area with no trees. The National Weather Service suggests that in order to get the highest level of accuracy of temperature a thermometer should be place four to six feet above ground and “be should be freely exposed to sunshine and wind and not close to or shielded by trees, buildings, or other obstructions” (National Weather Service Instruction, 2014).

I determined that the best time of day to monitor temperature differences is at the hottest time of the day, which is usually around 2:00 pm. In this case, one is likely to get the greatest difference in temperature between the shaded and the non-shaded areas. I recommend monitoring this on a monthly frequency as opposed to daily to obtain the best results over a long period of time, throughout the year.

The third ecosystem service that I chose to monitor was stormwater interception. I recommend using a rain gauge to monitor this. Similar to monitoring the last two
ecosystem services, I opted to place one rain gauge under a tree canopy and another rain gauge in an open area with no trees. Similarly to getting the highest level of accuracy of temperature the National Weather Service suggests that in order to get the highest level of accuracy of rainfall, a rain gauge “should be horizontal and located approximately 3 feet above the ground” (National Weather Service Instruction, 2014). Street trees are good to mitigate urban stormwater because some of the rain never comes down to the ground; it stays on the leaves of the tree and then evaporates directly.

I decided that the best time to monitor this would be when there is roughly one-tenth of an inch of rain because there will be a big difference between levels under the tree compared with levels outside of the tree area. It is important that whoever is collecting this information is paying close attention to the weather forecasts to know the amount of precipitation anticipated and when the rain event will occur. If around one-tenth of an inch is anticipated then it would be appropriate for the rain gauges to be set up before the rainfall event. If a rainfall event is anticipated to be greater than one-tenth of an inch then setting up the rain gauges would not be necessary.

When there is a greater rainfall event there will be less of an effect because the leaves on the trees can only intercept so much water. During greater rain fall events the leaves are not capable of collecting all of the rainwater and so the tree becomes saturated and unable to hold any more water. Furthermore, if the data of rain fall interception between under a tree canopy and not under a tree canopy is compared over time, it will show whether the trees are providing this type of ecosystem service.

The fourth and last ecosystem service that I chose to monitor was carbon sequestration. This would be done using a soil auger. Soil samples would be taken
directly beside the trunk of a tree at different depths to determine the carbon accumulation in the soil and roots over time. Once the soil samples are taken, they would be brought to a lab for an analysis to determine the carbon that is sequestrated by that particular tree (Rowell, 2014). In terms of frequency, it is recommended that soil samples for any given tree should not be taken more than once a year because if it is done more frequently it may damage the tree and negatively impact its health.

Conducting this research using urban roadsides in Springfield, Massachusetts as a test/demonstration area, enabled me to study and learn about many of the ecosystem services that street trees may provide in a community. Urban roadsides and the ecosystem services that they provide is a very important component within the complete street design because of the environmental, ecological, and recreational benefits. Understanding the validity of urban roadsides and how they improve the overall quality of life is essential in understanding the ecosystem services that are provided by the complete street design.
Urban Design Studio, Landscape Architecture 606:

The City of Springfield Planning and Economic Development Department hired the University of Massachusetts Amherst Urban Design Studio to find opportunities to revitalize Page Boulevard, a main street in the East Springfield Neighborhood. The directive given by City of Springfield Planning and Economic Development Department was to find ways and opportunities to develop the neighborhood into a more welcoming and pedestrian-friendly place. The reason why Page Boulevard does not have many opportunities for pedestrians to walk or bicycle is because of the high volume of traffic, the high driving speeds, and the lack of pedestrian space along the street. Due to these present conditions, the City of Springfield Planning and Economic Development Department wanted the students of the Urban Design Studio to come up with proposed design interventions.

Page Boulevard is one of the main corridors in the East Springfield neighborhood. It is an arterial street that is highly utilized by vehicles throughout the day. A reason for this is because it connects to Interstate 291, towards the northeast edge of the neighborhood. Additionally, it is one of the only streets that runs from the northeast to the southwest end of the neighborhood. Because Page Boulevard is a main corridor running through the neighborhood, there is potential to revitalize it into a more pedestrian accessible street. These proposed design interventions were targeted to redesign the street in order for it to be used for multiple modes of transportation including walking and bicycling. In other words, revitalizing Page Boulevard into more of a complete street design. According to the National Association of City Transportation Officials (NACTO) a complete street is defined as a street that is “designed, built and operated to enable safe
access for all users, in that pedestrians, bicyclists, motorists and public transportation users of all ages and abilities are able to safely move along and across the street right-of-way” (NACTO, 2012). However, before we could begin developing proposed design interventions for Page Boulevard research on the neighborhood was needed.

One of the first things we did was speak to several residents of the community during a community engagement event that was run by the East Springfield Neighborhood Council. This event helped us gather insight on how the residents perceived the street. Generally speaking, just about all of them had many negative things to say about Page Boulevard. Some of the main points they mentioned were that drivers drive too fast, they are not cautious towards pedestrians, the Boulevard lacks street trees, and the sidewalks and bus stops are not well maintained.

We also visited the neighborhood several times to analyze it. After hearing what some of the residents had to say about how they perceived the street, it was important for us to get personal experience and an idea of what the character was like along the street in order to develop more holistic designs. In other words, understanding characteristics like the driving conditions, pedestrians’ behavior along the street, how the bus system works with the general traffic conditions would inform our proposed design interventions. Conducting these site visits not only gave us an idea of potential proposed design interventions, but it also gave us a visual understanding of how the residents feel about it based on what they said during the community engagement event.

Once these two things were done we visited the site again to take measurements of the area on Page Boulevard that we were specifically focusing on. We took measurements of the total right-of-way (sidewalk edge to sidewalk edge) lane widths,
sidewalk widths, and the widths of the buffers separating the sidewalk from the street. Taking these measurements gave us an idea of how much space we were allowed to work with to redesign this area of the street in order to allow additional “complete street” elements such as bicycle lanes and vegetated buffers.

Once we collected insight from the community residents, made personal observations and specific measurements, we were then able to begin developing ideas for proposed design interventions. However, the first and most important thing we needed to do before developing proposed design interventions was to look back at what the residents had to say about the current conditions of Page Boulevard. This is because the basis of our proposed design interventions was dependent on the thoughts and views of the residents and their suggestions to what should be added within the street design. We valued the citizen’s comments because these are the people who live here and experience and understand what the current conditions along Page Boulevard were on a day-to-day basis.

To come up with proposed design interventions for this area on Page Boulevard we decided to choose two focus areas at different ends of Page Boulevard in the East Springfield Neighborhood. The first focus area was the intersection of Page Boulevard with Sargon Street and the second focus area was the intersection of Page Boulevard and Haumont Terrace. An aerial map showing Page Boulevard and the two focus areas is shown on the following page.
For each of the focus areas we came up with two proposed design interventions. Scheme A was a modest and less expensive design. It was aimed to be a short-range design solution. Scheme B, on the other hand was the more ambitious. It was a more complex and long-range design. Because of its complexity compared to scheme A, it would also be more expensive. Both schemes were implemented in both focus areas. This is so the City of Springfield could choose from one or the other.

Focus area one, right near the intersection of Page Boulevard and Sargon Street is a four-lane street. However, heading southwest on Page Boulevard, it is unclear whether it is two lanes in each direction or one because the dotted white line identifying the lanes disappears. People tend to use it both ways, depending on the level of traffic and if there are parked cars along the street. Also, the buffers on the street side separating the street
from the sidewalk are not well maintained. They are mostly made up of gravel with some paved surfaces, which contain a lot of potholes. In addition to that, the few bus stops in the area are poorly defined. The only thing that defines them is a very small bus stop sign. There is no designated space on the side of the street where the bus could stop. In this case, when the buses stop it could hold up the traffic, particularly at times when traffic levels are high. This would obviously result in more traffic congestion on Page Boulevard. A sketch of the cross section and the plan view representing the existing conditions is shown below.
For scheme A for this focus area (focus area one) we designed the vehicular travel lanes so the lanes were properly defined with lane markers. There would be two lanes in each direction. We reduced the lane widths from thirteen feet to eleven feet (for both schemes in both focus areas). According to NACTO, eleven feet is the minimum width for vehicular travel lanes (NACTO, 2016) to accommodate all vehicle types. For the right-side lanes we implemented a sharrow, which is the combination of a vehicular lane with a bicycle lane. This would offer bicycling opportunities on Page Boulevard. Please see the sketch on the following page showing the implementations of the sharrows.

For the bus stops we designed bus pull-outs. We were able to contact the Pioneer Valley Transit Authority (PVTA) to find out the standard dimensions to accommodate bus pull-outs. By having bus pull-outs, traffic impacts would be reduced or eliminated. When buses stop to pick or drop off people other vehicles would not need to wait behind them while they are stopped. Also, from a pedestrian safety standpoint, people would feel safer getting on or off the bus because they would not be as close to the vehicular traffic.

To further enhance pedestrian safety along this area of Page Boulevard, instead of having gravel and somewhat paved buffer separating the street and the sidewalk like there are currently, we designed a vegetated buffer with street trees. This way with street trees on these buffers, it provides a sense of safety for pedestrians using the sidewalk because the street trees act as a divider between the people and the street. Street Trees also provide other benefits. One in particular is noise abatement, which reduces the noise created by the traffic making it more pleasant to walk along the street. Not to mention that they were strongly recommended by the community residents. A sketch of the cross section and the plan view for this proposed design intervention is shown below.
Unlike scheme A for focus area one, scheme B is one lane in each direction with a center turn lane. The reason why we designed this was because along Page Boulevard there are several building and store entrances. The idea of a center turn lane would be to minimize traffic when vehicles are trying to make a left-handed turn. These center turn lanes would be well defined for drivers. Not only would they have marked lines on the street, but they would also have a narrow vegetated median acting as a lane divider between the center turn lane and the opposing traffic.

Again, from a pedestrian standpoint, the vegetated buffers would also reduce the crossing distance for pedestrians. The street is over 50 feet wide. On a major street like
Page Boulevard crossing the street may be unsafe and often difficult at times because of the high levels of traffic. These vegetated medians would serve as refuge islands where pedestrians can stop if there is oncoming traffic and therefore they do not have to cross the entire street all at once.

There would also be a vegetated median on both sides of the street separating the driving lanes from the bicycle lane unlike in scheme A. In other words, the vegetated buffer would be between the bicycle lane and driving lane instead of bicycle lane and the sidewalk like in scheme A. This adds a greater sense of safety as compared to scheme A. Cyclist would not need to worry about keeping their distance from the vehicles because they have their own designated bicycle lane separated by this five foot vegetated buffer. The sidewalk would be adjacent to the bicycle lane. Unlike the bicycle lane, which is at street level, the sidewalk would be elevated by about six inches. A sketch of the cross section and the plan view for this proposed design intervention is shown on the following page.
Focus area two, which again is towards the southeast end of the neighborhood, is where Page Boulevard intersects with Haumont Terrace. Unlike focus area one, we specially focused on the intersection. Similarly to the current conditions of focus area one, around this intersection, particularly on Page Boulevard, the street-side buffers separating the street and the sidewalk are not well maintained. They are mostly made up of gravel with some paved surfaces, which contain a lot of potholes. Also, at the intersection, there are curb cuts to store entrances that are right at the intersection, which are prone to cause traffic issues just like the current bus stops in focus area one. A sketch of the plan view representing the existing conditions is shown on the following page.
Scheme A in focus area two is a similar concept to the design concept of scheme A in focus area one. The bicycle lanes would be adjacent to the vehicle lanes. Just like in focus area one, the vehicle lanes would be eleven feet wide. The difference between the bicycle and vehicle lanes compared to focus area one, scheme A was that the bicycle lane did not share the vehicle lane on the right side of the street. There would be lane markers that differentiate the bicycle lane from the vehicular lanes. The bicycle lanes would also be marked in each direction in the intersection with a dotted white line.

Also, just like in focus area one, scheme A, to further enhance pedestrian safety along this area of Page Boulevard we designed a vegetated buffer instead, that would be in-between the bicycle lane and the sidewalk. This way with street trees on these buffers, it would provide a sense of safety for pedestrians using the sidewalk because the street
trees would act as a divider between the people and the street. As mentioned in focus area one, street trees would also help with noise abatement, which again reduces the noise created by the traffic making it more pleasant to walk along the street.

As mentioned before, the curb cuts to building and store entrances are right beside the intersection. This may create traffic issues and also collisions when vehicles are trying to pull into the store front parking lot. To reduce these concerns, we moved the curb cut as far away from the intersection as we could by narrowing it because they were much wider than they needed to be, but they would still be wide enough for any type of vehicle. While we narrowed the curb cuts away from the intersection, we filled in that initial area where the curb cut extended with vegetation including a few street trees. A sketch of the plan view for this proposed design intervention is shown below.
Similarly to focus area two in scheme A, focus area two for scheme B also was designed to have narrower curb cuts, which were further away from the intersection for the same purposes as described above. Also, another similar trait that scheme B would have is that the bicycle lanes would be marked with white dotted lines in each direction in the intersection.

The design for this scheme of the bicycle lane and sidewalk mimics the design from focus area one in scheme B. The vegetated buffer, which is about three feet wide, separates the bicycle lane from the street. The sidewalk is adjacent to the bicycle lane and also is about six inches elevated compared to the bicycle lane.

One distinct feature that this design offers is the paved refuged islands (marked as “X X” in the diagram) on the crosswalks. Just like the center median concept in focus area one, scheme B, these small refuge islands shorten the crossing distance slightly for pedestrians. They also would act as a divider or an extension to the buffer that would be between the bicycle lane and the vehicle lane because it would go out to the crosswalks. To add an additional sense of safety and comfort to walkers and cyclists it may be necessary to have a few bollards on these refuge islands. They may act as a barrier separating pedestrians from the vehicles just like the street trees on the vegetated buffers would.

However, there are two areas in this intersection where these refuge islands would not be placed. The reason behind this is because these two turns are quite sharp. Particularly, this would be an issue for larger vehicles who require a larger turning radius. In other words, if these refuge islands were in these two areas then larger vehicles would have a really difficult time turning. As a result these vehicles may either hit this refuge
island or need to reverse in order to increase their turning radius, which may create traffic congestion and or collisions at the intersection. A sketch of the plan view for this proposed design intervention is shown below.

After visiting the site several times to analyze it gave me an understanding of what the current conditions are along Page Boulevard. As emphasized earlier, our directive given by our client was to come up with proposed design interventions to revitalize this area of Page Boulevard into a safer and pedestrian friendly street that offers multiple modes of transportation. In other words, revitalizing Page Boulevard that offers elements of a complete street.
The process of this studio project gave us an understanding of what a real life situation may be with some of the beginning steps in order for a street to be revitalized into a complete street. Page Boulevard, one of the main corridors running through the neighborhood is currently perceived by the residents as an unsafe and unfriendly place to be. In order to take action to change these existing conditions and perceptions of Page Boulevard, it was important that we took the steps, which included: speaking to the community residents, consistently communicated with stakeholders from the City of Springfield by updating them on our progress, and by doing additional research. Doing all of this helped us generate proposed design interventions for the two focus areas on Page Boulevard in order for Page Boulevard to have elements that a complete street would. These elements, which were included in our proposed design interventions included bicycle lanes and sidewalks, both of which would have street trees and vegetated buffers to provide an additional sense of safety for the walkers and the cyclers.
Conclusion

To fulfill the Master of Regional Planning Degree at the University of Massachusetts Amherst, I chose to do a three-course option to study and understand the theory and practice of complete streets and how they may accommodate the needs for the people and the environment. I strongly believe that the three courses I took, which were: Climate Adaptation in Urban Areas/RP 591LC, Advanced Topics in Green Infrastructure Performance Monitoring, Landscape Architecture 591K, and Urban Design Studio, Landscape Architecture 606 along with the work each of them consisted of gave me a comprehensive understanding in this area of study. This is because each of these three courses allowed me to study and analyze definitions, planning and design implications, and strategies associated with complete streets and the important ecosystem services they provide.

The Climate Adaptation in Urban Areas/RP 591LC course taught me how streets may be designed so they are resilient rather than vulnerable to the changes that result from climate change. For streets to be perceived in this manner, it is important that climate change adaptation and mitigation strategies are incorporated into the street design. I learned in this course streets must have complete street elements in their design to have climate adaptation potential. Some of these elements include roadside vegetation and accommodating additional modes of transportation other than vehicular driving. Both of these elements that are part of the complete street design include some form of the climate change adaptation and mitigation strategies that I learned throughout this course. The accommodation of other modes of transportation rather than vehicular travel reduces
emissions, which is a climate mitigation strategy and the roadside vegetation reduces stormwater flooding and runoff, which is a climate adaptation strategy.

The Advanced Topics in Green Infrastructure Performance Monitoring, Landscape Architecture 591K research seminar taught me the values of street trees in a community and the ecosystem services they provide based on a project I did, in Springfield, Massachusetts. There were two main components in this research project. The first one was using the software *i-Tree Design* to get an estimation of the benefits provided by individual trees. The second main component was to research appropriate tools and methods to measure the ecosystem services performance provided by the street trees. These two main components along with the rest of the data collection, research, and site analyses done throughout this research project taught me the tools and the methods needed in order to assess the ecosystem service benefits and values provided by street trees on different streets regardless of the location.

The Urban Design Studio, Landscape Architecture 606 course gave me a real life, community-engaged experience on how to develop a street into a complete street. Our client, The City of Springfield Planning and Economic Development Department hired our studio to develop proposed design interventions for Page Boulevard, one of the main corridors in the East Springfield neighborhood. Our client had informed us that when these proposed design interventions were completed, they would be reviewed and potential implemented by a consulting team that the City will soon hire. This real life experience allowed me to understand some of the actions needed, which included speaking to community residents to gather their insight on how the residents perceive the street and visiting the site several times for analysis and measurements to be taken in
order for something like this to happen. Although this studio project taught me some of the general steps needed to be done for a project like this, one of the elements that it did not include were the policy implications and how it would impact a project like this.

Although I did not touch on policy implications in my proposal, it is important to acknowledge them because complete street policy implications address issues including safety concerns. Complete Street policies are designed to “ensure that the entire right-of-way is planned, designed, constructed, operated, and maintained to provide safe access for all users” (Smart Growth America, 2016). Safety is one of the top priorities in the complete street design. It is, and will continue to remain as a concern in a complete street design.

If policy implications are not ensured in a complete street design, then complete streets would lack safety elements such as traffic signals and traffic-calming features including raised and well identified crosswalks that are clearly visible for drivers. Cities that are implementing complete street plans are continuing to prioritize in these policy measures to maximize the level of safety in order for all users to feel safe along the street. A great example of this is the recently developed complete streets plans done in Seattle, Washington in 2013. In this complete streets plan there were several policies made, which allowed for several safety components to be part of the street design. Two of which include that there were 21 schools with improved signage and over 50 pedestrian countdown signals added throughout the City (Smart Growth America, 2016). With these policy implications made by community stakeholders such as this one in Seattle, data collections have shown that accident rates decreased from before compared to after these implementations were made. Therefore, it is important to note that as complete street
policies implications are continuing to become more recognized by community stakeholders, it is important that these implications are implemented in a way that maximizes pedestrian safety on the streets.

To refer back to these three courses that I took to fulfill my Master of Regional Planning Degree and the additional research that I have done for this proposal, I now have a comprehensive understanding of several features that may be included in a complete street design. I strongly believe that everything that I learned and obtained in these courses along with the research done for this proposal will set me up well for my future professional work in planning. In addition, I am also confident that the support, guidance, recommendations, and suggestions given by the professors who have helped me throughout this process will also be something I can reflect back on as a professional with the ambition and the desire to be a transportation planner.
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